



**Version 7**  
Suite Compatible

# DownHole SAT<sup>TM</sup>

oilfield brines & mixtures



## DownHole SAT User Manual

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# DownHole SAT<sup>tm</sup>

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## **Why Use DownHole SAT!**

*Indices calculated by DownHole SAT*

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## **WHY USE DownHole SAT®?**

DownHole SAT allows a water treatment chemist to evaluate the scale potential for common scalants over the range of water chemistry, temperature, pressure, pH and pCO<sub>2</sub> anticipated in a surface water, brine, or mixture. DownHole SAT can evaluate the scale potential for common scalants at both the lowest and highest temperatures anticipated, (and at the lowest and highest pH values or pCO<sub>2</sub> expected), and assist in predicting scale problems downhole, or when a water is brought to the surface. DownHole SAT also evaluates mixtures of waters at the ratios, pressures, partial pressures and temperatures you select.

DownHole SAT was developed to allow a water treater to readily evaluate the scale potential for common scalants over the broadest of parameter ranges without the necessity for tedious manual calculations for the Stiff-Davis, Odco-Tomson, Langelier saturation index, Ryznar stability index, or other indices. Even when all of these common indices are available conflicting results can cloud interpretation of what they are foretelling. These indices are also limited to calcium carbonate scale prediction. DownHole SAT provides additional information in the form of indicators of scale for major foulants which are useful, and would be popular, if they weren't so difficult to calculate with a pencil, paper, tables, and a calculator. DownHole SAT allows a water treater to review popular and some less known indicators relatively painlessly to develop a more complete picture of problems, and potential problems anticipated from a water.

DownHole SAT also provides "portable" indices in the form of saturation levels. The saturation levels calculated by the program account for "common ion effects" through a procedure called speciation or ion pairing. This method allows indices to be based upon free ions present rather than total analytical values to provide meaningful common denominators for comparing the scale potential of vastly different water chemistries on as close to an apples to apples basis as possible. The use of ion pairing also allows calculations at very high ionic strength where the association of ions become as important, or more important, than the method used to estimate activity coefficients.

*In summary you should use DownHole SAT to:*

- 1) To develop an overall profile of scale potential for common scalants over the entire range of critical parameters anticipated.*
- 2) To model the scale potential of a formation water as it is brought to the surface.*
- 3) To evaluate the scale potential of mixtures of water under varying ratios, pressures, and temperatures.*
- 4) To quickly review these indicators as water quality changes, or environmental constraints force operation with reduced water quality and increased scale potential.*
- 5) To learn more about the interaction of water chemistry and operating conditions (pH, temperature, partial pressures of gasses, pressure) by using the program as a system simulator.*
- 6) To save time. DownHole SAT can calculate and save the indices you currently calculate by hand, and store the water analyses and calculated indices. In many cases, DownHole SAT allows you to prepare presentation quality graphical profiles in about the same time it would take to manually calculate the Langelier and Stiff-Davis indices. DownHole SAT provides a complete profile for the manpower cost of calculating a few indices using a nomograph or water chemistry slip-stick.*

*Additionally, the R<sub>x</sub> series develops models of inhibitor performance and optimizes treatment program applications.*

## WHAT INDICATORS DOES DownHole SAT® CALCULATE?

DownHole SAT calculates indicators of scale potential for barium sulfate (barite), barium carbonate, (witherite) calcium carbonate, calcium sulfate (anhydrite and gypsum), strontium sulfate (celestite), calcium phosphate (hydroxyapatite and tricalcium phosphate), amorphous iron hydroxide, iron phosphate (strengite), iron carbonate (siderite), amorphous silica, calcium fluoride (fluorite), and magnesium hydroxide (brucite). It also calculates common, simple indices for reference. Simple indices calculated over the range of conditions specified include:

- the most common (Stiff-Davis, Langelier and Ryznar);
- an evolving index (Oddo-Tomson);
- those that have been used by the major water treatment companies but have generally been unavailable to most water treaters (Saturation levels based upon an ion association model);
- and some that the program author has found useful (the Larson-Skold corrosivity index).

### The Langelier Saturation Index

The Langelier Saturation index (LSI) is a purely equilibrium model derived from the theoretical concept of saturation. A water is said to be saturated with calcium carbonate when it will neither dissolve, or precipitate calcium carbonate “scale”. This equilibrium condition is based upon an undisturbed water, at constant temperature, which is allowed to remain undisturbed for an infinite period of time. A water is said to be under-saturated if it will dissolve an existing calcium carbonate substrate if left at rest for the same infinity. A supersaturated water will precipitate calcium and carbonate from a water if allowed to rest. The Langelier saturation index provides an indicator of a water’s degree of saturation with respect to calcium carbonate.

Saturation is referenced to the solubility product for a compound. By definition the ion activity product of reactants (e.g. Ca and CO<sub>3</sub>) is equal to the solubility product (K<sub>sp</sub>) when the water is in equilibrium.



A saturation level is defined as the ratio of the ion activity product to the solubility product.

$$\text{Saturation level} = \frac{\alpha_{\text{Ca}}[\text{Ca}]\alpha_{\text{CO}_3}[\text{CO}_3]}{K_{\text{sp}}}$$

If a water is under-saturated with respect to calcium carbonate, the saturation level will be less than 1.0 . When a water is at equilibrium, the saturation level will be 1.0 by definition (although our estimation of the ion activity product or solubility product might be in error). A water which is supersaturated with calcium carbonate will have a saturation level greater than 1.0 .

Saturation level is the driving force for crystal formation, and crystal growth. As the saturation level increases beyond 1.0, the driving force for calcium carbonate crystal formation or crystal growth increases.

It can be shown that the Langelier saturation index approximates the base 10 logarithm of calcite saturation level. The Langelier saturation level approaches the concept of saturation using pH as a master variable(1). The Langelier saturation index can be interpreted as the pH change required to bring a water to equilibrium. A water with a Langelier saturation index of 1.0 is one pH unit above saturation. Reducing the pH by 1 unit will bring the water into equilibrium. This occurs because the portion of total alkalinity present as CO<sub>3</sub> (the bad actor) decreases as the pH decreases. A pH decrease of 1 unit will decrease the CO<sub>3</sub> concentration of the water about ten fold. This impacts saturation level directly by also decreasing the ion activity product tenfold. So a 1 pH unit decrease will decrease the Langelier saturation index by 1 unit. A 1 pH unit decrease will also decrease the saturation level (IAP/K<sub>sp</sub>) ten fold.

A negative Langelier saturation index indicates that a water is under-saturated with respect to calcium carbonate (calcite). If the LSI is -1.0, raising the pH of the water 1 unit will increase the calcium carbonate (calcite) saturation level to equilibrium. The 1 pH unit increase does this by increasing the CO<sub>3</sub> portion of the carbonate alkalinity present ten fold. The calcite saturation level increases accordingly (ten times).

The Langelier saturation index is probably the most widely used indicator of cooling water scale potential. It is purely an equilibrium index and deals only with the driving force for calcium carbonate scale formation and growth. It provides no indication of how much scale (CaCO<sub>3</sub>) will precipitate to bring a water to equilibrium. It simply indicates the driving force for scale formation and growth in terms of pH as a master variable.

The Langelier saturation index is defined as:

$$\text{Langelier saturation index} = \text{pH} - \text{pH}_s$$

- pH is the measured water pH
- pH<sub>s</sub> is the pH where the water will be saturated (at equilibrium) with respect to CaCO<sub>3</sub>.

In the cooling water pH range of 6.5 to 9.5, the pH<sub>s</sub> calculation simplifies to:

$$\text{pH}_s = (\text{pK}_2 - \text{pK}_s) + \text{pCa} + \text{pAlk}$$

- pK<sub>2</sub> is the negative log<sub>10</sub> of the second dissociation constant for carbonic acid;
- pK<sub>s</sub> is the negative log<sub>10</sub> of the solubility product for calcite;
- pCa is the negative log<sub>10</sub> of calcium measured in the water;
- pAlk is the negative log<sub>10</sub> of the total alkalinity measured for the water being evaluated.

DownHole SAT uses the full iterative method for estimating the pH of saturation for calcite for calculating the Langelier saturation index.

The LSI is analogous to voltage for those who are electrically minded. A voltage is the driving force for moving electrons across a resistance. As voltage potential difference increases, there is a higher driving force for current (electron) flow. Voltage, however, indicates nothing of the current being moved. The LSI, and other saturation level based indices, describe the driving force for scale formation and growth, but say little of the amount of scale which will form (or be dissolved) in order to bring a water to equilibrium. Although they are very useful, a second factor must be considered in interpreting saturation level based indices. Saturation level based indices indicate the potential for scale formation if a water is unperturbed for an infinite period of time. Most cooling water systems have a substantially shorter holding time index.

A final point on the Langelier index deals with the concept of “corrosivity.” The LSI was not intended as an indicator of corrosivity towards mild steel or other metals of construction. The LSI describes only the corrosivity of a water towards an existing calcium carbonate scale, or other calcium carbonate bearing structure. The LSI does describe the tendency of a water to dissolve (corrode) calcite scale. It has also been used to control the “corrosion” of asbestos-concrete-board (ACB) fill which uses calcium carbonate as part of the binder. Water is adjusted to be non-corrosive to ACB fill by increasing the pH to a saturated, “non-corrosive” LSI. But the interpretation of corrosivity towards metals is not explicit in the LSI.

It has been postulated that a supersaturated water will form an eggshell like film of calcium carbonate scale which will act as an inhibitor film for corrosion of mild steel. This can occur in highly buffered waters. The LSI or other saturation based indices do not guarantee this inhibitory behavior. Calcium carbonate film formation is typically observed in highly buffered waters.

Researchers (Stumm(3), Lowenthal, and Marais(4)) have shown that waters supersaturated with calcium carbonate often develop tubercular deposit which do not inhibit corrosion on mild steel. This behavior is typically associated with waters of low buffer capacity. Puckorius(5) also warned against using saturation level derived indices as the basis for foretelling corrosion problems in cooling systems.

The Langelier saturation index is elegantly derived in the original published form(2). It is also thoroughly explained by Lowenthal and Marais(4).

## **RYZNAR STABILITY INDEX**

The Ryznar stability index attempts to correlate an empirical data base of scale thickness observed in municipal water systems to the water chemistry. Like the Langelier saturation index, the Ryznar stability index has its basis in the concept of saturation level. Ryznar attempted to quantify the relationship between calcium carbonate saturation state and scale formation. The Ryznar index takes the form:

$$\text{Ryznar stability index} = 2(\text{pH}_s) - \text{pH}$$



The empirical correlation of the Ryznar stability index can be summarized as follows:

- RSI << 6** scale tendency increases as the index decreases;
- RSI >> 7** calcium carbonate formation will probably not lead to a protective corrosion inhibitor film;
- RSI >> 8** mild steel corrosion becomes an increasing problem.

DownHole SAT uses the  $pH_s$  calculated by the rigorous iterative method for RSI estimation.

### **STIFF-DAVIS**

The Stiff-Davis index attempts to overcome the shortcomings of the Langelier Index with respect to high TDS waters and the impact of “common ion” effects on the driving force for scale formation. Like the Langelier saturation index, the Stiff-Davis index has its basis in the concept of saturation level. The solubility product used to predict the pH of saturation ( $pH_s$ ) for a water is empirically modified in the Stiff-Davis index. Stiff-Davis indices will predict that a water is less scale forming than the Langelier index calculated for the same water chemistry and conditions. The deviation between the indices increases with ionic strength. Interpretation of the index is by the same scale as for the Langelier Saturation index.

### **ODDO-TOMSON INDEX**

The Oddo-Tomson index accounts for the impact of pressure and partial pressure of CO<sub>2</sub> on the pH of a water, and on the solubility of calcium carbonate. This empirical model also incorporates corrections for the presence of two or three phases (water, gas, and oil). Interpretation of the index is by the same scale as for the Langelier Saturation and Stiff-Davis indices.

## PUCKORIUS SCALING INDEX

The Puckorius (or Practical) scaling index attempts to further quantify the relationship between saturation state and scale formation by incorporating an estimate of buffering capacity of the water into the index. The previously discussed saturation derived indices only account for the driving force for calcium carbonate scale formation. They do not account for two other critical parameters: the buffering capacity of the water, and the maximum quantity of precipitate that can form in bringing a water to equilibrium.

A water high in calcium, but low in alkalinity and buffering capacity can have a high calcite saturation level. The high calcium level increases the ion activity product. A plot of ion activity product versus precipitate for the water would show a rapid decrease in pH as calcium precipitated due to the low buffering capacity. Even minuscule decreases in carbonate concentration in the water would drastically decrease the ion activity product of the water due to the small quantity present prior to the initiation of precipitation. The water might have a high tendency to form scale due to the driving force, but scale formed might be of such a small quantity as to be unobservable. The water has the driving force but no capacity and no ability to maintain pH as precipitate forms.

The Puckorius scaling index is calculated in a manner similar to the Ryznar stability index. Puckorius uses an equilibrium pH rather than the actual system pH to account for the buffering effects:

$$\text{Puckorius scaling index} = 2 (\text{pH}_{\text{eq}}) - \text{pH}_s$$

DownHole SAT calculates the  $\text{pH}_s$  for this index using the rigorous iterative method. Puckorius' formula for  $\text{pH}_{\text{eq}}(5)$  is used

$$\text{pH}_{\text{eq}} = 1.465 \times \log_{10}(\text{"M" Alkalinity}) + 4.54$$

The Puckorius scaling index provides another tool for evaluating the calcium carbonate scale potential for a water and is included in the DownHole SAT indices of calcium carbonate scale potential.

## LARSON-SKOLD INDEX

The Larson-Skold index describes the corrosivity of water towards mild steel. The index is based upon evaluation of in-situ corrosion of mild steel transport lines in systems transporting Great Lakes waters. The index is the ratio of equivalents per million (epm) of sulfate ( $\text{SO}_4$ ) and chloride (Cl) to the equivalents per million of alkalinity in the form bicarbonate plus carbonate ( $\text{HCO}_3 + \text{CO}_3$ ).

$$\text{Larson-Skold index} = \frac{(\text{epm Cl} + \text{epm SO}_4)}{(\text{epm HCO}_3 + \text{epm CO}_3)}$$

As outlined in their paper (6), the index correlated closely to observed corrosion rates and to the type of attack in the Great Lakes water study.

It should be noted that the waters studied in the development of the relationship were not alkalinity or buffering capacity deficient. They were capable of forming an inhibitory calcium carbonate film, if no interferences were present.

The results of the study demonstrate that chlorides and sulfates increase the aggressiveness of a cooling water with adequate buffering capacity and alkalinity to otherwise not be overly aggressive. Perhaps the presence of chloride and sulfate interferes with the film formation which otherwise would be expected.

It must be noted that the Larson-Skold relationship is based upon Great Lakes waters.

Extrapolation to other waters, such as those of low alkalinity or extreme alkalinity, goes beyond the range of the original data. Such extrapolations should be closely scrutinized or weighted lightly. Most water treaters will agree, however, that the aggressiveness of a water increases with increasing chloride and/or sulfate levels, and that corrosivity also increases with decreasing alkalinity.

The index has proven a useful tool in predicting the aggressiveness of once through cooling waters. It is included in DownHole SAT due to the preponderance of waters of composition similar to the Great Lakes waters, and due to its potential usefulness as an indicator of aggressiveness in reviewing the applicability of corrosion inhibition treatment programs which rely heavily on the natural alkalinity and film forming capabilities of a cooling water.

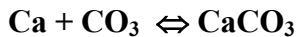
The index might be interpreted by the following guidelines:

<b>Larson-Skold</b>	<b>Indication</b>
<b>&lt;&lt; 0.2</b>	chlorides and sulfate probably will not interfere with natural film formation.
<b>&gt;&gt; 0.2 but &lt;&lt; 0.6</b>	chlorides and sulfates may interfere with natural film formation. Higher than desired corrosion rates might be anticipated.
<b>&gt;&gt; 0.6</b>	the tendency towards high corrosion rates of a local type should be expected as the index increases.

## **SATURATION LEVEL**

Saturation level has been previously discussed as the basis for many of the common indices used by water treaters. The saturation level is defined as the ratio of the ion activity product of the reactants to the solubility product. Saturation level can be defined as follows for common cooling system scalants based upon their respective solubility products:

For CaCO<sub>3</sub> (calcite and aragonite)



$$\text{Saturation Level} = \frac{[\text{Ca}] \alpha_{\text{Ca}} [\text{CO}_3] \alpha_{\text{CO}_3}}{K_{\text{sp}}}$$

where  $\alpha_{\text{Ca}}$  is the activity coefficient for calcium  
 $\alpha_{\text{CO}_3}$  is the activity coefficient for carbonate  
[Ca] is the molar concentration of calcium  
[CO<sub>3</sub>] is the molar carbonate concentration

This relationship can be simplified if we incorporate the activity coefficients into the solubility product so that our examples can be expressed in a more readily viewed format. The conditional solubility product incorporates the activity coefficients into the solubility product:

$$K_{\text{spc}} \text{ CaCO}_3 = K_{\text{sp}} \times (1/\alpha_{\text{Ca}}) \times (1/\alpha_{\text{CO}_3})$$

This notation ( $K_{\text{spc}}$ ) will be used for the remainder of the examples.

For Calcium sulfate (anhydrite):



$$\text{Saturation level}_{(\text{CaSO}_4)} = \frac{[\text{Ca}][\text{SO}_4]}{K_{\text{spc}}(\text{CaSO}_4)}$$

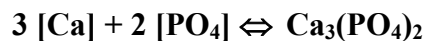
For Silica



$$\text{Saturation level}(\text{SiO}_2) = \frac{[\text{H}_4\text{SiO}_4]}{([\text{H}_2\text{O}]^2 K_{\text{spc}})}$$

Note that the activity of water is included in the calculation.

For tricalcium phosphate, a higher order of reaction is encountered:



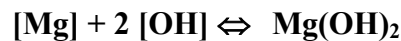
$$\text{Saturation level} = \frac{[\text{Ca}]^3 [\text{PO}_4]^2}{K_{\text{spc}}}$$

A higher order of reaction is also encountered for calcium fluoride (Fluorite)



$$\text{Saturation level} = \frac{[\text{Ca}][\text{F}]^2}{K_{\text{spc}}}$$

and magnesium hydroxide (Brucite):



$$\text{Saturation level} = \frac{[\text{Mg}][\text{OH}]^2}{K_{\text{spc}}}$$

The method used for estimating activity coefficients is a major target of criticism for most indices. DownHole SAT uses the mean salt activities for estimating ion activity coefficients based upon temperature and ionic strength. The method is well covered in reference Truesdell and Jones(7). The use of ion pairing expands the usefulness of DownHole SAT calculated saturation levels.

The simple indices previously described are based upon saturation levels calculated using the total ions present. For example, calcium carbonate indices, such as the Langelier saturation index, assume that all calcium is present as free calcium ions, and that all carbonate is present as the unbound ion. In actual waters, the reactive species are present in many forms. Not all of the ion measured analytically is available to react. For example, calcium can be bound with hydroxide, sulfate, carbonate, and bicarbonate and unavailable for other reactions. This binding, or reduced availability of the reactants, decreases the effective ion activity product for a saturation level calculation. DownHole SAT uses an ion association model to estimate the available (or free) ions present in the water. The ion association method is well described in the literature.<sup>(7)(8)(9)(10)(11)</sup> DownHole SAT uses the free ion concentrations estimated by the ion association method in saturation level calculations. The resultant saturation levels calculated are significantly lower than those based upon total analytical values.

The ion association model saturation levels have been in use by the major water treatment companies since the early 70's. The indices tend to give a more accurate indication of the driving force for scale formation. They have not been in general use, however, due to the difficulty of calculating them. The iterative approach required for the calculations mandates the use of a computer. One of the purposes of DownHole SAT is to make the ion association method for saturation levels available to all Water Treaters.

Saturation levels, no matter how refined, are still an equilibrium based index. They provide a measure of the driving force for a scalant to form, but do not incorporate the capacity of the water for continued scaling. A water can have a high saturation level with no visible scale

formation. The driving force might be present but there is insufficient mass for gross precipitation.

Saturation levels should be viewed as another tool for developing an overall picture of a water's scale potential. They can point out what scales won't form under the conditions evaluated, but they can not predict that deposits of an economically significant quantity will form. The next index covered incorporated the properties of quantity as well as driving force to round out the DownHole SAT indicators of scale potential.

### **MOMENTARY EXCESS (PRECIPITATION TO EQUILIBRIUM)**

This index is adapted from a little used calculation of Momentary Excess. This index describes the quantity of scalant which would have to precipitate instantaneously to bring a water to equilibrium. In the case of calcium carbonate:

$$[\text{Ca}][\text{CO}_3] = \text{Ksp}_c \text{ at equilibrium.}$$

If a water is supersaturated:

$$[\text{Ca}][\text{CO}_3] \gg \text{Ksp}_c$$

Precipitation to equilibrium assumes that one (1) mole of calcium will precipitate for every mole of carbonate that precipitates. On this basis, we can estimate a quantity X, the precipitation required to restore a water to equilibrium, as follows:

$$[\text{Ca} - \text{X}][\text{CO}_3 - \text{X}] = \text{Ksp}_c$$

X is a quantitative indicator of precipitation reserve for a water. X will be a small value when either calcium is high and carbonate low, or when carbonate is high and calcium low. It will increase to a maximum when equal parts of calcium and carbonate are present. As a result, this index (Precipitation to Equilibrium) will provide vastly different values for waters with the same saturation level. Although the original Momentary Excess index was applied only to calcium carbonate scale, DownHole SAT extends the index to other scale forming species.

In the case of sulfate, momentary excess is calculated by solving for "X" in the relationship:

$$[\text{Ca} - \text{X}][\text{SO}_4 - \text{X}] = \text{Ksp}_c$$

The solution becomes more complex for tricalcium phosphate:

$$[\text{Ca} - 3\text{X}]^3 [\text{PO}_4 - 2\text{X}]^2 = \text{Ksp}_c$$

The index provides a quantitative indicator of scale potential and has been used to correlate scale formation in a kinetic model(12). The index does not account for two critical factors. The pH will change in some cases as precipitate forms by the precipitation of alkalinity contributors such

as carbonate or phosphate. Secondly, the index does not account for changes in driving force as the reactant levels decrease due to precipitation.

DownHole SAT includes Momentary Excess (precipitation to equilibrium) as a final indicator of scale potential for the scalants covered by the computer program. DownHole SAT expresses the precipitation to equilibrium in parts per million.

Momentary Excess does not represent a quantitative assessment of the amount of a fouling which will precipitate. It is an indicator of the capacity of a water to scale, and can be compared to the buffer capacity of a water. The calculation method is covered in more detail in the literature(12).

## **INTERPRETING DownHole SAT INDICES**

### **Scale Potential As Indicated By Saturation Level**

All but one of the indices discussed in this section describe the tendency of a water to form, or dissolve, a particular scale. These indices are derived from the concept of saturation. For example, saturation level for any of the scalants discussed is described as the ratio of a compounds observed ion activity product (**IAP**) to the ion activity product expected if the water were at equilibrium (**Ksp**). In DownHole SAT graphically profiles, the degree of supersaturation is labeled as this ratio (**IAP/Ksp**). This ratio has many names and is referred to as *Saturation Level*, *Degree of supersaturation*, and *x Saturation*. This ratio will be referred to as *Saturation Level* or *Degree of supersaturation* throughout the manual.

The following general guidelines can be applied to interpreting the degree of supersaturation:

- 1) If the saturation level is less than 1.0, a water is under saturated with respect to the scalant under study. The water will tend to dissolve, rather than form, scale of the type for which the index was calculated. As the saturation level decreases and approaches 0.0, the probability of forming this scale in a finite period of time also approaches 0.
- 2) A water in contact with a solid form of the scale will tend to dissolve or precipitate the compound until an IAP/Ksp ratio of 1.0 is achieved. This will occur if the water is left undisturbed for an infinite period of time under the same conditions. A water with a saturation level of 1.0 is at equilibrium with the solid phase. It will not tend to dissolve, or precipitate the scale.
- 3) As the saturation level (IAP/Ksp) increases above 1.0, the tendency to precipitate the compound increases. Most waters can carry a moderate level of supersaturation before precipitation occurs in a finite period of time. The degree of supersaturation acceptable for a system varies with parameters such as residence time, the order of the scale reaction, and the amount of solid phase (scale) present in the system. To be on the safe side, it is recommended that an appropriate inhibitor be fed to a water if the saturation level is above 1.0.

The acceptable degree of saturation for a given system should be based upon your experience. The author has found the following guidelines useful.

**Calcium carbonate:** In once through cooling systems, treatment is necessary when the saturation level at the highest temperature and pH in the system is above 1.2 to 1.5.

A slightly higher degree of supersaturation can be carried in some cooling towers.

**Calcium sulfate:** Treatment is recommended when the saturation level for gypsum exceeds 1.0. In higher temperature systems ( $>> 130$  °F), treatment is required normally when anhydrite saturation level exceeds 1.0.

**Barium sulfate:** Treatment is recommended when the saturation level exceeds 1.0.

**Strontium sulfate:** Treatment is recommended when the saturation level exceeds 1.0.

**Silica:** Most waters can carry a silica saturation level of 1.1 to 1.2. DownHole SAT silica saturation levels are calculated using the solubility product for amorphous silica. A saturation level in this range equates to a silica level of around 150 ppm (as SiO<sub>2</sub>) at an acid to neutral pH, and 180 ppm or above in waters with a pH above 8.0.

It is of particular importance to evaluate silica saturation level in systems with borderline solubility as temperature or pH decrease.

**Magnesium silicate:** Mag-silicate compounds do not necessarily form due to a stoichiometric reaction. The author believes that magnesium silicate forms through the adsorption of silica onto precipitated magnesium hydroxide. Brucite saturation level was added to DownHole SAT calculated indices as a measure of the potential for magnesium silicate to form in a cooling system based upon this philosophy. If a water is supersaturated with magnesium hydroxide (Brucite) and even low levels of reactive silica are present in the cooling water, magnesium silicate formation is possible. Magnesium silicate formation is probable when the water is supersaturated with Brucite and silica levels are 40 ppm (as SiO<sub>2</sub>) or above.

A recent NACE paper reported the formation of stoichiometric magnesium silicate scales in cooling systems. A stoichiometric form was added to the scales evaluated by DownHole SAT as a result of this paper. Precipitation might be expected when the magnesium silicate saturation level exceeds 1.2.

**Calcium fluoride:** Treatment, or operating parameter changes, are recommended when the saturation level for Fluorite exceeds 1.0.

**Tricalcium phosphate:** Tricalcium phosphate saturation level calculations are a fifth order affair. As a consequence, small changes in free phosphate concentration, or even smaller changes in calcium concentration, have a dramatic impact on the calculated saturation level. For this reason, high saturation levels, on the order of 100,000 or above, can be observed in waters treated for calcium phosphate scale control. The authors experience is as follows:



Beware when a system is supersaturated with tricalcium phosphate.

A tricalcium phosphate saturation level below 100 is easily treated. Most inhibitor treatments can prevent scale formation, even if not specifically directed towards tricalcium phosphate. pH decrease can decrease tricalcium phosphate saturation level to an acceptable level.

pH reduction and/or a tricalcium phosphate specific treatment program is recommended when tricalcium phosphate saturation level rises above the 100 to 1000 range.

**hydroxylapatite:** Hydroxylapatite saturation level calculations are a ninth order affair even higher than that of tricalcium phosphate. As a consequence, small changes in free phosphate concentration, or even smaller changes in calcium concentration, have a dramatic impact on the calculated saturation level. For this reason, high saturation levels, on the order of 100,000 or above, can be observed in waters treated for calcium phosphate scale control. Saturation level guidelines are similar to those for tricalcium phosphate, although a significantly higher hydroxylapatite saturation level can be carried in the presence of a copolymer, terpolymer, or other calcium phosphate scale control agents.

**Iron carbonate:** Siderite, the mineral name for iron carbonate, is usually found in conjunction with calcium carbonate scale in a system. Iron carbonate scale can be expected when the saturation level exceeds 1.2 .

**Amorphous iron hydroxide:** Iron hydroxide precipitation can be expected when the saturation level exceeds 1.0, a very common situation when iron is present. Iron may precipitate in the bulk water as iron hydroxide, but not form scale in high flow rate systems. Remedial action, such as a dispersant, should be taken in systems with high iron hydroxide saturation levels. Note that iron hydroxide momentary excess values reported will almost always be negligible. This is due to the high order of the reaction. Rely upon the saturation level for deposition prediction and ignore the momentary excess in most cases.

**Iron phosphate:** Strengite, the iron phosphate mineral modeled by DownHole SAT, should be considered a problem when the saturation level exceeds 1.0 . Momentary excess for this scale former will be negligible in most cases due to the low level of “free” phosphate typically available. Rely upon the saturation level for prediction of iron phosphate scale.

### **CaCO<sub>3</sub> Scale & Corrosion Potential As Inferred From Simple Indices**

The Langelier Saturation Index, Ryznar Stability Index, and Puckorius (or Predictive) Scaling Index are well documented. Values calculated by DownHole SAT for these indices should be very close to those calculated using normal methods. Guidelines for these indices are covered in their respective sections of this manual. It should be noted that these indices are limited to calcium carbonate scale potential. They are based upon total calcium and total alkalinity present and may be of limited usefulness in high TDS waters for this reason. The indices, as previously discussed, do not account for ion pairing which reduces the free calcium and carbonate concentrations available for scale formation. It is recommended that these indices be used as

points of reference and that the more rigorous saturation level for calcite be adopted, especially in high TDS waters.

## DownHole SAT COLOR CODING

Graphs produced by DownHole SAT are color coded as an aid in interpreting them. This section discusses the meaning of the colors.

### *Saturation Level and Simple Scale Indices*

**RED** - Red signifies a definite problem prediction. Corrective action such as treatment, pH adjustment, or concentration ratio decrease (blowdown) should be taken to eliminate, or alleviate, the problem. Red signifies loss of control in TREATED SATURATION LEVEL PROFILES.

**MAGENTA** - Magenta (purple) signifies that a problem is highly likely. Some systems might be able to carry the degree of supersaturation indicated by magenta without deposition occurring. Most system will scale if operated in the Magenta range without treatment.

**YELLOW** - Yellow signifies that a problem will occur with a minimum of change. Make sure of your measurements. A slight error in pH could mean that you are really operating in a RED zone. The system is borderline and should be watched.

**GREEN** - No problems are likely. Significant changes (e.g. a 0.1 pH increase, a 10 °C increase) could result in a problem.

**BLUE** - Blue signifies a safe operating range where deposition from the scale evaluated would not be expected. Blue is also used to signify a successful treatment in TREATED SYSTEM PROFILES.

### *Dosage Profiles*

**RED** - Red signifies a definite problem prediction. The treatment will not work regardless of dosage level. The system is out of range (e.g. too high a saturation level) for the treatment selected.

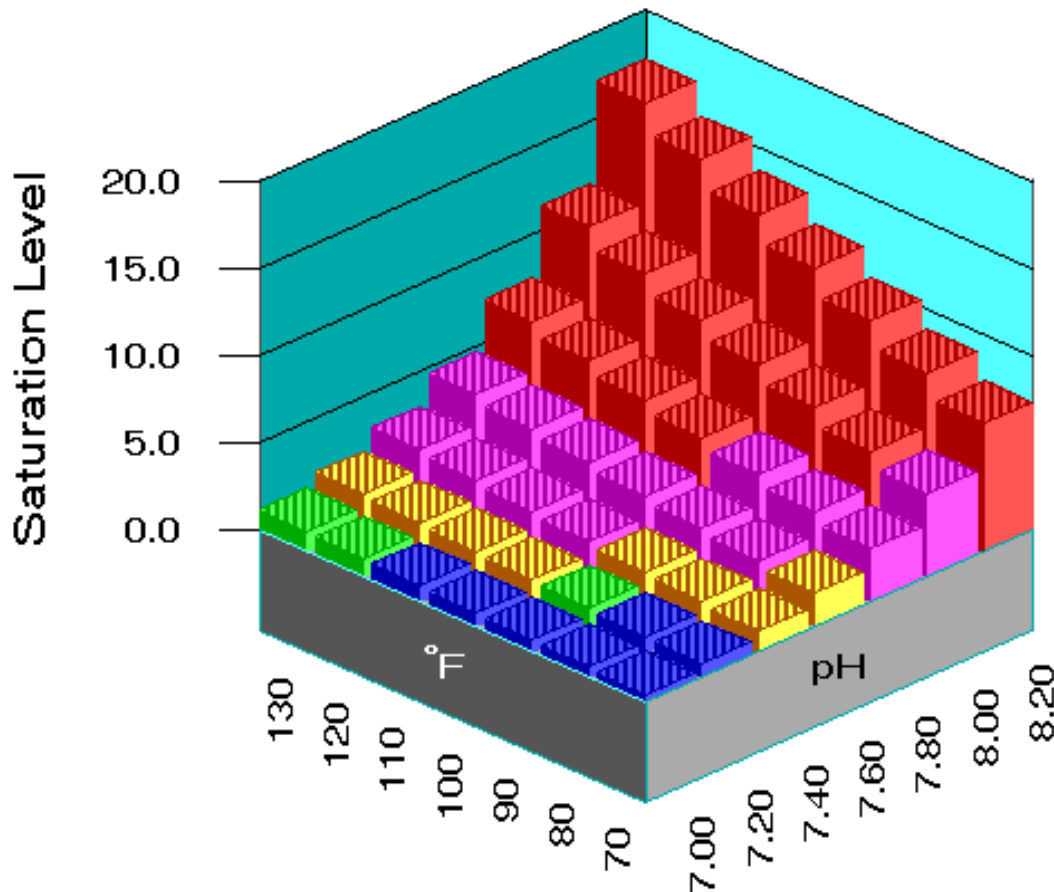
**MAGENTA** - Magenta (purple) signifies that a problem is approaching or highly likely. In the case of calcium carbonate inhibitors, MAGENTA signifies that the system is within ten (10%) percent of the limit for the inhibitor (e.g. 135 calcite saturation level to 149 calcite saturation level for an inhibitor that fails at 150 or above).

In the case of blended orthophosphate/copolymer products, MAGENTA signifies that insufficient polymer is present for calcium phosphate scale control when the product is dosed at the level required for adequate corrosion protection. The corrective action is to increase the ratio of copolymer to phosphate.

**BLUE** - Blue signifies a safe operating range where the treatment will prevent deposition of the scale evaluated.

DownHole SAT's "Fuzzy Chemistry"<sup>™</sup> Profiles Predict Problems Over A Broad Range of Operating Conditions

## Calcite Saturation Level



Color coding identifies the severity of the problem.

Blue signifies a safe range.

Green indicates a mild problem potential if conditions change slightly.

Yellow warns you to check measurements, trouble is near.

Magenta indicates a problem is likely. Take corrective action.

Red warns of a problem. Treatment or other remedial action is required.



## DownHole SAT Rx Series

Most of us use our own system for varying inhibitor treatment levels with water chemistry. Over the years we've developed our own rules of thumb. For example,

- Most of us apply higher levels of inhibitors as temperature increases.
- Most of us increase dosage as the driving force for scale formation increases. Higher levels of CaCO<sub>3</sub> inhibitors are applied as the Langelier Saturation index or calcite saturation level increase.
- Many of us will feed higher inhibitor levels to a 72 hour holding time index system than to a 3 hour residence time system. Scale inhibitor dosage levels increase with time.
- And finally, most of us will feed a slightly higher dosage in high pH systems.

All other things being equal, dosages for scale inhibitors are applied as a function of a driving force for scale formation and growth (e.g. Calcite saturation level), temperature as it affects reaction rates, pH as it affects the dissociation state of the inhibitor, and time. DownHole SAT R<sub>x</sub> allows you to develop mathematical models for the minimum effective scale inhibitor dosage as a function of these parameters: driving force, temperature, pH and time. Mathematical models for inhibitors can be developed using the Laboratory version of DownHole SAT by editing water chemistry, temperature, and time data developed in the laboratory, through field experience, or both.

The DownHole SAT R<sub>x</sub> series is composed of the following programs:

- **DownHole SAT R<sub>x</sub> Field Engineer's Edition** - This version of the program allows a user to select a product and obtain a dosage or dosage profile. Product (.PRD) files must be supplied for each product the Field Engineer's version can model. The program can also perform all functions of the basic DownHole SAT program. Dosage recommendations are incorporated into the basic DownHole SAT system as an additional line of output on the tables output, and as an additional graph selection in the "What-if" modules.
- **DownHole SAT R<sub>x</sub> Product Manager's Edition** - This version allows a user to input a product formulation and create a Product (.PRD) file. The program must have access to Inhibitor(.INH) files for an inhibitor to be incorporated into a formulation. The Product Manager's version incorporates all functions and printouts available in the basic DownHole SAT program, and in the Field Engineer's Edition of the DownHole SAT R<sub>x</sub> series.
- **DownHole SAT R<sub>x</sub> Laboratory Edition** - This version allows a user to develop mathematical models for scale and corrosion inhibitors, in addition to the functions of the other programs in the series. Mathematical model templates are available for common inhibitors types. Laboratory and/or field data can be entered in forms almost identical to the regular DownHole SAT chemistry input forms.

Additional fields in the Laboratory version are time and dosage. Mathematical models for an inhibitor are developed by the program using multiple regression. The correlations (models)

developed are output in the form of inhibitor (.INH) files. The goodness of fit for the data can be presented in table and graphical format.

The DownHole SAT R<sub>x</sub> Laboratory and Product Manager's Editions are shipped with inhibitor files for common materials such as AMP, HEDP, PBTC, and PAA to name a basic few. Inhibitor files are also available for calcium sulfate control agents, calcium phosphate control, corrosion inhibitors, and modeling corrosion rates on mild steel. Additional files are available from inhibitor's manufacturers.

The DownHole SAT R<sub>x</sub> Laboratory Edition includes the raw data for AA-AMPS as published by Calgon in a NACE paper.

Correlations can be developed for dosages versus any of the DownHole SAT indices, any of the data input, and some internal calculated values such as buffer capacity..

### **DIFFERENCE BETWEEN DownHole SAT and the DownHole SAT R<sub>x</sub> Series**

The DownHole SAT R<sub>x</sub> series adds one or two pull down menus to the main DownHole SAT menu.

The Field Engineer's Edition has one selection on the additional menu (FORMULARY) and one additional selection - SELECT PRODUCT. This module displays a list of the products on file, and their description. The Product Names and Descriptions listed are derived from the Product(.PRD) files. Printouts contain one additional line for the recommended dosage for the current product selected. An additional graph selection is available for Product dosage profiles. Although the Field Engineer's Edition of the program allows the use of the mathematical models and formulation data in the product file, the original data cannot be accessed. Someone with a product file cannot determine the active ingredients or their percentage in the formulated product.

The Product Manager's Edition adds a second additional selection to the FORMULARY menu - INPUT PRODUCT. The product's name, description, and formulation are entered in this menu to create a Product (.PRD) file. Only inhibitors for which you have Inhibitor (.INH) files can be included in the formulations.

The Laboratory Edition adds a second additional pull down menu, which is appropriately labeled - LABORATORY. Water chemistry data, dosage, temperature, and the time period during which the water was "stable" are entered into the RAW DATA INPUT module. Once data is entered, multiple regression is used to develop a model and determine the goodness of fit between your data, and the model. This module generates Inhibitor files for use by the Product Manager version of the program, or the related modules in the Laboratory version. Note: the Laboratory version can perform any function done by the Field Engineer's or Product Manager Versions.

### **DownHole SAT R<sub>x</sub> Files**

The DownHole SAT R<sub>x</sub> series uses three (3) file types in addition to those generated by the original DownHole SAT program. The original files included the .DHS work files and the .PCX graphic output files. The R<sub>x</sub> series adds the .PRD product information file, the .INH inhibitor correlation file, and the .COR, laboratory data for correlation file.

#### ***Original DownHole SAT Files -***

**.DHS (workspace)** files store water analysis entered into DownHole SAT, units information, ""What-if" parameters, and any indices which were calculated prior to being stored in .DHS file format. .DHS files are DownHole SAT work files which allow you to stop work, save what you have completed, and return at another time. A .DHS file returns the DownHole SAT program, analysis, and values to the same condition they were when the file was saved.

**.PCX** files are a standard graphic format used to store pictures on the screen for transfer to other programs. DownHole SAT creates a type 5 .PCX file with all color (palette) information stored as well as the graphic information.

**.BMP** files are a standard windows graphic format. BMP bitmap files store the same information as .PCX files, but tend to be significantly larger.

**.TIF** files are a third graphic format used to store pictures on the screen for transfer to other programs.

#### ***DownHole SAT R<sub>x</sub> Field Engineer Edition Files -***

The Field Engineer Edition creates the same files (.DHS and graphic files) that are created by the original DownHole SAT program. The Field Engineer Edition .DHS file includes any dosage recommendations calculated prior to the file being saved as well as information on the current product.

The Field Engineer Edition uses (but cannot create, modify, or display) product information files (.PRD). .PRD files contain product formulation information such as active ingredients and their percentages. This information is used in conjunction with mathematical inhibitor model coefficients to calculate dosage recommendations. The Field Engineer Edition can use the information in the files, but is not capable of displaying this sometimes proprietary information. The active ingredient list, and their percentages, cannot be obtained by loading a product (.PRD) file into the Field Engineer Edition program.

#### ***DownHole SAT R<sub>x</sub> Product Manager Edition Files -***

The Product Manager Edition creates the same files that are created by the original DownHole SAT program. Additionally, the Product Manager Edition can create product (.PRD) files. It can also access inhibitor (.INH) files.

The Product Manager Edition can create, modify, and display product information files (.PRD). The INPUT FORMULATION module is used to access or create a .PRD file. Active ingredients information is added to the .PRD files through the loading of the inhibitor file for the active



ingredient being added. The appropriate percentage(s) for active ingredients thus loaded are entered into the form. The inhibitor (.INH) files contain the mathematical inhibitor model coefficients to calculate dosage recommendations. The Product Manager Edition can use the information in the .INH files, but is not capable of displaying this sometimes proprietary information, or the laboratory data which was used to generate the inhibitor correlations.

The Product Manager Edition has full access to the formulation information such as active ingredients, and their percentages.

***DownHole SAT R<sub>x</sub> Laboratory Edition Files -***

The Laboratory Edition creates the same files that are created by the original DownHole SAT program. The Laboratory Edition has all of the capabilities of the Product Manager Edition. It can create product (.PRD) files.

Additionally, the Laboratory Edition can be used to directly edit inhibitor (.INH) files. The Laboratory Edition has the unique capability of processing .COR file data to generate inhibitor (.INH) files.

The Laboratory Edition can create, modify, and display product information files (.PRD). The Laboratory Edition has full access to .INH files, including the capability of displaying the sometimes proprietary information stored in them.

The Laboratory Edition has full access to laboratory and field data stored in .COR files. .COR files contain water chemistry information, dosage required for 100% inhibition, and temperature data for laboratory and/or field data. A series of analysis can be used to statistically model the inhibitor performance and develop a .INH file mathematical model. A minimum of five (5) analysis are required for a .COR file to be used.

# **GETTING STARTED**

**System Requirements**

**Installation**

**Selecting Analytical Units**

**Carbonate Calculations**



## **System Requirements**

As a general rule, French Creek Software programs will run on the minimum system configuration for a given Windows operating system. Performance increases with memory and processor speed. Suggested minimums are as follows.

The program requires approximately 700 mb of hard drive space for a full installation.

Please note that each workspace file will consume up to 50K of hard drive space. Each graph stored as a PCX file will use around 50K. Each graph stored as a .BMP file can take up to 600K of hard drive space.

## **INSTALLATION**

**BEFORE YOU DO ANYTHING ELSE, WHY NOT MAKE A BACKUP COPY OF THE INSTALLATION PROGRAM. PUT THE ORIGINAL CD IN A SAFE PLACE. IF YOU DOWNLOADED THE INSTALLATION PROGRAM BACK IT UP TO A CD OR OTHER MEDIA.**

The program is installed like most Windows software: by running the SETUP.EXE file on the installation CD.

**1) Insert the program CD.**

**2) Use the Windows RUN command to execute**

**SETUP.EXE    <press enter>**

You can also execute by double clicking on the SETUP.EXE program icon from FILE MANAGER, FILE EXPLORER, or MY COMPUTER, depending on your version of Windows.

**3) The install program will search for an existing installation.** You must install to the ÖPÙØË/ { |å^!, e.g. C:\ÖPÙØË/ or D:\ÖPÙØË/

**4) Execute the program by clicking on the French Creek Software Icon, by using the Windows RUN command, or from the Windows START menu.**

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## Selecting Analytical Units

The first time DownHole SAT is run, it will display a warning that default analytical input units are in affect. This is a reminder to run the **Input Units** module (which can be selected from the **Preferences** menu) and choose the analytical reporting units used by your company.

**ANALYTICAL UNITS SELECTION**

Calcium	[as Ca]	Iron	[as Fe]	Sulfide	[as H2S]
Magnesium	[as Mg]	Ammonia	[as NH3]	Silica	[as SiO2]
Barium	[as Ba]	Aluminum	[as Al]	Phosphate	[as PO4]
Strontium	[as Sr]	Boron	[as B]	Fluoride	[as F]
Sodium	[as Na]	Manganese	[as Mn]	Nitrate	[as NO3]
Potassium	[as K]	Zinc	[as Zn]	Temperature	[as °F]
Lithium	[as Li]	Lead	[as Pb]	Pressure	[Atm.]
pH	[pH Units]	Bromide	[as Br]	pCO2	[Atm.]
Residence time	[seconds]	Chloride	[as Cl]	Density	[g/mL]
Date	MM/DD/YR	Sulfate	[as SO4]	Corrosion rate	mpv
Brine Flow	BPD	Acidity	[as CO2]		
Oil Flow	BPD	M Alkalinity	[as HCO3]		
Gas Flow	MMCF/D	P Alkalinity	[as CO3]		

**Standard Units**

As The Ion  
As CaCO3  
Combination  
epm

**REPORTED AS**

ppm   
mg/l   
epm

**BALANCING IONS**

**CATIONS**

Sodium   
Potassium

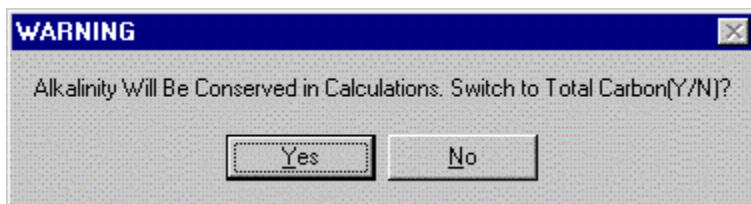
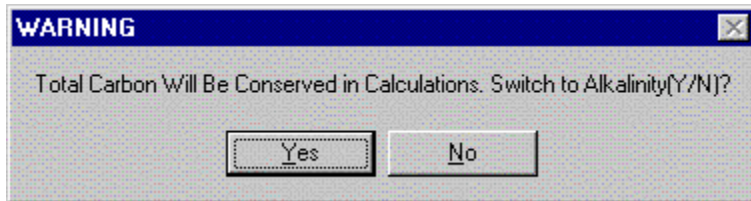
**ANIONS**

Chloride   
Sulfate   
Nitrate

OK  
Cancel

Analytical units are available for almost any reporting method in use. Date format can also be changed in this module. You might also wish to select the ions which will be used to balance incomplete water analyses.

## Carbonate Calculations



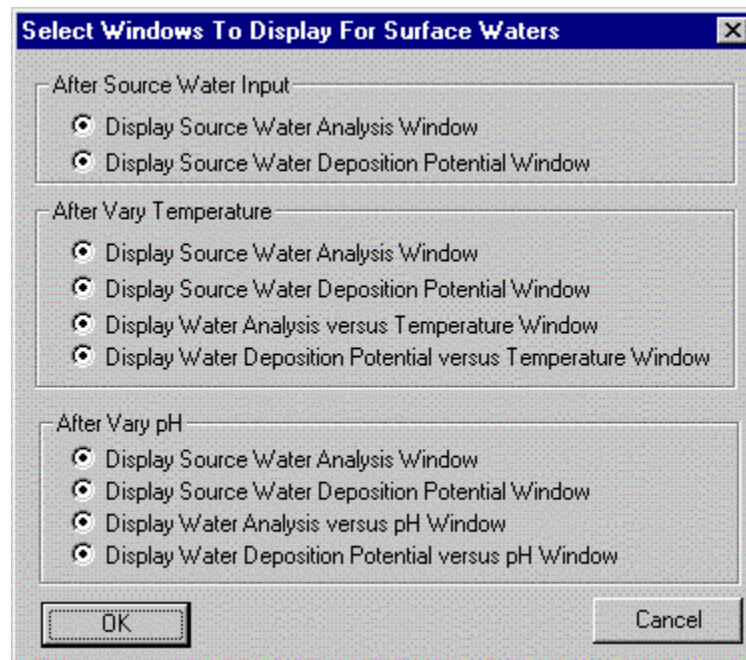
DownHole SAT deals with the carbonate equilibrium in two basic ways as it cycles a water: *Conservation of Alkalinity* or *Conservation of Total Molar Carbon*.

Carbonate based Alkalinity is conserved in systems open to the atmosphere due to the free exchange of carbon dioxide ( $\text{CO}_2$ ) with the atmosphere. Molar carbon is conserved in totally closed, air tight systems. For most systems, carbonate calculations should be based upon the conservation of alkalinity.

You can select the appropriate method for carbonate calculations in the **CO<sub>3</sub> Calculations** module which can be selected from the Preferences menu. When in doubt, conserve alkalinity!

## Selecting Windows To Display

DownHole SAT displays an enormous amount of information. At times a total display is useful. At other times too much information is confusing or a nuisance. You can determine which informational output windows will be displayed in the **Select Windows To Display for Surface Waters** and **Select Windows To Display for Mixed Waters** modules which can be accessed from the preference menu.



The image shows a dialog box titled "Select Windows To Display For Surface Waters". It contains three sections, each with a group box header and a list of radio button options:

- After Source Water Input**
  - Display Source Water Analysis Window
  - Display Source Water Deposition Potential Window
- After Vary Temperature**
  - Display Source Water Analysis Window
  - Display Source Water Deposition Potential Window
  - Display Water Analysis versus Temperature Window
  - Display Water Deposition Potential versus Temperature Window
- After Vary pH**
  - Display Source Water Analysis Window
  - Display Source Water Deposition Potential Window
  - Display Water Analysis versus pH Window
  - Display Water Deposition Potential versus pH Window

At the bottom of the dialog box are two buttons: "OK" and "Cancel".

These forms allow you to customize the display of these output windows.



**Select Windows To Display For Mixed Waters** [X]

After Injection Water

- Display Injection Water Analysis Window
- Display Injection Water Deposition Potential Window

After Formation Water Input

- Display Formation Water Analysis Window
- Display Formation Water Deposition Potential Window

After Mix (Injection and Formation)

- Display Water Analysis vs % Injection Window
- Display Water Deposition Potential vs % Injection

After Multi-Mix Analysis Input

- Display Source Water Analyses Summary Window
- Display Waters Deposition Potential Summary Window

After Multi-Mix

- Display Source Water Analyses Summary Window
- Display Waters Deposition Potential Summary Window
- Display Final Mixed Water Analysis
- Display Final Mixed Water Deposition Potential

OK Cancel

It is recommended that new users set all windows to display. They can be deactivated and reactivated as desired using these forms.

## CHOOSING DATA TO PRINT

You can also determine what analytical values and indices will be included in printouts by activating or deactivating individual items in the **Choose Ions To Print** and **Choose Scales To Print** forms, which can be accessed from the **Preferences** menu.

**Select Chemistry Items To Print**

CATIONS

- Calcium
- Magnesium
- Barium
- Strontium
- Sodium
- Potassium
- Lithium
- Ammonia
- Aluminum
- Iron
- Boron
- Manganese
- Zinc
- Lead

ANIONS

- Chloride
- Sulfate
- Bromine
- Silica
- Acidity (or CO<sub>2</sub>)
- M Alkalinity (or HCO<sub>3</sub>)
- P Alkalinity (or CO<sub>3</sub>)
- Sulfide
- Phosphate
- Fluoride
- Nitrate

PROPERTIES

- pH
- Temperature
- Calculated T.D.S.
- Pressure
- pCO<sub>2</sub>
- Density
- Dosage
- Corrosion Rate

OK      SELECT ALL      Cancel

**Deposition Indicators To Print**

Saturation Levels

- Calcite
- Aragonite
- Witherite
- Strontianite
- Magnesite
- Anhydrite
- Gypsum
- Barite
- Celestite
- Fluorite
- Tricalcium phosphate
- Hydroxyapatite
- Amorphous Silica
- Brucite
- Magnesium Silicate
- Iron hydroxide
- Strengite
- Siderite
- Halite
- Thenardite
- Iron sulfide

Momentary Excess

- Calcite
- Aragonite
- Witherite
- Strontianite
- Magnesite
- Anhydrite
- Gypsum
- Barite
- Celestite
- Fluorite
- Tricalcium phosphate
- Hydroxyapatite
- Amorphous Silica
- Brucite
- Magnesium Silicate
- Iron hydroxide
- Strengite
- Siderite
- Halite
- Thenardite
- Iron sulfide

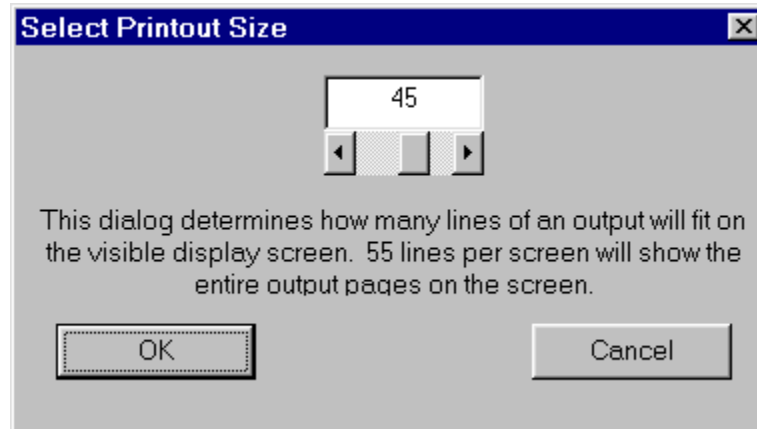
Simple Indices and Indicators

- Langelier
- Ryznar
- Puckorius
- Larson-Skold
- Stiff-Davis
- Oddo-Tomsor
- Free vs Total Ca
- Free vs Total CO<sub>3</sub>
- Free vs Total PO<sub>4</sub>
- Free vs Total SO<sub>4</sub>

OK      Cancel      Select All

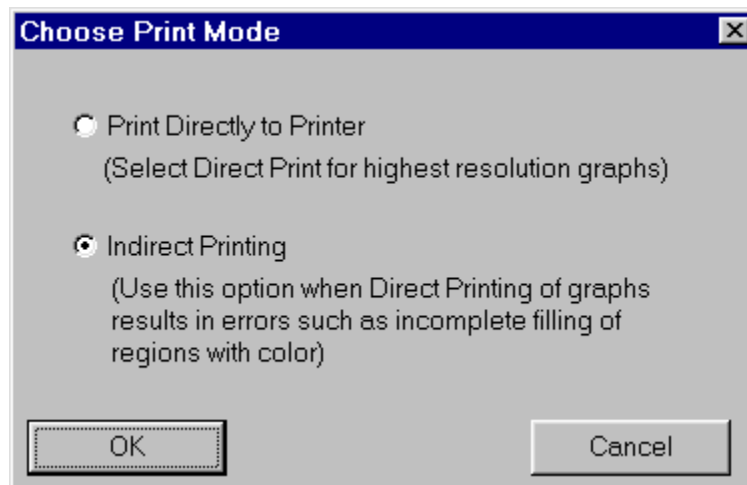
## CHOOSING DISPLAY SIZE

The **Output Size On Screen** form allows you to select the number of lines from a printout that will be displayed on the screen. This allows you to size the output window so that an entire printout can be displayed on the screen. This form is also accessed through the **Preferences** menu.



## PRINT MODE

The final setup form is rarely needed. It allows the selection of either directly printing to a printer or printing indirectly by preparing the printout in the computer's memory prior to transmitting to the printer. Choose Direct Print initially. Change your selection to Indirect Print if problems are encountered printing graphs.



# **What-if Scenario Modeling**

**Introduction**

**Surface “What-if ”**

**Water Flood and Mixing “What-if”**

**Predicting pH**

**Report Options**

*Copy to the Clipboard*

*Print*

*Choosing Ions/Scales to Print and Copy/Paste*

**Change Range/Change Treatment**

*Tables*

*Graphs*



## “WHAT-IF” SCENARIO MODELING

What-if scenario modeling provides one of the greatest benefits from using DownHole SAT™. The WHAT-IF SCENARIO modules allow you to visualize what will happen to the scale potential and corrosivity of a water as environmental parameters and water chemistry change. The What-If scenarios allow you to evaluate the impact of bringing a water to the surface, or of mixing waters under varying conditions to find the safe ratios for mixing. The What-If’s also provide a predictor for use in anticipating problems in new or proposed wells.

For SURFACE waters, the What-If scenarios allow you to evaluate the scale potential of a water over the temperature range expected, the pH range, and the pCO<sub>2</sub> range encountered. Input parameters for selecting the What-If scenario ranges include minimum and maximum temperature, and minimum and maximum pH and pCO<sub>2</sub> values.

All of the What-if Scenario modules can be run versus pH, or pH predicted from pCO<sub>2</sub>. The pH or pCO<sub>2</sub> mode is selected in the PREFERENCES pull down menu.

For WATERFLOOD systems, the What-If scenarios allow you to evaluate these indicators over a broad ratio range. The modules provide a means to evaluate the impact of pH/pCO<sub>2</sub> changes on scale potential. An overall evaluation with the What-If Scenario family of modules allows you to review the water from the perspective of many complementary indices and reach conclusions tempered by your practical expertise.

The next section discusses the WHAT-IF Scenario family from the perspective of functions both the SURFACE and WATERFLOOD modules have in common, and based upon their own unique properties. What-if scenario modeling provides one of the greatest benefits from using DownHole SAT™.

### SCALES MODELLED BY DownHole SAT

Calcite	CaCO <sub>3</sub>	Fluorite	CaF <sub>2</sub>
Aragonite	CaCO <sub>3</sub>	Amorphous Iron	Fe(OH) <sub>3</sub>
Witherite	BaCO <sub>3</sub>	Brucite	Mg(OH) <sub>2</sub>
Magnesite	MgCO <sub>3</sub>	Strengite	FePO <sub>4</sub> *2H <sub>2</sub> O
Siderite	FeCO <sub>3</sub>	Tricalcium phosphate	Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>
Barite	BaSO <sub>4</sub>	Hydroxyapatite	Ca <sub>5</sub> (PO <sub>4</sub> ) <sub>3</sub> (OH)
Anhydrite	CaSO <sub>4</sub>	Thenardite	Na <sub>2</sub> SO <sub>4</sub>
Gypsum	CaSO <sub>4</sub> *2H <sub>2</sub> O	Halite	NaCl
Celestite	SrSO <sub>4</sub>	Iron sulfide	FeS
Amorphous Silica	SiO <sub>2</sub>		

### SIMPLE INDICES

Langelier Saturation Index  
Ryznar Stability Index  
Puckorius Equilibrium Index

Stiff-Davis Saturation Index  
Oddo-Tomson  
Larson-Skold Corrosivity Index

## CONVENIENCE GROUPS

Three CONVENIENCE GROUPS have been programmed into DownHole SAT™ to allow multiple graph selection of common groups.

- The Common Foulants Group includes Calcite ( $\text{CaCO}_3$ ), Barite ( $\text{BaSO}_4$ ), Witherite ( $\text{BaCO}_3$ ), and Anhydrite ( $\text{CaSO}_4$ ) saturation levels.
- The Common Indices Group includes the Langelier, Stiff-Davis, Oddo-Tomson and Ryznar.
- The Calcium Carbonate Group includes Calcite saturation level, Langelier saturation index, the Stiff-Davis index, and the Oddo-Tomson index.

The graphs are prepared using the profile modules which are unique to the system type and are discussed separately in the following sections. PROFILES WILL BE CALCULATED VERSUS pH, IF THE pH MODE IS ACTIVE, OR VERSUS  $\text{pCO}_2$ , IF THE  $\text{pCO}_2$  MODE IS ACTIVE.

## SURFACE "WHAT-IF"

Four scenario types can be run for SURFACE systems. The scenarios calculate the indicators of scale potential and corrosivity versus pH/ $\text{pCO}_2$ , temperature, or both. The modules are called VARY TEMPERATURE, VARY pH, Vary  $\text{pCO}_2$ , and 3D PROFILE for these scenarios.

Surface Water "What-if" Scenarios

Temperature Selection

Low Temp  High Temp  Evaluation Temp

pH Selection

Low pH  High pH  Evaluation pH

$\text{pCO}_2$  Selection

Low  $\text{pCO}_2$   High  $\text{pCO}_2$   Evaluation  $\text{pCO}_2$

pH Prediction Method

Extrapolated pH-Alk  User Defined  Theor. pH- $\text{pCO}_2$

Lawrence-Caldwell  Default  Oddo-Tomson

When you enter any of these modules, a menu pops-up requesting information on the minimum and maximum pH,  $\text{pCO}_2$ , and temperature for the scenario calculations. The typical pH is the pH which will be used for 2D plots which VARY TEMPERATURE when the pH mode is active. The typical  $\text{pCO}_2$  is the partial pressure of  $\text{CO}_2$  which will be used for 2D plots which VARY TEMPERATURE when the  $\text{pCO}_2$  mode is active. The typical temp is the temperature which will



be used for 2D plots which VARY pH or pCO<sub>2</sub>. When the 3D PROFILE is run, both the pH (or pCO<sub>2</sub>) and temperature ranges selected for the scenario are used for calculations. The first graph selected for a series of profiles takes the longest. All indices are calculated during the first run of the "What-If" scenario. Once they are calculated, recalculation is not required until you change either the pH, pCO<sub>2</sub>, temperature range, or water chemistry. Once a graph is displayed, it can be printed, or saved as a graphics file.

## WATERFLOOD "WHAT-IF"

All of the graphs can be generated using the WATERFLOOD "What-If" scenario modules. The first step in generating any of the WATERFLOOD graphs is to SELECT PARAMETERS for the scenario using the SELECT PARAMETERS module (see form below). The parameters you can vary include minimum and maximum percent injection water, and increment, and the relationship to use for predicting pH as the water MIXs. Run the SELECT PARAMETERS module prior to MIX or any of the PROFILES.

**Select Mixing Zone Specifications**

Mixing Zone % Injection Water Range (For 2D and 3D Graphs)

Low Percent  High Percent  Typical Percent

pH Prediction Method

Extrapolated pH-Alk     
  User Defined     
 Theor. pH-pCO<sub>2</sub>

Lawrence-Caldwell     
  Default     
 Oddo-Tomson

Temperature Range For 3D Graphs

Minimum  Maximum

pH Range For 3D Graphs

Low pH  High pH

pCO<sub>2</sub> Range For 3D Graphs

Low pCO<sub>2</sub>  High pCO<sub>2</sub>

OK Cancel



# MIXING WATER AND CALCULATING

## INDICES VERSUS % INJECTION WATER

The MIX module mixes the INJECTION water and FORMATION water entered in the WATERFLOOD pulldown menu. Water is mixed according to the Initial, Final and Increment entered in the DownHole SAT PARAMETERS menu under the % INJECTION heading. The water is mixed at the Typical Temperature entered. The pH of the mixed water is estimated by the method specified in the SELECT PARAMETERS module ( pH-pCO<sub>2</sub> relationship, HCO<sub>3</sub>/CO<sub>3</sub> Mix, or Oddo-Tomson). Tables summarizing the mixed water chemistry and calculated indices are displayed upon completion of the MIX module.

The indices can be graphed in 2D format versus % Injection using the GRAPH module. The tables can be printed using the ALT and P hot key combination when they are displayed on the screen, or by selecting the MIX Water module in the REPORTS menu.

## 3D MIXING ZONE PROFILES

This module uses the Operating Range Specification to model the operating range at the Typical % Injection over the Low to High Temperature range, and the Low to High pH (or pCO<sub>2</sub>) range. IF an acid pH control option was selected, pH control is used.

Graphs can be displayed as 3D bar graphs or as 3D contour plots. The ALT C combination will toggle the graph type from 3D Bar to 3D contour when a bar graph is displayed. The ALT B combination will toggle the graph type between 3D Contour and 3D Bar plots.

## MULTIMIX

This module allows you to enter up to ten (10) different waters, and their relative flows or percentages, and project the properties of the final mixture.

**Multi Mix Water Chemistry Input**

Sample Date: 07-21-2000 Time: 11:11:10 ID#: Report Date: 07-21-2000

Sample Description:

Calcium (as Ca)		Ammonia (as NH3)		H2S (as H2S)	
Magnesium (as Mg)		Aluminum (as Al)		Silica (as SiO2)	
Barium (as Ba)		Manganese (as Mn)		Phosphate (as PO4)	
Strontium (as Sr)		Zinc (as Zn)		Bromine (as Br)	
Sodium (as Na)		Lead (as Pb)		Fluoride (as F)	
Potassium (as K)		Boron (as B)		Nitrate (as NO3)	
Lithium (as Li)		Chloride (as Cl)		Temperature (as °F)	77.00
Iron (as Fe)		Sulfate (as SO4)		Density (g/mL)	1.00
pH	7.00	Acidity (as CaCO3)		Pressure (Atm.)	1.00
Induc. time (sec)		M Alkalinity (as CaCO3)		pCO2 (Atm)	0.0003162
Comments		P Alkalinity (as CaCO3)			

Flows:  
 Weight %  
 Brine Flow (bpd)  
 Oil Flow (BPD)  
 Gas Flow (MMCF/D)

C2 - C5 Acids:  
 C2  
 C3  
 C4  
 C5

Water #:  
 1 of 1  
 GO TO #  
 ADD NEW Deactivate  
 PREVIOUS Activate

OK MIX Change Units Recalculate Display Result Print Result Cancel

## FEATURES COMMON TO SURFACE AND WATERFLOOD GRAPHS

The CHOOSE GRAPHS module should be used to select the graphs desired. Once a graph is displayed on the screen, it can be saved as a PCX file for use in other programs such as word processing programs, or printed. Like the other modules, the ALT and G hot key combo will pop-up the CHOOSE GRAPHS menu. The ALT and F hot key combo will pop-up the SAVE FILE menu for saving a graph as a PCX file, and the ALT P combo will print the graph to the selected printer.

Calculated values used to plot the 3D and 4D graphs can be exported as quotation mark-comma delimited ASCII files. These .DAT files can be imported into most spreadsheet and graphics programs and used to recreate graphs, or further manipulate the data.

## **pH PREDICTION**

Predicting pH as the water cycles is one of the more difficult aspects of computer modeling. DownHole SAT provides three options, chosen from the **SELECT PARAMETERS** menu form.

- The **DEFAULT** curve is a pH:Alkalinity curve which is used by several of the major water treatment companies for predicting pH from alkalinity.
- The **USER DEFINED** curve uses data input in the **INPUT pH-ALKALINITY** module to predict pH from alkalinity.
- The **Caplan curve** is similar to the default curve. It is derived from a paper published by Gary Caplan at Corrosion '90 (NACE).
- The **Translate Source Water** option is based upon a modified Lawrence Caldwell method, more commonly applied to pH prediction of softened or mixed waters.
- The **Theoretical pH-pCO<sub>2</sub>** curve uses the theoretical relationship and predicts a pH based upon pCO<sub>2</sub>.

## **Report Options**

### *Choosing What Output Windows To Display and When*

Several options are available for displaying and printing table and graphs from DownHole SAT. The output windows which will display can be selected from the **Choose Surface Water Windows To Display** and **Choose Mixing Windows To Display** modules in the Preferences menu. (See the **Getting Started** section of the manual for an example).

### *Choosing What Scale Indices and Ions To Display*

A report can become cluttered and information sometimes overlooked in an extremely detailed report. DownHole SAT options allow you to choose the ions to include in reports copied to the Windows Clipboard or printed. DownHole SAT options also allow you to choose the indicators of scale to include in reports copied to the Windows Clipboard or printed. Reports can be customized, for example, to exclude all Momentary Excess indices. Refer to the Getting Started section for examples of the forms **Choose Ions To Print** and **Choose Scales To Print**. These may be accessed from the **Preferences Menu**.

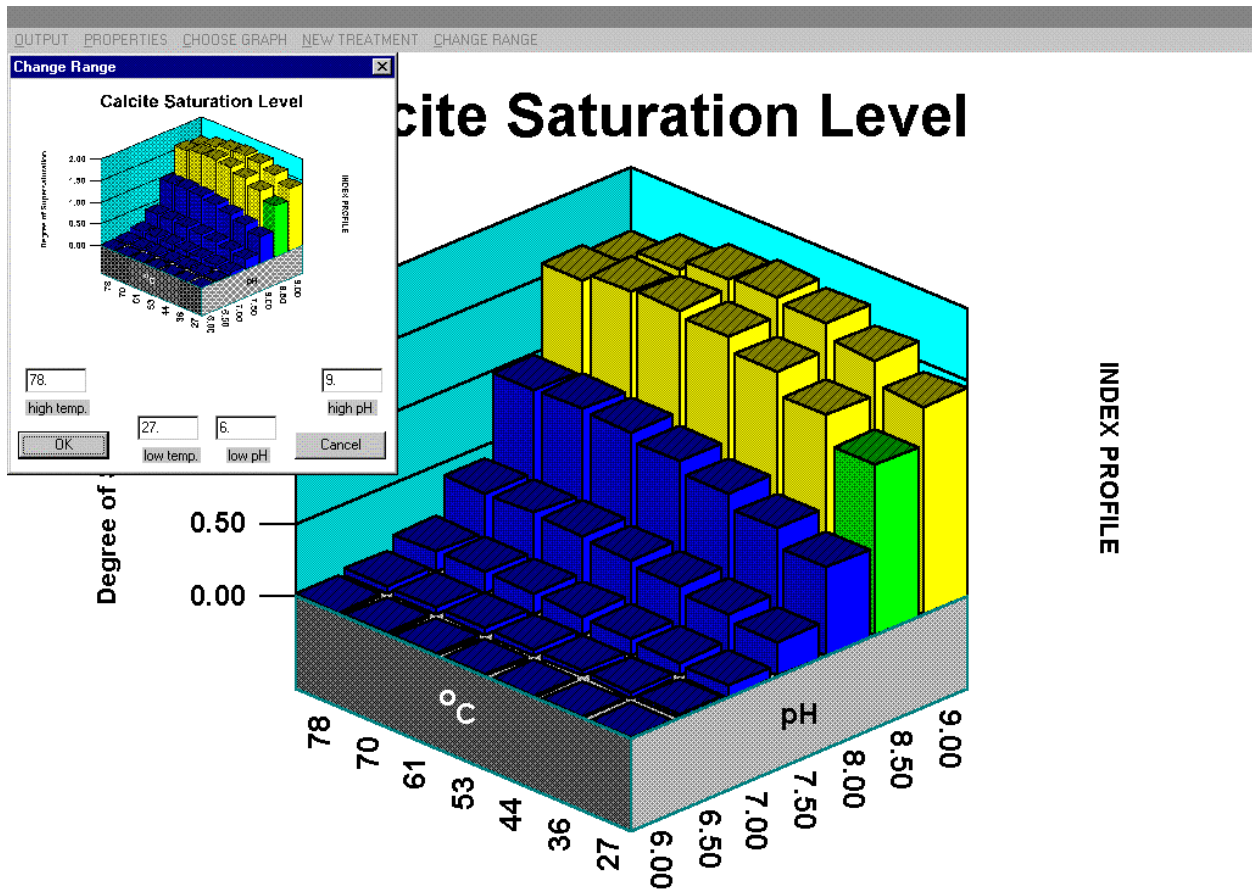
### *Change Range -- New Product Options*

In early versions of DownHole SAT changing products and displaying the new results could be a cumbersome, and sometimes inefficient process. You had to leave a graph or table, access the Select Parameters form, and then go back to the output form or graph to see the results of the change. Version 3.0 adds the ability to change the range for a report and see the results updated on the screen without leaving the graph or report. For pH profiles, you can press the Change Range button on the output form, and input a new pH range. For Temperature profiles, you can

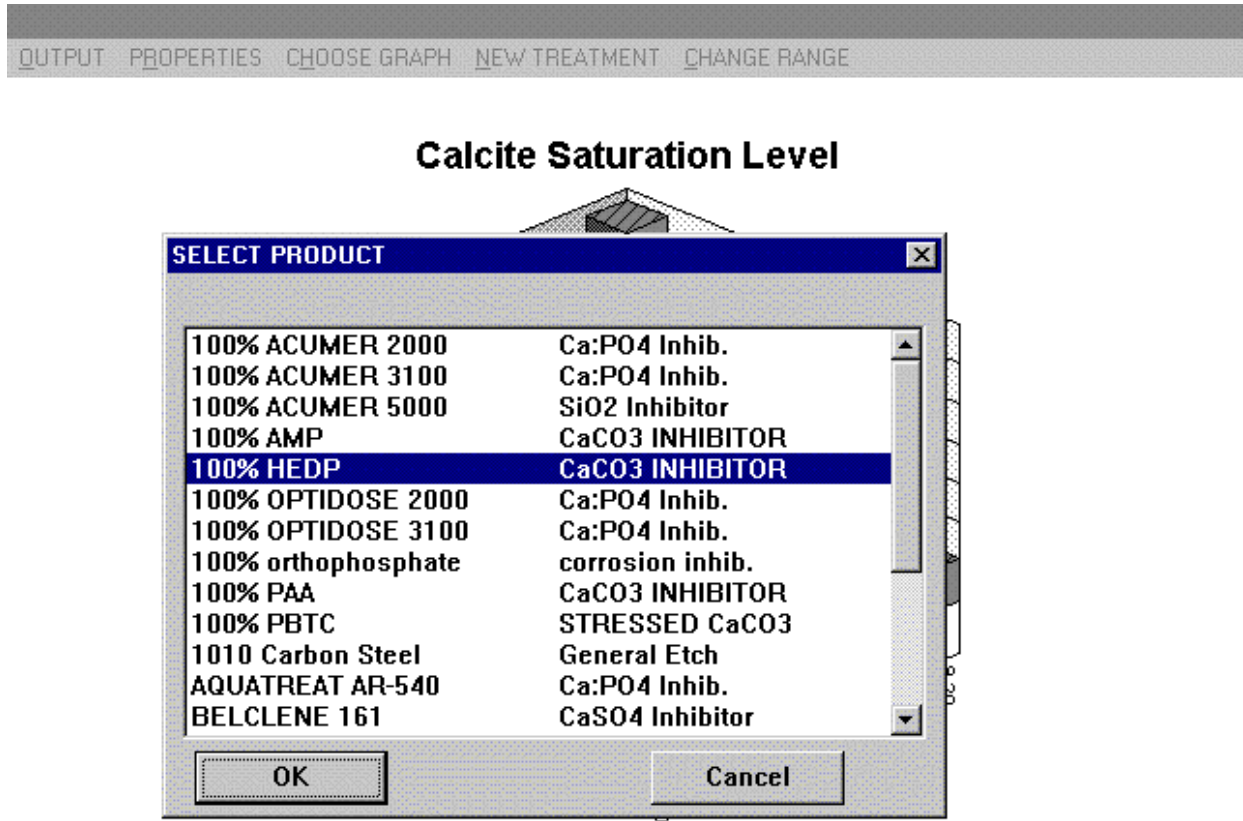
press the Change Range button on the output form, and input a new Temperature range. The New Product and Change Product buttons allow you to select a new treatment, and view the new dosages and color coded ranges on the screen.

The NEW TREATMENT and CHANGE RANGE selections on output windows allows you to quickly see the impact of parameter or treatment changes.

The CHANGE RANGE and NEW TREATMENT selections on the menu bar when a graph is displayed work in a similar manner. The Change Range option displays a smaller version of the graph with edit fields to change any relevant parameters.



The NEW TREATMENT option displays the CHOOSE PRODUCT menu over the current graph or table.



These new features are common throughout the French Creek Software product line. Other menu bar selections, such as PROPERTIES and OUTPUT allow you to further customize a graph or table. Use PROPERTIES to switch a graph from treated to untreated color coding, or from bar graph format to contour. PROPERTIES also can switch between grey scale and color display and printing. PROPERTIES also allows the reversal of axis, when appropriate.

The OUTPUT selections include Copy to the clipboard, which will copy a table or graph to the clipboard for pasting into another application.

NOTE: WHEN COPYING A TABLE TO A WORD PROCESSING PROGRAM, MAKE SURE A **FIXED WIDTH** FONT SUCH AS COURIER IS SELECTED. The table may lose all alignment when pasted into a word processing window with a variable width font (e.g. Times New Roman) selected as the current font. If you encounter this don't despair:

- 1) Go to the Word Processors SELECT ALL command. The entire table should be highlighted.
- 2) Go to the FONT selection menu for the word processor and select a fixed width font like Courier or Courier New.
- 3) You may have to adjust the margins to the minimum, or select a smaller sized font.

## **COPY and PASTE BETWEEN PROGRAMS**

If you right click on the top of a 3D graph bar, or a 2D graph bar, the water analysis for that point will be copied to the Windows clipboard and can be pasted into other French Creek programs. For example, you can right click on the top of the 3D bar, copy the analysis to the Windows clipboard, and paste it into the chemistry input forms of a French Creek program like WaterCycle®, DownHole SAT™, MineSAT™, or WatSIM.™ You can also right click on a column in any table to copy the analysis to the Windows clipboard.

A typical application for the French Creek copy and paste is optimizing water reuse in a plant and for disposal. For example, you can use hyd-RO-dose™ to optimize recovery, click on the 3D graph bar representing the concentrate for the target pH and recovery, paste into DownHole SAT Multi-Mix. Copy and paste in other streams from other programs, or enter manually. Copy the resultant mix into DownHole SAT for a deep injection well disposal scenario to check compatibility with the target aquifer.

Mix other streams such as cooling tower blowdown, and fresh water. Reuse in hyd-RO-dose as RO feedwater or paste into WaterCycle as cooling tower make-up water.

You can also copy and paste within a program.

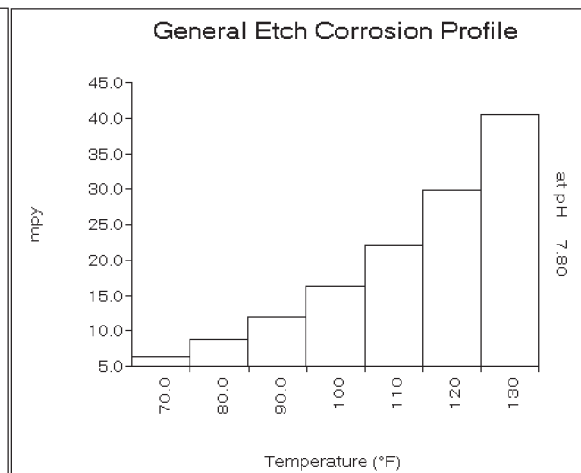
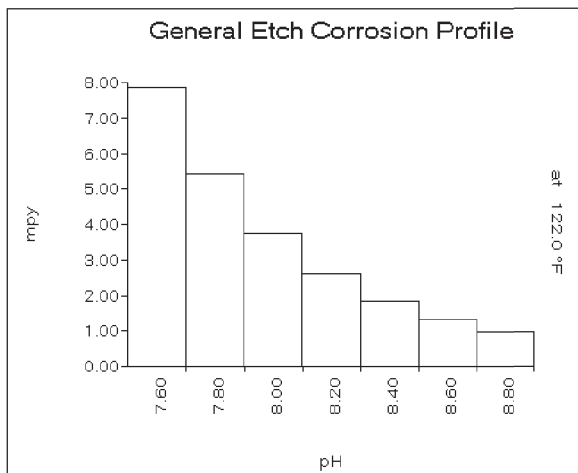
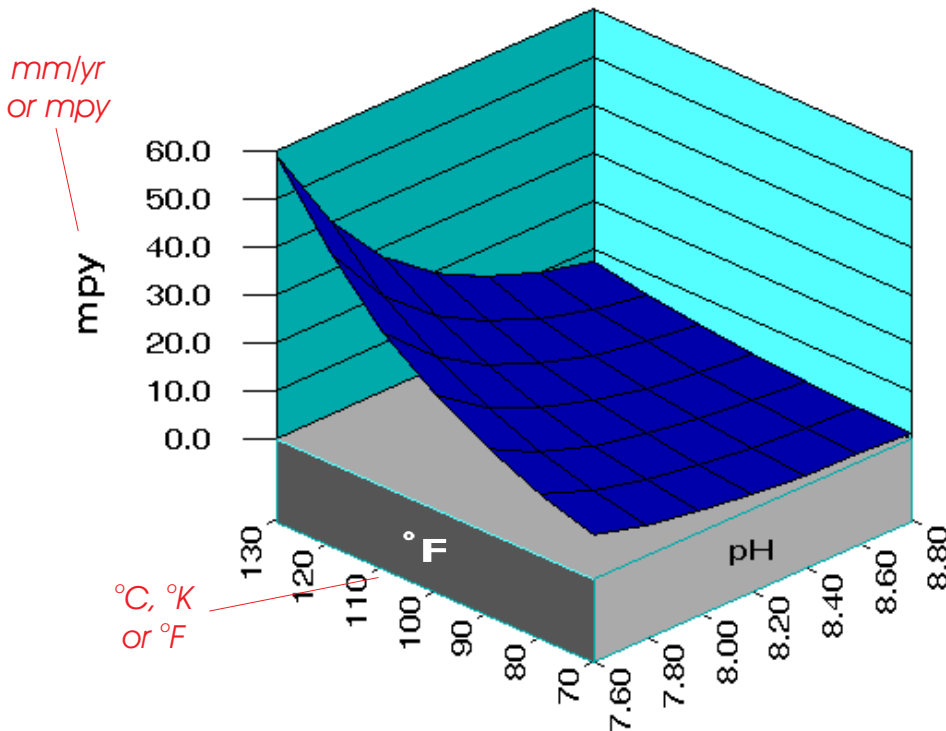
French Creek confirms the copy action after you right click.

# DownHole SAT

Models & Predicts Corrosion Rate

Load the product "General Etch"  
using the SELECT PRODUCT module  
to predict mild steel corrosion rates.

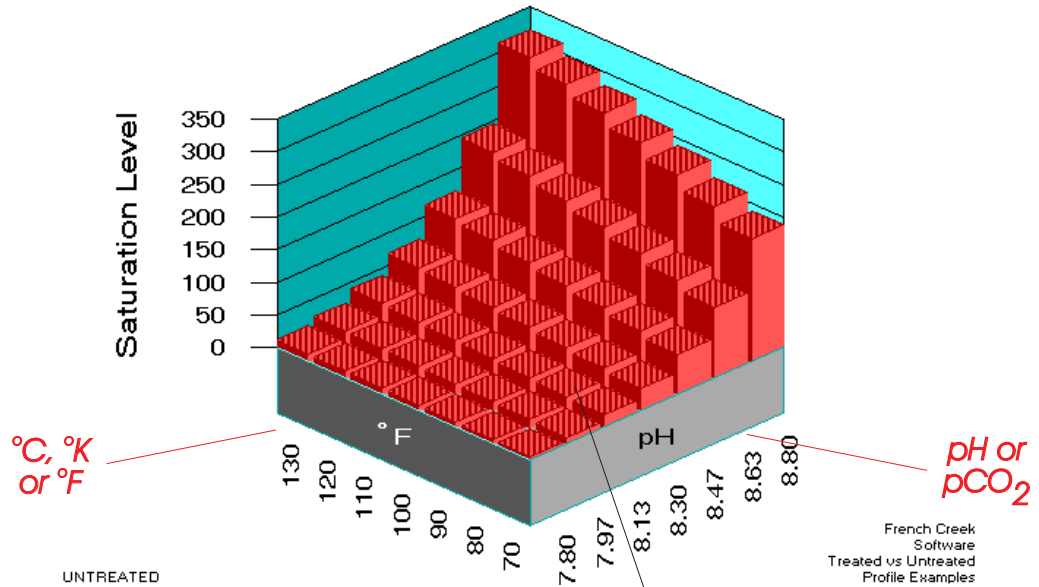
## General Etch Corrosion Profile



# DownHole SAT

Compares The Safe Operating Range  
For a Treated versus Untreated System

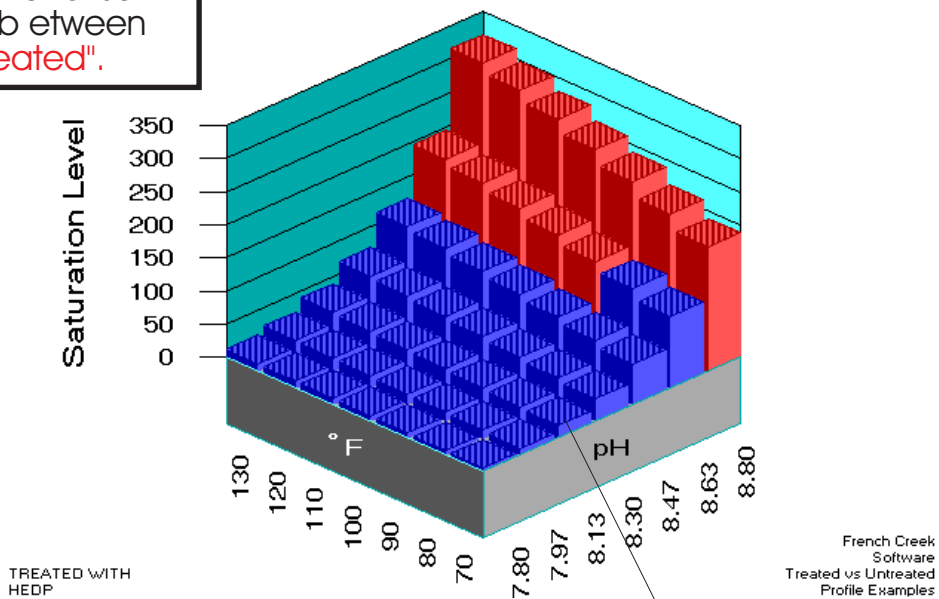
Calcite Saturation Level



The RED color code indicates potential trouble.

Choose the "Treated" or "Untreated" color coding option from the Options Pop-up Menu. The **ALT and T** Hot Key Combination also toggles the display between "Treated" and "Untreated".

Calcite Saturation Level



The BLUE color code indicates a safe zone for operation.





## **DEVELOPING AND USING INHIBITOR MODELS**

**SELECTING A PRODUCT**

**INPUTTING A FORMULATION**

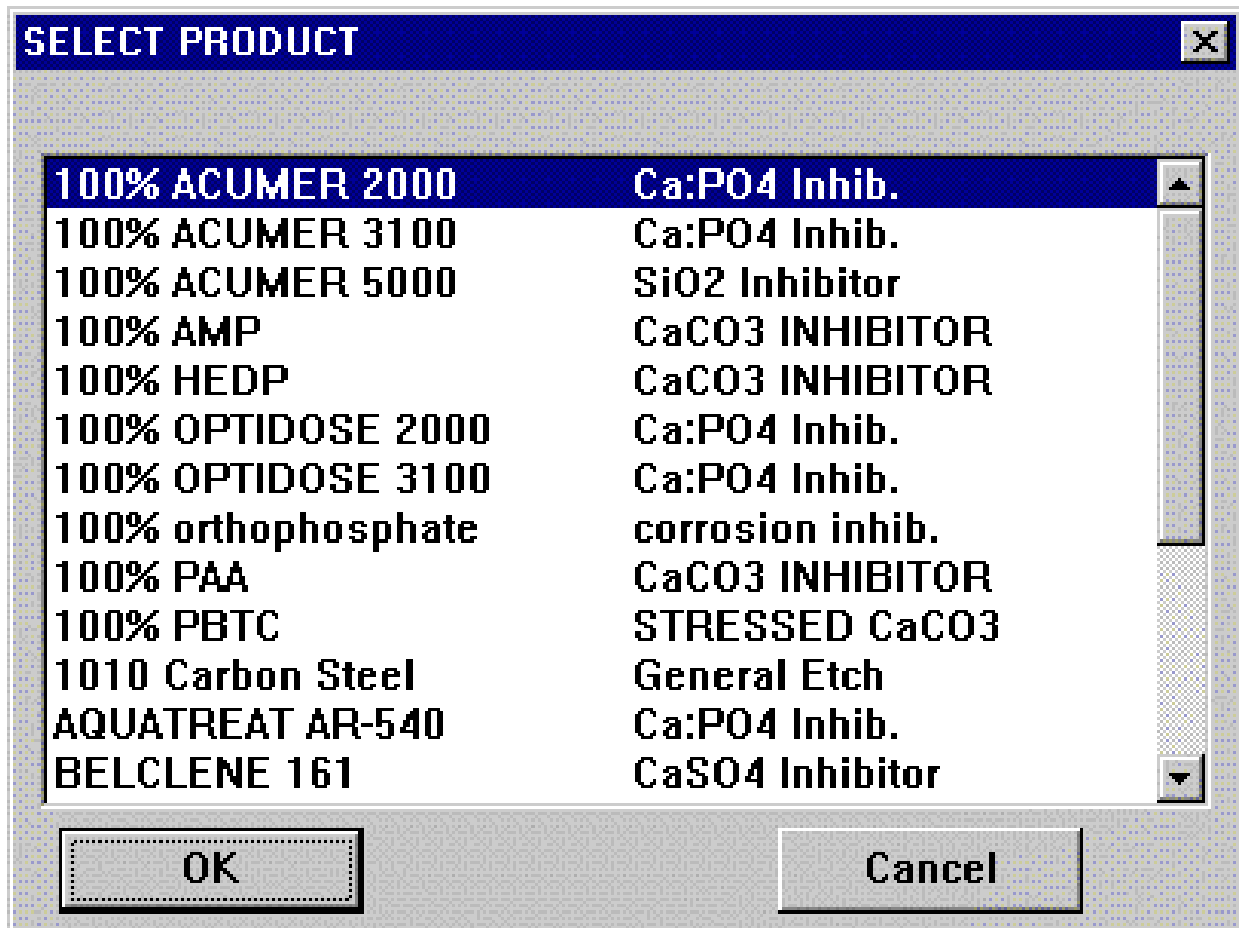
**DOSAGE MODULATION**

**DEVELOPING INHIBITOR MODELS**



## SELECTING A PRODUCT

DownHole SAT® products can be accessed from the FORMULARY menu, by clicking on SELECT PRODUCT, or from the Options Menu Bar on Table displays and graphs. Clicking on the SELECT PRODUCT or NEW TREATMENT buttons elicits the following menu for product selection:



A product file (.PRD) is associated with every menu selection. Each product file contains the models for the components and the product formulation "recipe". Loading the product file loads the mathematical models for the inhibitors in the product into DownHole SAT. Once loaded, they are used by the program for calculating optimum treatment rates (dosages).

## INPUTTING A PRODUCT FORMULATION

The Input Product module, in the FORMULARY pull down menu is used to create a product (.PRD) file. The Input Product module is available only in the DownHole SAT R<sub>x</sub> Product Manager and Laboratory Editions.

The screenshot shows a software dialog box titled "Inhibitor Formulation Input Form". It contains several input fields and buttons for configuring a product formulation.

Field	Value
Formulation Name	100% PAA
Description	CaCO3 INHIBITOR
Product File Name	PAA.PRD
Inhibitor 1	PAA
Inhibitor 2	
Inhibitor 3	
Inhibitor 4	
Inhibitor 5	
Inhibitor 6	
Inhibitor 7	
% Actives	100.000
% Water	0.000

Buttons at the bottom: OK, Calc %, Delete File, Help, Cancel.

Additional fields: Password (empty), ENCRYPT ON (checkbox).

Use the Input Product module to create a new product file or modify an existing product file's Product Name, Description, or Formulation. All entries are made in the form reproduced on the next page. The Product Name and Description information entered are stored in the product file and used as the Product Name and Description list in the Select Product module pop up menu.

Inhibitors MUST be selected from the pop-up menu list of available inhibitors on file. Move the cursor to the Inhibitor Field. Click on the button next to the ingredient field to pop-up the list of available inhibitors. Select the inhibitor of interest. The inhibitor file will be loaded for the ingredient selected.

***ENTER THE % IN THE FORMULATION BASED UPON 100% ACTIVE INGREDIENTS!!***

e.g. if you are using a material which is 50% active AMP, and you wish to have the product be 10% active, you would enter 20% on a manufacturing batch sheet for the material on an "as-is" basis. Enter 10% on the DownHole SAT R<sub>x</sub> formulation sheet for the material on an active basis.

DownHole SAT will total the active ingredients and balance the formula with water.

Pressing the OK button saves the formulation and inhibitor information in the product (.PRD) file named in the File Name field. Copies of this file can be distributed to users of the DownHole SAT R<sub>x</sub> Field Engineer Edition program.

**NOTE: Inhibitors should be re-loaded into a formulation sheet when an inhibitor file is updated. Product files load a copy of the inhibitor file when they are created. They DO NOT automatically re-load a new file when the inhibitor data is updated.**

The module accepts input data for a product file, loads the mathematical correlations for the individual inhibitors in the formulation, and outputs the new or updated product file.

An inhibitor file (\*.INH) must be in the \DHSAT\INHIB\ sub directory for each inhibitor which is an active ingredient.

Inhibitor files are created in the Input Lab Data module of the LABORATORY pull down menu in the DownHole SAT R<sub>x</sub> Laboratory Editions. They can be created from in-house laboratory and/or field data, or obtained from raw material suppliers who use the DownHole SAT R<sub>x</sub> series as a technical support tool.

The ENCRYPTION option allows product files to be encrypted as a precaution against prying.

## DOSAGE MODULATION

The section describes the basis for the models used by and developed using DownHole SAT  $R_x$ . Models are discussed by parameter.

**DRIVING FORCE** - The basic parameter to which scale inhibitor dosages have been correlated historically is the driving force for crystal formation, and crystal growth. Early models attempted to develop models based upon the Langelier Saturation Index or the Ryznar Stability Index. More recently, correlations have been published to the Practical Stability Index on the back of the Puckorius and Associates slide rule. Most water treaters are in agreement that dosage requirements increase with the driving force for scale formation. They differ in which driving force is used. Calcite saturation level provides an excellent driving force for calcium carbonate scale inhibitor models, gypsum saturation level for calcium sulfate in the water temperature range, and tricalcium phosphate saturation level for calcium phosphate scale prevention. The Momentary Excess indices can also be used effectively to model dosage requirements. DownHole SAT  $R_x$  allows the water treatment chemist to develop models using any of the indices calculated by DownHole SAT.

**TIME** - A second critical factor in determining an effective dosage, or developing a model for an inhibitor is time. Time is the residence time of scale forming species in the system you wish to treat. The time where scale inhibition can be as short as 4 to 10 seconds in a once through system, or extend into days for ponds or storage tanks. Induction time is a term applied to the period before a water will begin to form scale. In high saturation level systems, the induction period can be very short. In systems where a water is barely supersaturated, the induction time can approach infinity. Scale inhibitors have been observed to extend the induction time before scale formation, or growth on existing scale substrate, occurs. Gill et al. presented a paper at the 1984 International Water Conference which provides excellent examples of the variation of dosage requirements as critical parameters change.

## IMPACT OF HEDP CONCENTRATION ON INDUCTION TIME

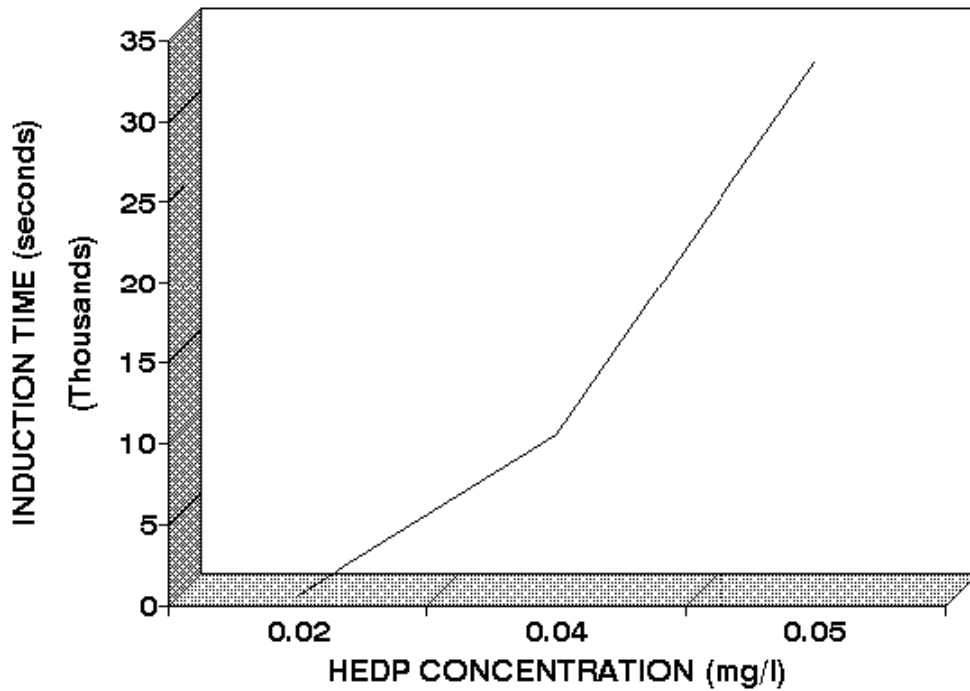
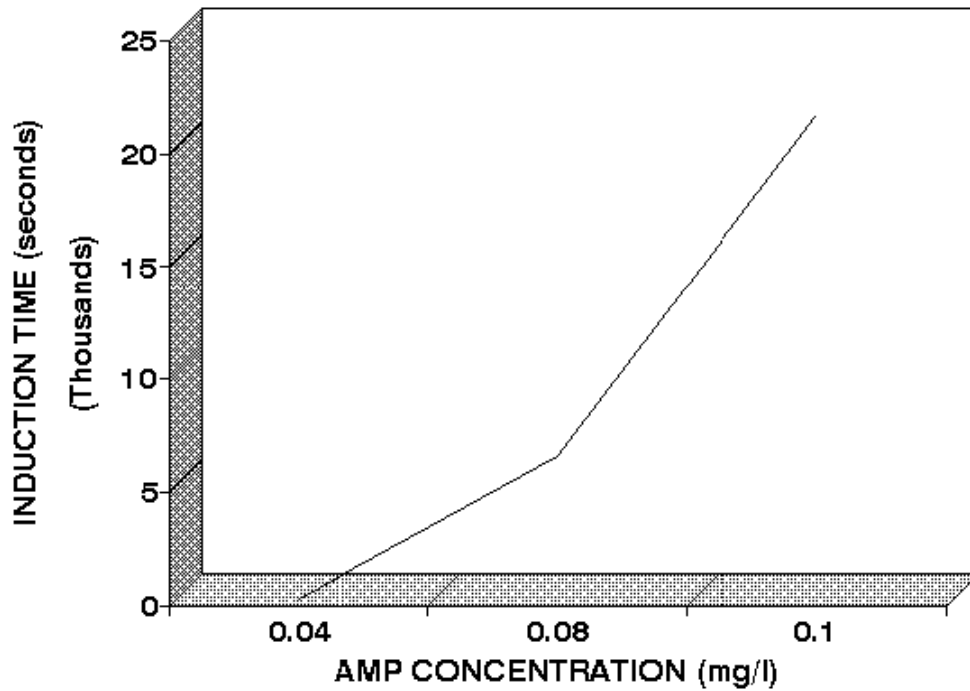


Figure 1 portrays the impact of HEDP dosage on induction time at constant driving force. Figure 2 presents similar data for AMP.



## IMPACT OF AMP CONCENTRATION ON INDUCTION TIME



It can be seen from figures 1 and 2 that induction time increases as inhibitor dosages increases. In many water systems, scale inhibitors may function by increasing the induction time until the water has passed through the system.

## IMPACT OF CALCITE SATURATION LEVEL ON INDUCTION TIME

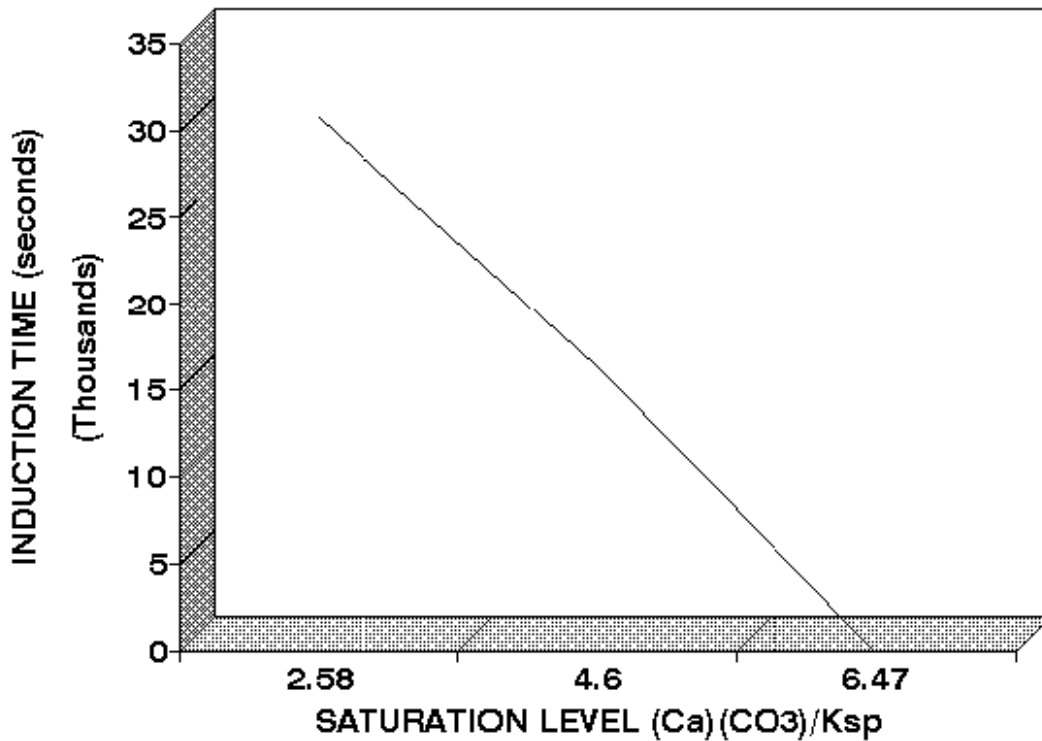


Figure 3 demonstrates that induction time decreases with saturation level, even in the presence of an inhibitor.

A simple mathematical description of these relationships might be modeled as:

$$\text{Induction Time} = \text{function}(1./\text{Saturation Level})$$

This models the decrease in induction time as saturation level increases. The degree of supersaturation is the driving force which increases the rate at which scale will form.

$$\text{Induction Time} = \text{function}(\text{Inhibitor Dosage})$$

Inhibitors extend the time before scale will form in a system by interfering with the kinetics of crystal formation and growth. Rate decreases as inhibitor dosages increase.

$$\text{Induction Time} = \text{function}(\text{Inhibitor Dosage}, 1./\text{Saturation Level})$$

Scale inhibitors fight the driving force for scale formation and growth. Inhibitors increase the induction time, and interfere with reaction rates, so that scale formation will not occur until the treated water has passed through the system.

DownHole SAT  $R_x$  uses more sophisticated relationships than these to model the dosage requirements for scale inhibition. Additional parameters include temperature, as it affects the rate of crystal formation and/or growth.

Dosage changes with temperature can be modeled by the Arrhenius relationship:

$$A \cdot e^{-(Ea/RT)}$$

where

- **A** is a constant
- **Ea** is the activation energy
- **R** is the gas constant
- **T** is absolute temperature.

pH can also be included in the models. pH is an important parameter to include when an inhibitor can exist in two or more forms within the pH range of use, and where one of the forms is much more active as a scale inhibitor than the other(s). pH can also affect the type of scale that forms (e.g. Tricalcium phosphate versus hydroxylapatite).

## DEVELOPING INHIBITOR MODELS

This section describes the use of the Laboratory Edition Modules for:

- Inputting laboratory and field data to develop an inhibitor model.
- Editing inhibitor files to add special rules for handling iron.
- Editing inhibitor files to include a safety factor.

The Input Lab Data module, in the **LABORATORY** pull down menu is used to create inhibitor (.INH) file. The module accepts initial specifications for the inhibitor (e.g. Name, Description, Molecular weight) and instructions for developing a model (e.g. the Driving Force to use, the modeling method).

Property	Variable	Transform	Lower Limit	Upper Limit
	Dosage	LOG(X)		
Variable 1	Hydroxyapatite x Sat.	LOG(X-1)	-99.00	-99.00
Variable 2	pH	AS IS	-99.00	-99.00
Variable 3			-99.00	-99.00
Variable 4			-99.00	-99.00
Variable 5			-99.00	-99.00
Variable 6			-99.00	-99.00

After this preliminary data is entered, and the Correlate button is pressed to signify completion, the module accepts input of water analysis data through almost the same analytical input form that is used in the Source Analysis, Surface Water Analysis, Injection Water and Formation Water input modules. The Input Lab Data form adds two (2) significant fields to the water analysis forms - dosage and time. The input form differs in another way - operation. The Lab Data Input Form replaces itself with a fresh form every time OK is pressed.

**Water Chemistry Input**

Sample Date: 07-21-2000    Time: 17:22    ID#:    Report Date: 07-21-2000

Sample Description:

Calcium (as Ca)	131.00	Iron (as Fe)	0.00	H2S (as H2S)	0.00
Magnesium (as Mg)	0.00	Ammonia (as NH3)	0.00	Silica (as SiO2)	0.00
Barium (as Ba)	0.00	Aluminum (as Al)	0.00	Phosphate (as PO4)	0.00
Strontium (as Sr)	0.00	Manganese (as Mn)	0.00	Bromine (as Zn)	0.00
Sodium (as Na)	0.00	Zinc (as Mn)	0.00	Fluoride (as F)	0.00
Potassium (as K)	0.00	Boron (as B)	0.00	Nitrate (as NO3)	0.00
Lithium (as Li)	0.00	Chloride (as Cl)	0.00	Temperature (as °F)	77.00
pH	7.300	Sulfate (as SO4)	0.00	Density (g/mL)	1.00
Induc. time (sec)	0.00	Acidity (as CaCO3)	0.00	Pressure (Atm.)	1
Corrosion rate (as mpy)	1.2	M Alkalinity (as CaCO3)	100.00	pCO2 (Atm)	0.00
Pitting Index (as mpy)	0.00	P Alkalinity (as CaCO3)	2.00	Dosage (mg/L)	1.2

Flows:  
 Brine Flow (bpd): 1  
 Oil Flow (BPD): 1  
 Gas Flow (MMCF/D): 1

C2 - C5 Acids:  
 C2: 0.0  
 C3: 0.0  
 C4: 0.0  
 C5: 0.0

REC #:  
 1 of 5  
 GO TO #  
 NEXT Deactivate  
 PREVIOUS Activate

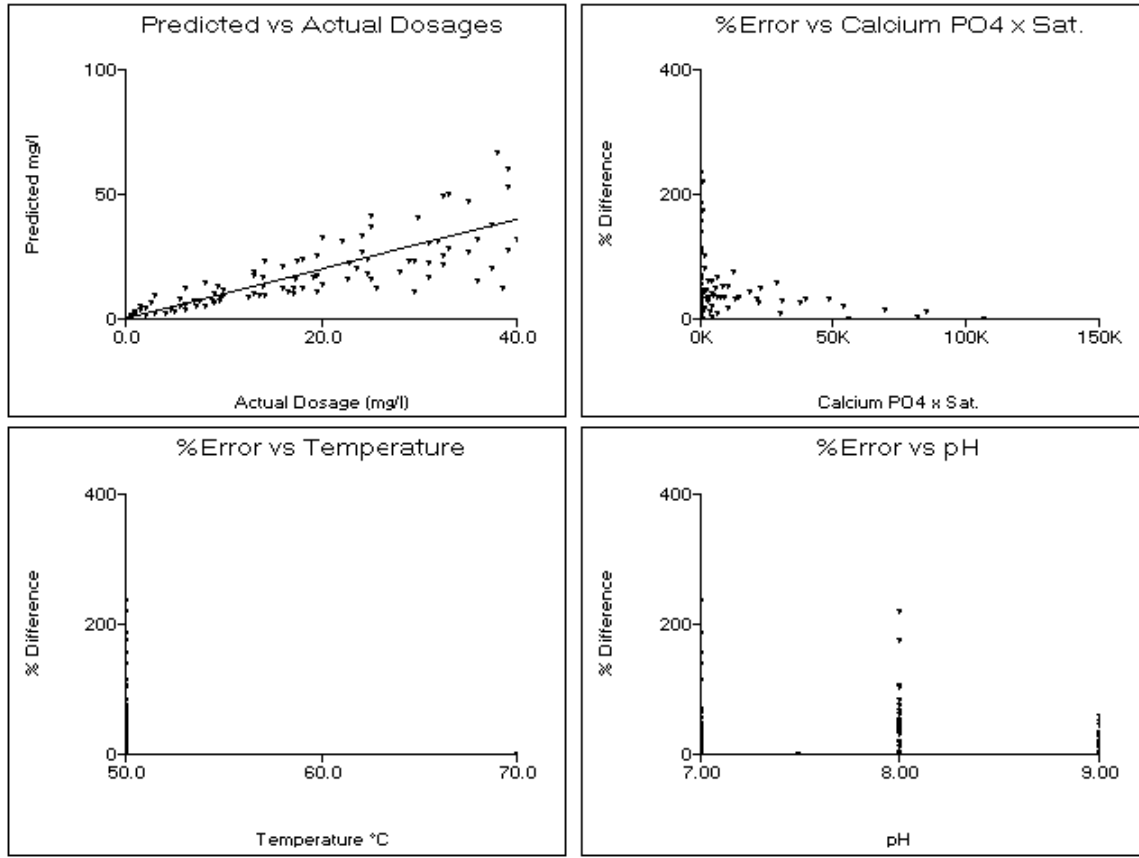
Comments:

OK    Change Units    Correlate    Recalculate    Display Result    Print Result    Cancel

The Next Page and Last Page buttons allow you to browse through the analysis that have been input and make changes. The program will sound a warning when the first analysis on file is reached. The program will ask if you wish to add another analysis when the last analysis is reached.

Once all data has been entered, press **Correlate** to invoke the statistical analysis of the data and generation of an inhibitor file. A table of predicted versus input dosages will be displayed. Use this table to determine crudely how well the data was modeled. A correlation coefficient is also output. Typical coefficients for usable models will range from 0.9 to 1.00 .

Pressing the Graph button will present further information on the correlation in graphical format.



The Input Lab Data module is available only in the DownHole SAT R<sub>x</sub> Laboratory Edition. The Edit Coefficients module is used to add special rules and safety factors to the inhibitor files.

The raw laboratory analysis and calculated values are stored in a .COR file. The data is used to create an inhibitor (.INH) file.

### OPERATION HINTS:

1. Enter inhibitor dosages on a **100% ACTIVE BASIS**.
2. Make backup copies of .COR files under another name. This will prevent anguish and stressed tempers when a .COR file with a thousand or so analysis is over-written unintentionally.
3. Always press Graph after completing the correlation to see the graphs of predicted versus observed dosages, and graphs of error % versus versus the independent parameters.
4. The Options Menu Bar allows correlation graphs to be saved as a .PCX , TIF or BMP file.
5. Always enter at least 5 valid analysis.

## DEVELOPING LABORATORY DATA

A common question from DownHole SAT  $R_x$  users is What should I use for an experimental design? French Creek Software recommends that the experimental designs for developing mathematical models for inhibitors include:

**FIVE TEMPERATURES PREFERRED:** Data should be run at a minimum of three temperatures to account for variation in dosage due to the effect of temperature on reaction rate. When possible, an experimental design should include five temperatures. The temperature range studied should include the lowest and highest temperatures expected in the field, or where the models generated by DownHole SAT  $R_x$ .

**THREE TO FIVE pH POINTS PREFERRED:** Data should be run at a minimum of three different pH to account for variation in dosage due to the effect of pH on the form in which the inhibitor exists (see Hann and Bardsley). When possible, an experimental design should include five pH points. The pH range studied should include the lowest and highest expected in the field.

**THREE TO FIVE INDUCTION PERIODS PREFERRED:** Data should be run at a minimum of three different times to allow for the correlation of induction time versus inhibitor dosage. In some test methods, the times for each replicate will vary naturally. In other methods, dosages are evaluated at constant time extensions, and the last dosage to provide 100% inhibition is selected as the minimum effective dosage. Assure that the time spans covered by the data cover the full range over which you expect to use the model.

**INCLUDE THE MINIMUM AND MAXIMUM FOR CRITICAL PARAMETERS:** Tests should ideally be run over the range of parameters under which the model will be used for inhibitor dosage recommendations. For example, the experimental design should include the minimum and maximum driving force where the model will be used. If a calcium carbonate inhibitor is being evaluated, the range of calcium and hardness levels anticipated should be bracketed as well as the range of calcite saturation levels.

**RUN SUPPLEMENTAL TESTS WHERE APPROPRIATE:** Some inhibitors are known to lose activity in the presence of iron. Tests run in the presence and absence of iron can help to expand the accuracy of models by allowing an Iron Factor to be input using the Edit Coefficients module.

Several papers are referenced in the Appendix of this manual which outline test methods which have been used effectively to characterize the performance of inhibitors. Successful correlations can also be developed based upon the field experience of water treatment personnel have worked with an inhibitor over a broad range of conditions.

## EDITING INHIBITOR FILES TO ADD SAFETY FACTORS

The EDIT COEFFICIENTS module in the Laboratory menu allows

- 1) adding a safety factor to a model;
- 2) adding a safety factor to account for iron; and
- 3) phosphate content of the inhibitor, if any

**FACTORS FOR SPECIAL CASES**

INHIBITOR  FILENAME

PURPOSE

SAFETY FACTOR  1.1 increases by 10%, 1.2 by 20%, etc.

IRON FACTOR  
Increase inhibitor dosage by  ppm for every ppm Fe above

PHOSPHATE FACTORS  
% Orthophosphate as PO4  % Organic phosphate as PO4

A 20% to 100% general safety factor (1.20 - 2.00) typically is added to account for scatter in the data.

The Iron Factor accounts for demand for polymer by iron in the water.

Contact French Creek Software for custom editing of models, such as the combination of several discrete models into one correlation.



## CURRENT & PAST DownHole SAT R<sub>x</sub> Models

Early versions of DownHole SAT R<sub>x</sub> provides four (4) fixed basic models as well as the current custom option for developing inhibitor correlations. The fixed options are included for historic perspective. The same models can be setup using the current custom option forms. Older models are updated to the custom format when imported into newer version of DownHole SAT R<sub>x</sub>. Older models are as follows:

1. **Model 0 - Dosage = f(DF-1, time)** The first model develops a correlation of dosage as a function of driving force, temperature, and time, The driving force selected for this, or other models, should be appropriate for the scale forming species under study. For example, calcite saturation level is a common driving force used to model calcium carbonate scale inhibitors. Tricalcium phosphate saturation level is a recommended driving force for use in modeling the effectiveness of calcium phosphate control agents. Gypsum saturation level is recommended for modeling calcium sulfate control at low (< 130 °F) temperature, while anhydrite saturation level might be more appropriate at higher temperatures. This model subtracts 1.0 from the saturation levels. This accounts for the driving force for scale formation not being present until the test water becomes supersaturated - at a saturation level above 1.0.
2. **Model 1 - Dosage = f(DF, time)** The second model differs from the first in that the correlation is developed to the raw driving force rather than to the driving force - 1.
3. **Model 2 - Dosage = f(DF-1, time, pH)** The third model is identical to model 0 with one exception. pH is included as a variable to account for the impact of pH upon the form in which an inhibitor exists. This is typically the model of choice for developing a correlation for a scale inhibitor.
4. **Model 3 - Corrosion Model** This method should be used to model the performance of a corrosion inhibitor versus water chemistry, temperature, and time. Data should be selected to be at a milestone for desired results. For example, all data might be collected at < 1.0 mpy, < 2 mpy, < 5 mpy, or another performance target. This will allow for the development of a model of dosage required to achieve the target mpy or less.

### DEACTIVATING ANALYSIS FILES

There will be times when it is desired to perform a statistical modeling of the data with the results of one or more analysis excluded from the evaluation. This can be valuable in eliminating outliers to see their impact. Pressing the ACTIVATE or DE-ACTIVATE buttons when an analysis is on the screen ACTIVATES or DE-ACTIVATES an analysis. De-activating does not eliminate the data from the .COR file, it merely excludes it from statistical evaluation.

### LEARNING THE LABORATORY MODULES

The best way to learn these modules is by using them. A .COR file is included for practice on modeling inhibitor performance and requirements.

## REFERENCES

- 1 Stumm, Werner and James J. Morgan, "Aquatic Chemistry," John Wiley & Sons, 1981.
- 2 Langelier, W.F., "The Analytical Control of Anti-Corrosion Water Treatment," J.A.W.W.A., 8, 500-1521(1936).
- 3 Stumm, Werner, "Investigations on the Corrosive Behavior of Waters," A.S.C.E., 86, 2657.
- 4 Loewenthal, R.E., and G.v.R. Marais, "Carbonate Chemistry of Aquatic Systems," Ann Arbor Science, 1982.
- 5 Puckorius, Paul, "Getting A Better Reading on Scaling Tendency of Cooling Water," Power, September, 1983.
- 6 Larson, T.E., and Skold, R.V., Corrosion, 14, (1958).
- 7 Truesdell, A.H., and B.F. Jones, "WATEQ, A Computer Program for Calculating Chemical Equilibria in Natural Waters," N.T.I.S. Publication PB220460 (1973).
- 8 Schell, Charles J., "The Use of Computer Modeling in Calguard to Mathematically Simulate Cooling Water Systems, and Retrieve Data," Proceedings of the 41rst International Water Conference, 1980.
- 9 Chow, Winston, Aronson, John T., Michletti, Wayne C., "Calculations of Cooling Water Systems: Computer Modeling of Recirculating Cooling Water Chemistry," Proceedings of the 41rst International Water Conference, 1980.
- 10 Johnson, Donald A., Fulks, Kenneth E., "Computerized Water Modeling in the Design and Operation of Industrial Cooling Systems," Proceedings of the 41rst International Water Conference, 1980.
- 11 Musil, R.R., and H.J. Nielsen, "Computer Modeling of Cooling Water Chemistry," Proceedings of the 45th International Water Conference, 1984.
- 12 Ferguson, R.J., "A Kinetic Model for Calcium Carbonate Deposition", Materials Performance, November, 1984.
- 13 Caplan, Gary, "Cooling Water Computer Calculations: Do They Compare", Corrosion '90, Paper 100.
- 14 Ferguson, R.J., "Computerized Ion Association Model Profiles Complete Range of Cooling System Parameters", Proceedings of the 52nd International Water Conference, 1991.
- 15 Gill, J.S., Anderson, C.D., and Varsanik, R.G., "Mechanism of Scale Inhibition by Phosphonates", Proceedings of the 44th International Water Conference, 1983.

16 Boffardi, B.P., Schweitzer, G.W., "Advances in the Chemistry of Alkaline Cooling Water Treatment", Corrosion '85, Paper 132.

17 Ashcroft, R.H., "Scale Inhibition Under Harsh Conditions By 2-Phosphonobutane-1,2,4-Tricarboxylic Acid", Corrosion '85, Paper 123.

18 Hann, W.M., Natoli, J., "Acrylic Acid Polymers and Copolymers as Deposit Control Agents in Alkaline Cooling Water Systems", Corrosion '84, Paper 315.

19 Amjad, Z., Masler, W.F.,III, "The Inhibition of Calcium Sulfate Dihydrate Crystal Growth by Polyacrylates and the Influence of Molecular Weight", Corrosion '85, Paper 357.

20 Oddo, J.E., Tomson, M.B., "Scale Control, Prediction And Treatment Or How Companies Evaluate A Scaling Problem And What They Do Wrong". Corrosion '92, Paper 34.

21 Ferguson, R.J., Weintritt, D.J., "Developing Scale Inhibitor Dosage Models For Oil Field Operations," Corrosion '94, Paper 46.

**DownHole SAT ® Rx LICENSE AGREEMENT**  
FRENCH CREEK SOFTWARE, INC. (“FRENCH CREEK”)  
Kimberton & Hares Hill Road, Box 684  
Kimberton, PA 19442

French Creek has developed the automated capability to predict certain chemical properties of water samples. French Creek refers to this computer software as DownHole SAT, sometimes referred to as DownHole SAT Rx or System in this Agreement.

DownHole SAT is a predictive tool which will enable Customer to obtain a more complete understanding of the chemistry of the water being analyzed. DownHole SAT should be used as a supplement to Customer’s historical experience and other testing procedures which Customer may utilize. DownHole SAT is not intended as a substitute for the exercise of judgment by Customer’s employees or consultants.

These terms and conditions state the legally binding understandings between French Creek and Customer relating to the licensing of the System and the performance of services indicated in the French Creek Software Order Form (“Order Form”). The terms of this Agreement are incorporated by reference into the Order Form.

**1. DownHole SAT Rx**

Customer desires to license DownHole SAT as indicated by Customer on the Order Form and more fully described in its accompanying documentation. The System documentation indicates the equipment configurations which may be used to operate DownHole SAT, and is hereby incorporated by reference. Customer should specify on the Order Form the number of copies of the System to be licensed under this Agreement.

**2. DELIVERY AND SUPPORT**

French Creek will ship the number of copies of DownHole SAT as indicated on the Order Form as well as System documentation upon French Creek’s receipt and acceptance of an executed Order Form and accompanying fees. Delivery will be made at a mutually agreeable time, but no later than thirty (30) days after French Creek has accepted the Order Form. Payment of applicable fees is due upon execution of the Order Form.

DownHole SAT is capable of being installed by Customer by following the installation instructions in the documentation. As part of the license fee, French Creek provides 30 days of technical support. Technical support refers to assisting Customer to learn how to operate DownHole SAT, but does not include technical assistance in the interpretation of the various indices calculated by DownHole SAT. If additional assistance is required, French Creek will use its best efforts to assist Customer and will charge Customer for such services at its then current consulting charges.

**3. PAYMENT**

The fees and payment terms for the System and services are set forth in the Order Form.

Customer shall be responsible for the payment of any and all taxes or amounts paid in lieu thereof, however designated, levied or based on the System license granted hereunder or upon the services to be rendered or otherwise on account of this Agreement, exclusive only of taxes based on French Creek’s net income.

French Creek reserves the right to terminate the System license for failure to pay related license fees or taxes, and/or to terminate any service for failure to pay related service fees or taxes, as stated in the Order Form.

#### **4. CONDITIONS TO SYSTEM LICENSE**

French Creek hereby grants Customer a license to operate the System, subject to the terms and conditions of this Agreement. The DownHole SAT license is a non-exclusive, non-transferable right to use the System. Failure to abide by any of the conditions stated in this Agreement may result in termination of the license granted in this Agreement.

The DownHole SAT license is subject to the following conditions:

(a) Customer acknowledges that the software and other technical data licensed hereunder are subject to export controls imposed on Customer and French Creek by the provisions of the United States Export Administration Act of 1979, as amended, and that the software is exported under a General Export License, designation GTDR, and that the documentation is exported under a General License, designation GTDA. Customer certifies to French Creek that neither the technical data, (in the form of software or manuals), nor the direct product thereof is intended to be shipped, either directly, or indirectly, to Country Groups Q,S,W,Y, or Z, nor Afghanistan or the Peoples' Republic of China, without further compliance with the Validated License requirements of the Office of Export Administration, United States Department of Commerce. Customer agrees to use this technical data only at authorized destinations, and Customer will not knowingly permit exportation or transshipment in violation of the above law and regulations thereunder.

Customer agrees to indemnify and hold French Creek harmless from any and all costs, damages, fines, or other expenses incurred by French Creek by reason of Customer's violation of these representations of Customer.

(b) Each copy of the System may only be used by Customer on one equipment work station as defined in the System documentation at any one time. Customer may not use or allow use of the System in any time-sharing or service bureau arrangement, or with any interactive cable system or local area network. Customer may only use the System for its own internal business or in servicing the business requirements of its clients for whom Customer performs services.

(c) Customer shall not release, or allow the release of, the System or its related documentation, in any form to any third party, except to Customer's employees who are directly concerned with the licensed use of the System, except as otherwise specifically stated herein.

(d) Customer shall not copy the System, except for purposes of normal backup and testing, without the prior written consent of French Creek. In the event that Customer copies the System or its accompanying documentation as stated herein, Customer agrees to also copy French Creek's copyright notices and/or other proprietary notices in the same manner, location and method of presentation as existed in the materials supplied by French Creek to Customer.

(e) Other than as stated in this Agreement, Customer understands and agrees that it has no right, title or interest in the System, and agrees that it shall not attempt at any time to transfer its rights to use the System without the prior written consent of French Creek. Customer agrees that it will not use System, except as stated herein. Customer further agrees that it will not modify, decompile or disassemble the System, nor shall Customer incorporate the System into any updated or derivative work without the prior written consent of French Creek. For purposes of this Agreement, the term, "updated or derivative work", is intended to refer to the use of the System, either in whole or in part, in the development of some other system of work, whether or not such other system or work is operated by computer or otherwise. The term, "updated or derivative work", is not intended to refer to any interfaces or other methods of access to the System.

#### **5. WARRANTY**

For a period of thirty days following Customer's receipt of the System, French Creek warrants that Customer shall have the right to return the System and to receive a full refund of related license and initial maintenance fees (exclusive of travel, living and out-of-pocket expenses), if the System fails to operate substantially in accordance with the System documentation.

EXCEPT AS OTHERWISE STATED HEREIN, FRENCH CREEK MAKES NO REPRESENTATION OR WARRANTY (EXPRESS, IMPLIED OR STATUTORY) CONCERNING THE SYSTEM OR SERVICES

PROVIDED HEREUNDER. FRENCH CREEK SPECIFICALLY DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE FOR SUCH SYSTEM OR SERVICE. CUSTOMER UNDERSTANDS AND AGREES THAT THE SYSTEM IS LICENSED STRICTLY ON AN "AS IS" BASIS.

The terms and conditions of this section shall survive any termination of this Agreement.

## **6. INDEMNITY**

French Creek warrants that it has all necessary rights to license the System to Customer. French Creek agrees to indemnify, defend and hold Customer harmless for breach of such warranty, provided that, Customer gives French Creek prompt notice of a claim alleging such breach and, provided further, that French Creek shall have full authority to defend, settle or compromise such claim. If the use of the System provided hereunder is prohibited based on a claim of infringement of another party's rights, then French Creek shall either:

- (a) procure the right for Customer to use such licensed System;
- (b) modify such portion of the System to become non-infringing, provided that such modification does not adversely affect Customer's intended use of the System as contemplated hereunder;
- (c) replace the infringing portions of the System with equally suitable, compatible and functionally equivalent non-infringing programs and/or other materials at no additional charge to Customer;
- (d) if none of the above are commercially practicable, then Customer shall terminate its use of the licensed System and accept from French Creek as compensation therefor all license fees paid hereunder less an amount equal to such license fees, divided by 60, multiplied by the number of months of Customer's use of the System, commencing with the date of System delivery.

This warranty and indemnity shall not apply if Customer is in material breach of this Agreement and such breach gave rise to French Creek's liability hereunder. Similarly, this warranty and indemnity shall not apply if the basis for the infringement claim is due to the System being used in conjunction with software not supplied by French Creek hereunder, or which differs in any way from the software or equipment configuration specified in the documentation for use with the System.

This section states French Creek's entire liability concerning allegations that French Creek lacked the right to license the System hereunder. The terms and conditions of this section shall survive any termination of this Agreement.

## **7. CONFIDENTIAL INFORMATION**

Customer acknowledges that the System and accompanying documentation constitute valuable and proprietary property of French Creek. Customer understands and agrees that French Creek may suffer irreparable harm in the event of any unauthorized disclosure of any portion of the System and/or its accompanying documentation which may substantially diminish the value of such System and documentation to French Creek. Therefore, Customer agrees not to disclose any portion of the System or accompanying documentation without the prior written consent of French Creek, except that Customer may disclose such materials (a) to employees of Customer who have a need to be familiar with the operation of the System or its accompanying documentation; (b) to any governmental agency with supervisory authority over Customer, or pursuant to compulsory legal process; or (c) to others in a strict confidential relationship with Customer. In this regard, Customer shall take all steps as are necessary or appropriate to fulfill this obligation.

In the event that Customer materially breaches its obligations under this section, Customer understands and agrees that French Creek has the right to terminate this Agreement upon written notification to Customer. Customer further agrees upon such termination to return to French Creek the original and all copies of the licensed System and related documentation. Furthermore, Customer acknowledges that French Creek shall be entitled to an injunction prohibiting the use and further disclosure of such licensed System and materials, and further entitled to money damages resulting from such unauthorized disclosure. The rights and remedies set forth herein are not exclusive and are in addition to any other rights and remedies provided by law, and the exercise of one right shall not preclude the exercise of any other right stated herein.

The terms and conditions of this section shall survive any termination of this Agreement.

## **8. MAINTENANCE**

Customer may elect to have French Creek perform maintenance services for the System by so indicating on the Order Form. Maintenance services will commence upon Customer's execution of the Order Form and French Creek's receipt of the appropriate maintenance fee. Maintenance services will be provided for an initial term of one year, and will renew for additional one year terms unless either party gives 60 days prior written notice of its intention to terminate such services. Fees for renewal terms of maintenance services will be calculated as a percentage of the then current license fee for the System at time of renewal.

Under maintenance, French Creek will provide Customer with periodic releases of the System that will include minor enhancements as well as modifications to keep the System operating in accordance with its accompanying documentation. Prior releases of the System will be supported for three (3) months after a new release becomes available to Customer.

Support services under maintenance include telephone consultation and other reasonable services necessary to keep the System (as supplied by French Creek) performing in accordance with its documentation. These services will be performed during French Creek's normal East Coast (US) business hours. Ordinarily, French Creek will be able to correct the problem over the telephone. However, if requested by French Creek, Customer will document the circumstances giving rise to such problem and provide such explanation to French Creek in writing. If French Creek is unable to correct the problem within 48 business hours of receipt of such written explanation and such problem prevents normal operation of the System consistent with its documentation, French Creek will provide Customer with another copy of the System to help resolve the problem. If it is determined that the problem was caused by Customer or that Customer failed to properly follow French Creek's directions, French Creek shall be entitled to be reimbursed for all out-of-pocket expenses, plus consulting time at French Creek's then current billing rates.

If Customer declines maintenance at time of licensing or fails to continue maintenance services, and then elects to begin or resume maintenance coverage, Customer shall pay to French Creek all maintenance fees that would have been payable to French Creek if Customer had been or remained on maintenance plus an additional 10% reinstatement fee.

Thereafter, French Creek's liability to Customer shall not exceed the amount of license fees paid to French Creek on account of the System. French Creek shall have no liability to Customer for damages resulting from causes beyond French Creek's reasonable control.

IN NO EVENT WILL FRENCH CREEK BE LIABLE FOR ANY SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES (INCLUDING LOSS OF PROFITS OR GOODWILL) ARISING FROM OR IN CONNECTION WITH THE SYSTEM OR SERVICES PROVIDED UNDER THIS AGREEMENT, EVEN IF FRENCH CREEK IS ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

THIS SECTION STATES CUSTOMER'S EXCLUSIVE REMEDIES UNDER THIS AGREEMENT. THIS SECTION SHALL SURVIVE ANY TERMINATION OF THIS AGREEMENT.

## **11. TERM AND TERMINATION**

The license granted in this Agreement is for a term of twenty (20) years, or until sooner terminated as stated herein. Upon termination, Customer shall return to French Creek the original and all copies of the licensed System and related documentation, or certify in writing to French Creek the destruction of such materials. French Creek reserves the right to terminate any service provided hereunder as stated herein or in the Order Form.

## **12. GENERAL**

(a) AMENDMENT: No amendment or supplement to this Agreement shall be binding unless consented to in writing and signed by both parties, provided that such consent shall not be unreasonably withheld. The party

requesting any consent under this Agreement shall reimburse the other party for any expenses, including attorneys' fees, which result from the request for consent.

(b) ASSIGNMENT: Neither party may assign, sub-license, sub-lease, lend, rent or otherwise transfer this Agreement or the rights granted hereunder to any person, whether by operation of law or otherwise, without the other party's prior written consent, which consent shall not be unreasonably denied, PROVIDED HOWEVER, that no consent shall be required for any assignment or transfer Pursuant to any merger, consolidation or reorganization to which either Customer or French Creek is a party. This Agreement shall bind and inure to the benefit of any such successor or assign. The license granted hereunder shall not be assigned or assignable in any proceeding involving the liquidation of Customer.

(c) RELATIONSHIP OF THE PARTIES: It is clearly understood between the parties that at all times during this Agreement that the relationship between French Creek and Customer is solely as independent contractors and in no other capacity. The parties agree that there are no intended or incidental third party beneficiaries of this Agreement.

(d) COST OF ENFORCEMENT: If either party is required to engage in legal proceedings to enforce the obligations of the other, in law or in equity, the prevailing party shall be entitled to reasonable attorneys' fees and all related necessary and reasonable costs and expenses.

(e) SEVERABILITY: In the event that any one or more of the provisions of this Agreement shall for any reason be held to be invalid, illegal or unenforceable, the remaining provisions of this Agreement shall be unimpaired, and the invalid, illegal or unenforceable provisions shall be replaced by a mutually acceptable provisions, which being valid and legally enforceable, comes closest to the intention of the parties underlying the invalid, illegal or unenforceable provision. If this Agreement or any provisions hereof are held to be invalid, illegal or unenforceable under the laws of a particular jurisdiction, it is the intention of the parties that all of the provisions of this Agreement shall remain in full force and effect in all other states and jurisdictions.

(f) ATTACHMENTS: The terms and conditions of the attachments and Exhibits to this Agreement are incorporated herein by this reference and shall constitute a part of this Agreement as if fully set forth herein.

(g) HEADINGS: The section headings in this Agreement are for the purposes of reference only and shall not limit or otherwise affect any of the terms hereof.

(h) AUTHORITY: Both parties warrant that all approvals necessary for the execution of this Agreement have been obtained, and that the individuals signing the Order Form on behalf of their respective parties have full authority to do so.

(i) NOTICES: Unless otherwise provided herein, all notices or other communications under this Agreement must be in writing and signed by a duly authorized representative of the party giving such notice, or such other persons as either party shall specify in a written notice to the other. All such notices shall be deemed given and received when delivered by hand, or placed in the mails addressed to the other party, first class registered mail, postage prepaid, at the addresses indicated following the signatures of the parties on the Order Form or such other addresses as may be specified in writing.

(j) ENTIRE AGREEMENT: The terms and conditions stated herein constitute the entire and exclusive agreement between the parties for the System, and no other statements, unless agreed to in writing, shall be binding upon the parties. No statement of any marketing representative shall be binding on French Creek, unless set forth in writing and agreed to by French Creek. This Agreement shall be effective only after its acceptance by French Creek at its offices in Pennsylvania.

(k) GOVERNING LAW: This Agreement shall be governed and construed in accordance with the laws of the Commonwealth of Pennsylvania.





# **TECHNICAL SUPPORT**

**Via e-mail**

***frenchcreek@worldnet.att.net***

**At Our Web Site**

***http://www.frenchcreeksoftware.com***

**By Telephone**

***Voice (610) 935-8337***

***FAX (610) 935-1008***

# **SOFTWARE UPDATES**

**At Our Web Site**

Registered users with active Annual Maintenance Agreements can download updates from our web site. A USER ID and PASSWORD is required.

To register for a USER ID and PASSWORD  
Visit our web site and REGISTER FOR UPDATES

To download updates,  
visit the LICENSED USER DOWNLOAD AREA  
***http://www.frenchcreeksoftware.com***

# Windows Version **FAST TRACK INSTALLATION**

Insert the diskette in floppy drive **A** or **B**.

Execute the program **SETUP.EXE**  
from FILE MANAGER

*or*

Use the Windows RUN command to  
launch **SETUP.EXE**

To Execute DownHole SAT

Click on the French Creek Software icon  
(or use the run command for  
**\\DHSAT\DHWIN.EXE** )

Click on the START Button  
in Win95/98/2000 or NT  
and select the **DownHole SAT** icon  
in the French Creek program group

# The Security System

The software is protected against unauthorized access. To activate the software, you must obtain a **Program Release Code** from French Creek Software. The following dialog box will appear when the software is run prior to activating with a **Program Release Code**.

System Identification Code (submit the actual System ID displayed on your computer to French Creek to receive your computer/installation specific Program Release Code)

**Example - A System ID specific to your computer and installation will be displayed. Submit the actual ID displayed on YOUR computer.**

209A FR8C 6DOE 6F7G CH2I CJ2K 4L

Contact French Creek Software to obtain the Program Release Code. Copy the System Identification Code to the clipboard. Press the Copy ID Code button to copy and paste to another program. Enter the Program Release Code in the field below.

OK Copy ID Code Cancel ?

Enter Program Release Code Here  
(Calculated from System ID by French Creek)

## TO OBTAIN A COMPUTER SPECIFIC PROGRAM RELEASE CODE:

1) Copy the 26 character System Identification Code. This System Identification will be displayed when you run the software, until a Program Release Code is entered. Each system will have a unique System Identification Code. **YOU MUST SUBMIT THE SYSTEM ID DISPLAYED ON YOUR COMPUTER – NOT THE ID IN THIS MANUAL**

2) Send this code to French Creek Software

BY FAX TO (610) 935-1008

BY E-MAIL TO frenchcreek@worldnet.att.net (preferred method)

BY VOICE TO (610) 935-8337

3) French Creek will respond with a System Release Code

## HELPFUL HINTS

Press the COPY ID CODE button to copy the System Identification Number to the Windows clipboard.

Start an application such as a Word Processor or E-Mail program.

Paste the System Identification Number into the application.

You might wish to Paste the number into the Subject field of an E-Mail. Or you might wish to paste it into the subject field of a FAX.



## DownHole SAT<sup>tm</sup> Menu Quick Reference

<b>FILES</b>	<b>INPUT</b>	<b>WHAT-IF SCENARIOS</b>	<b>REPORTS</b>	<b>FORMULARY</b>	<b>LABORATORY</b>	<b>PREFERENCES</b>	<b>HELP</b>
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation			Edit Coefficients	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Browse Inhibitors	Mineral Name/Chemical Name
Quit	Input pH Curve	Select Parameters				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
<b>New</b>	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation		Edit Coefficients	CO3 Calc's	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Browse Inhibitors	Mineral Name/Chemical Name
Quit	Input pH Curve	Select Parameters				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

### NEW

**SELECTION PURPOSE:** The **New** selection, in the **FILES** pulldown menu, allows you to enter a new analysis without the possibility of “carryover” values from the previous water evaluated. It allows you to start afresh without exiting the program and starting over.

**WHEN SHOULD IT BE USED?** Select **New** when you have completed the evaluation of a water, saved the results if desired, and are ready to enter a new water analysis for evaluation. The **New** selection assures that the new analysis is entered on a “clean slate.”

**WHAT DOES IT DO?** The **New** module reinitializes all values to the startup, default values. When the **New** module is executed, it resets all flags in the program. For example, when a raw water is entered into the program, a flag is set that tells other modules that a valid raw water analysis has been entered. This allows the other modules that require a water analysis that this prerequisite has been completed. All data for an unsaved analysis is lost when the **New** option is executed.

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
<b>Open Workspace</b>	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation			CO3 Calc's	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Browse Inhibitors	
Quit	Input pH Curve	Select Parameters				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

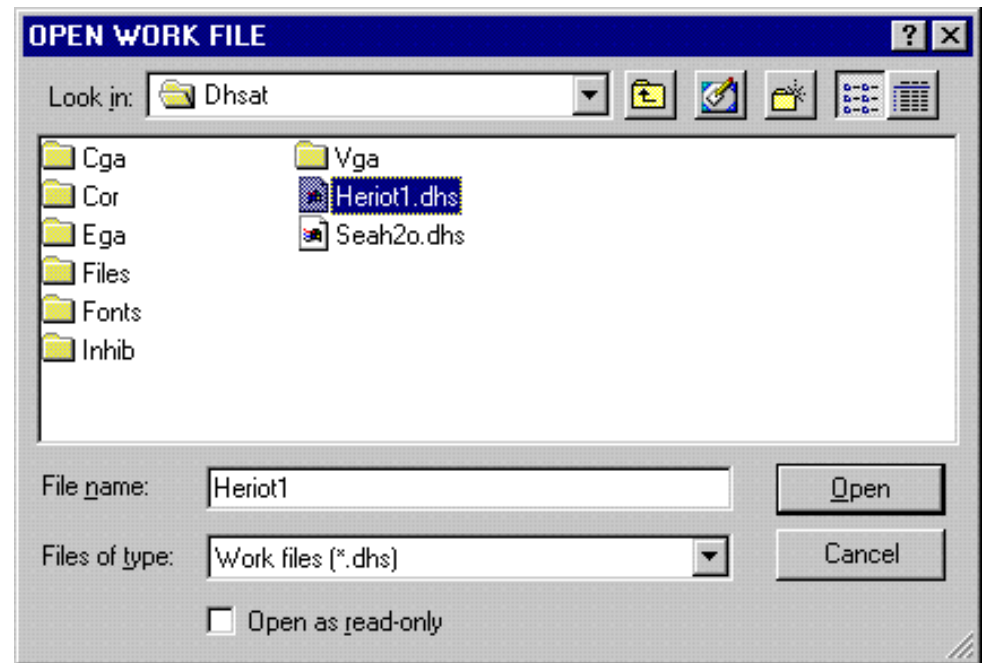
### OPEN FILE

**SELECTION PURPOSE:** The **Open File** selection, in the **FILES** pulldown menu, allows you to restore a previously evaluated water analysis and all calculations completed prior to the work being saved in a file. All program flags are reset to the state when the work was saved.

**WHEN SHOULD IT BE USED?** Select **Open File** when you wish to review the results of a previously completed water evaluation. Restore previously saved work when you wish to prepare further graphs, or evaluate further parameters using the **WHAT-IF SCENARIOS**

**WHAT DOES IT DO?** The **Open File** module loads all input and calculated values from a previously saved disk file. Parameters in effect when the work was saved are also loaded, including graph choices.

**WHAT DO YOU NEED?** You need the name of the file where previous work was stored, as well as the disk drive and directory and/or subdirectory information. Unless you specify otherwise, the program automatically saves files on the disk drive and directory from which the program was executed.





## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
<b>Save Workspace</b>	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As	Injection Water Analysis	Vary pH	Print Injection		Edit Coefficients	3D Graph Types	
Printer Setup	Formation Water Analysis	Graph vs pH	Print Formation		Browse Correlations	CO3 Calc's	
What's Stored		3D Profile	Print Produced		Browse Inhibitors	Plot pH or pCO2	
About DownHole SAT	MULTI-MIX	Select Parameters	Print All Available			Mineral Name/Chemical Name	
Quit	Water Analysis	WATERFLOOD				Constant Values	
	Input pH Curve	Mix				DISPLAY/PRINT OPTIONS	
		2D Graph vs %				Output Size On Screen	
		3D Temperature - pH				Surface Water Windows To Display	
		3D Temperature - %				Mixed Water Windows To Display	
		3D pH - %				Choose Ions To Print	
		Select Injection Parameters				Choose Scales To Print	

### SAVE FILE

**SELECTION PURPOSE:** The **Save File** selection, in the **FILES** pulldown menu, allows you to save a water analysis and all calculations completed in a hard or floppy disk file. All program flags are saved in their current state so that modules with prerequisites will be aware of what work has been completed. (e.g. a raw water analysis must be entered prior to running the **Profile vs Temperature, Mix, etc.** modules or there would be nothing but garbage numbers to profile or mix!)

**WHEN SHOULD IT BE USED?** Select **Save File** when you wish to save work completed in the current .DHS file for later use or review. Save an analysis in this manner also allows you to make minor modifications to input analysis without having to totally re-enter all parameters. It can also save time and date re-entry if you wish to prepare further graphs, or evaluate further parameters using the **WHAT-IF SCENARIOS**.

**WHAT DOES IT DO?** The **Save File** module saves all input and calculated values to a the current .DHS disk file. Parameters in effect when the work was saved are also saved, including graph choices. Each file saved should have the .DHS extension (e.g. EXAMPLE.DHS) and will require between 56K and 60K bytes of available disk space.

**WHAT DO YOU NEED?** You need to previously have saved the workspace to a file. The program automatically saves files on the disk drive and directory from which the program was executed.

**PREREQUISITES:** This selection will not be active unless you have previously saved the workspace using the **Save File As** module).

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
<b>Save Workspace As</b>	Injection Water Analysis	Vary pH	Print Injection		Edit Coefficients	3D Graph Types	
Printer Setup	Formation Water Analysis	Graph vs pH	Print Formation		Browse Correlations	CO3 Calc's	
What's Stored		3D Profile	Print Produced		Browse Inhibitors	Plot pH or pCO2	
About DownHole SAT	MULTI-MIX	Select Parameters	Print All Available			Mineral Name/Chemical Name	
Quit	Water Analysis					Constant Values	
	Input pH Curve	WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

### SAVE FILE AS

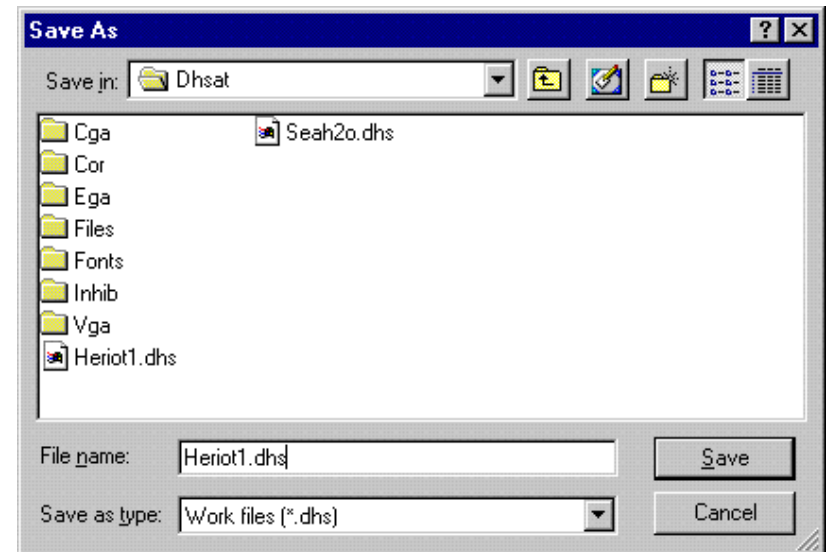
**SELECTION PURPOSE:** The **Save File As** selection, in the **FILES** pulldown menu, allows you to save a water analysis and all calculations completed in a hard or floppy disk file. All program flags are saved in their current state so that modules with prerequisites will be aware of what work has been completed. (e.g. a raw water analysis must be entered prior to running the **Profile versus Temperature, Mix, etc.** modules or there would be nothing but garbage numbers to profile or mix!)

**WHEN SHOULD IT BE USED?** Select **Save File As** when you wish to save work completed for later use or review. Save an analysis in this manner also allows you to make minor modifications to input analysis without having to totally re-enter all parameters. It can also save time and date re-entry if you wish to prepare further graphs, or evaluate further parameters using the **WHAT-IF SCENARIOS**.

**WHAT DOES IT DO?** The **Save File As** module saves all input and calculated values to a disk file. Parameters in effect when the work was saved are also saved, including graph choices. Each file saved should have the .DHS extension (e.g. EXAMPLE.DHS) and will require between 56K and 60K bytes of available disk space.

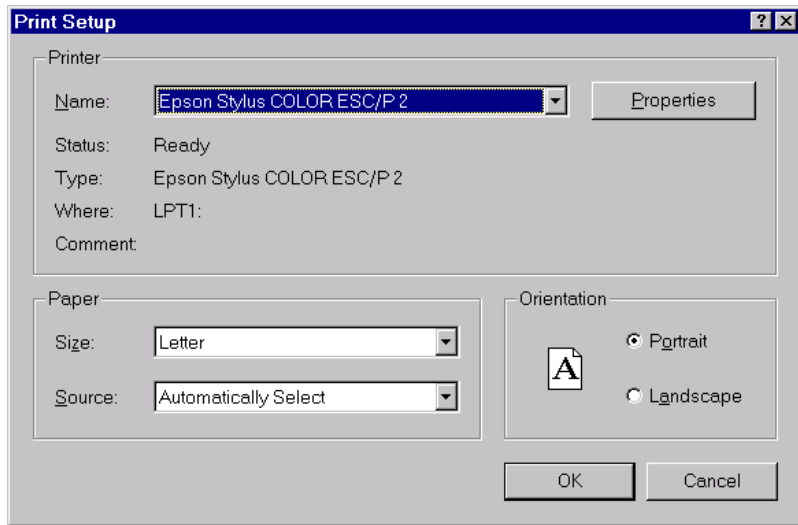
**WHAT DO YOU NEED?** You need a unique name for the file as well as the disk drive and directory and/or subdirectory information. Unless you specify otherwise, the program automatically saves files on the disk drive and directory from which the program was executed.

**PREREQUISITES:** This selection will not be active unless sufficient information has been entered (e.g. a minimum of the **Raw Water Analysis** must be run for the **Save File As** selection to be active).



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			Edit Coefficients	
<b>Printer Setup</b>	Formation Water Analysis	Vary pH	Print Formation			Browse Correlations	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Inhibitors	CO3 Calc's	
About DownHole SAT	Water Analysis	3D Profile	Print All Available			Plot pH or pCO2	
Quit	Input pH Curve	Select Parameters				Mineral Name/Chemical Name	
						Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					
		MULTI-MIX					
		Mix					



### PRINTER SETUP

**SELECTION PURPOSE:** The **Printer Setup** selection, in the **FILES** pulldown menu, accesses the Windows setup dialog box for your currently selected printer.

**WHEN SHOULD IT BE USED?** Select **Printer Setup** when you wish to select a different printer from the list of those currently installed in Windows, when you wish to change printer resolution, or other properties accessible by Windows.

**WHAT DOES IT DO?** The **Printer Setup** module calls the Windows printer setup dialog.

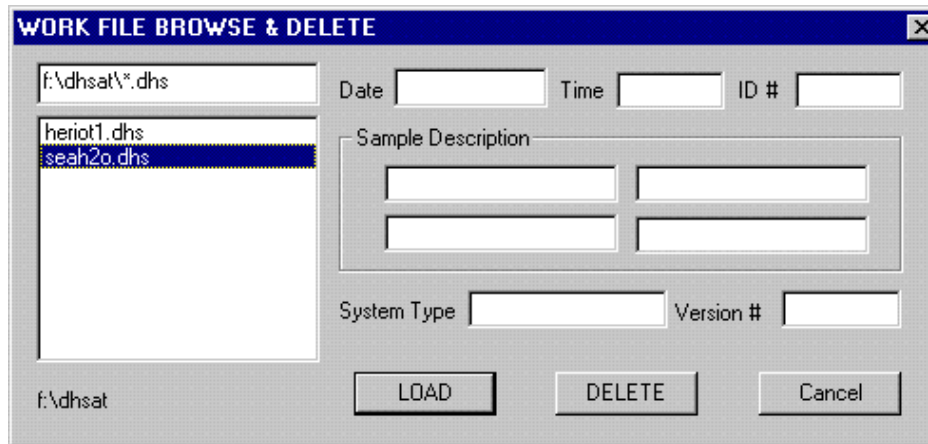
**WHAT DO YOU NEED?** You need to have a printer installed in Windows.

**NOTE:** THE DIALOG DISPLAYED WILL BE FOR YOUR CURRENTLY SELECTED DEFAULT PRINTER. CHANGING THE PRINTER FROM WITHIN DownHole SAT WILL ONLY AFFECT PRINTING FROM DownHole SAT. IT WILL NOT CHANGE YOUR DEFAULT PRINTER.

The dialog on the left is an example, and will vary with each printer and version of the Windows Operating System.

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			Edit Coefficients	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation			Browse Correlations	
<b>What's Stored</b>	MULTI-MIX	3D Profile	Print Produced		Browse Inhibitors	Plot pH or pCO2	
About DownHole SAT	Water Analysis	Select Parameters	Print All Available			Mineral Name/Chemical Name	
Quit	Input pH Curve	WATERFLOOD				Constant Values	
		Mix				DISPLAY/PRINT OPTIONS	
		2D Graph vs %				Output Size On Screen	
						Surface Water Windows To Display	
						Mixed Water Windows To Display	
						Choose Ions To Print	
						Choose Scales To Print	



### WHAT'S STORED

**SELECTION PURPOSE:** The *What's Stored* selection, in the **FILES** pulldown menu, allows you to quickly scan the work files previously saved by the program. The ID#, analysis description fields, comments, and file type are displayed for each filename selected.

**WHEN SHOULD IT BE USED?** Select *What's Stored* when you can't quite remember the name of a file in which you saved some critical work, or when you are about to perform housekeeping by deleting old, never to be used again files, and aren't sure What's Stored.

**WHAT DOES IT DO?** The *What's Stored* module displays the names of all files (\*.DHS) which were previously saved using the *Save File* or *Save File As* module.

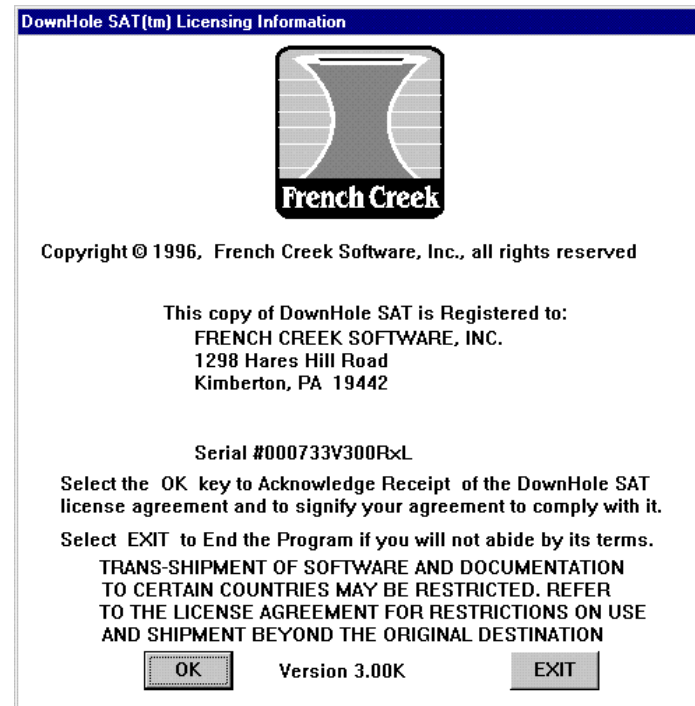
## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored	Injection Water Analysis	Vary pH	Print Injection		Edit Coefficients	3D Graph Types	
	Formation Water Analysis	Graph vs pH	Print Formation		Browse Correlations	CO3 Calc's	
	MULTI-MIX	3D Profile	Print Produced		Browse Inhibitors	Plot pH or pCO2	
<b>About DownHole SAT</b>	Water Analysis	Select Parameters	Print All Available			Mineral Name/Chemical Name	
Quit	Input pH Curve	WATERFLOOD				Constant Values	
		Mix				DISPLAY/PRINT OPTIONS	
		2D Graph vs %				Output Size On Screen	
		3D Temperature - pH				Surface Water Windows To Display	
		3D Temperature - %				Mixed Water Windows To Display	
		3D pH - %				Choose Ions To Print	
		Select Injection Parameters				Choose Scales To Print	
		MULTI-MIX					
		Mix					

### ABOUT DownHole SAT

SELECTION PURPOSE: The **About DownHole SAT** selection, in the **FILES** pulldown menu, displays the registration and copyright information for the program.

WHEN SHOULD IT BE USED? Select **About DownHole SAT** when you wish to verify program registration details. This information may be needed when you call technical support for assistance.



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature Graph vs Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Vary pH Graph vs pH	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	3D Profile	Print Injection	Browse Correlations	3D Graph Types	CO3 Calc's	
	Formation Water Analysis	Select Parameters	Print Formation	Browse Inhibitors	Plot pH or pCO2	Mineral Name/Chemical Name	
<b>QUIT</b>	MULTI-MIX	WATERFLOOD	Print Produced			Constant Values	
	Water Analysis	Mix	Print All Available			DISPLAY/PRINT OPTIONS	
	Input pH Curve	2D Graph vs % 3D Temperature - pH 3D Temperature - % 3D pH - % Select Injection Parameters				Output Size On Screen Surface Water Windows To Display Mixed Water Windows To Display Choose Ions To Print Choose Scales To Print	
		MULTI-MIX Mix					

### QUIT

SELECTION PURPOSE: The **Quit** selection, in the **FILES** pulldown menu, does just that. It exits the program and returns control to the Windows Operating System.

WARNING: Make sure all files are saved before you **Quit**. Once you exit the program all unsaved data is lost.

## DownHole SAT™ Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	<b>Source Water Analysis</b>	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	Vary pH	Print Injection	EDIT CORRELATION	3D Graph Types		
	Formation Water Analysis	Graph vs pH	Print Formation	Edit Coefficients	CO3 Calc's		
Quit	MULTI-MIX	3D Profile	Print Produced	Browse Correlations	Plot pH or pCO2		
	Water Analysis	Select Parameters	Print All Available	Browse Inhibitors	Mineral Name/Chemical Name		
	Input pH Curve	WATERFLOOD			Constant Values		
		Mix					
		2D Graph vs %					
		3D Temperature - pH					
		3D Temperature - %					
		3D pH - %					
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

### SOURCE WATER ANALYSIS

**SELECTION PURPOSE:** The *Source Water Analysis* module in the INPUT pulldown menu generates a form on the screen for input of surface water analyses.

**WHEN SHOULD IT BE USED?** Select *Source Water Analysis* to enter a surface water and calculate DownHole SAT indicators of scale potential. This module is also a prerequisite for running the SURFACE *What-if Scenarios*.

**WHAT DOES IT DO:** The *Source Water Analysis* module accepts water chemistry input via a user friendly form and runs simple validation tests on the values entered. Calculated values are displayed after entry is complete. You can change analytical units by pressing the UNITS button.

**PREREQUISITES:** There are no prerequisites for the *Source Water Analysis* module. Be sure to set up analytical units in the *Input Units* form found on the PREFERENCES pulldown menu, or by clicking the UNITS button when the form is displayed.

**SURFACE WATER CHEMISTRY INPUT FORM**

Sample Date:  Time:  ID#:  Report Date:

Flows

Brine Flow (BPD)

Oil Flow (BPD)

Gas Flow (MMCF/D)

C2 - C5 Acids

C2

C3

C4

C5

Manganese (as Mn)

Zinc (as Zn)

Lead (as Pb)

Bromine (as Br)

Corrosion Target (mpy)

Calcium (as Ca)

Iron (as Fe)

Hydrogen sulfide (as H2S)

Magnesium (as Mg)

Ammonia (as NH3)

Silica (as SiO2)

Barium (as Ba)

Aluminum (as Al)

Phosphate (as PO4)

Strontium (as Sr)

Boron (as B)

Fluoride (as F)

Sodium (as Na)

Chloride (as Cl)

Nitrate (as NO3)

Potassium (as K)

Sulfate (as SO4)

Temperature (as °F)

Lithium (as Li)

Aciditv (as CO2)

Density (g/mL)

pH (pH Units)

M Alkalinity (as HCO3)

Pressure (Atm.)

Residence time (sec)

P Alkalinity (as CO3)

pCO2 (Atm.)

Comments



## DownHole SAT™ Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	<b>Injection Water Analysis</b>	Vary pH	Print Injection		Edit Coefficients	3D Graph Types	
	Formation Water Analysis	Graph vs pH	Print Formation		Browse Correlations	CO3 Calc's	
Quit	MULTI-MIX	3D Profile	Print Produced		Browse Inhibitors	Plot pH or pCO2	
	Water Analysis	Select Parameters	Print All Available			Mineral Name/Chemical Name	
	Input pH Curve	WATERFLOOD				Constant Values	
		Mix					
		2D Graph vs %					
		3D Temperature - pH					
		3D Temperature - %					
		3D pH - %					
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

### INJECTION WATER ANALYSIS

**SELECTION PURPOSE:** The *Injection Water Analysis* module in the INPUT pulldown menu generates a form on the screen for input of injection water analyses for mixing in the WATERFLOOD modules.

**WHEN SHOULD IT BE USED?** Select *Injection Water Analysis* to enter the first of two (2) waters for mixing and calculate DownHole SAT indicators of scale potential. This module is also a prerequisite for running the WATERFLOOD *What-if Scenarios*.

**WHAT DOES IT DO:** The *Injection Water Analysis* module accepts water chemistry input via a user friendly form and runs simple validation tests on the values entered. Calculated values are displayed after entry is complete. You can change analytical units by pressing the UNITS button.

**PREREQUISITES:** There are no prerequisites for the *Injection Water Analysis* module. Be sure to set up analytical units in the *Input Units* form found on the PREFERENCES pulldown menu, or by clicking the UNITS button when the form is displayed.



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	Vary pH	Print Injection		Edit Coefficients	3D Graph Types	
	<b>Formation Water Analysis</b>	Graph vs pH	Print Formation		Browse Correlations	CO3 Calc's	
Quit	MULTI-MIX	3D Profile	Print Produced		Browse Inhibitors	Plot pH or pCO2	
	Water Analysis	Select Parameters	Print All Available			Mineral Name/Chemical Name	
	Input pH Curve	WATERFLOOD				Constant Values	

### FORMATION WATER ANALYSIS

**SELECTION PURPOSE:** The *Formation Water Analysis* module in the INPUT pulldown menu generates a form on the screen for input of formation water analyses for mixing in the WATERFLOOD modules.

**WHEN SHOULD IT BE USED?** Select *Formation Water Analysis* to enter the second water for mixing and calculate DownHole SAT indicators of scale potential. This module is also a prerequisite for running the WATERFLOOD *What-if Scenarios*.

**WHAT DOES IT DO:** The *Formation Water Analysis* module accepts water chemistry input via a user friendly form and runs simple validation tests on the values entered. Calculated values are displayed after entry is complete. You can change analytical units by pressing the UNITS button.

**PREREQUISITES:** There are no prerequisites for the *Formation Water Analysis* module. Be sure to set up analytical units in the *Input Units* form found on the PREFERENCES pulldown menu, or by clicking the UNITS button when the form is displayed.

**FORMATION WATER CHEMISTRY INPUT FORM**

Sample Date: 05-26-1994 Time: 17:03 ID#: 0 Report Date: 05-26-1994

Flows

Brine Flow (BPD) 1.00

Oil Flow (BPD) 1.00

Gas Flow (MMCF/D) 1.00

C2 - C5 Acids

C2 0.00

C3 0.00

C4 0.00

C5 0.00

Manganese (as Mn) 0.00

Zinc (as Zn) 0.00

Lead (as Pb) 0.00

Bromine (as Br) 0.00

Corrosion Target (mpy) 0.00

Calcium (as Ca) 3110 Iron (as Fe) 0.00 Hydrogen sulfide (as H2S) 0.00

Magnesium (as Mg) 480.00 Ammonia (as NH3) 0.00 Silica (as SiO2) 0.00

Barium (as Ba) 250.00 Aluminum (as Al) 0.00 Phosphate (as PO4) 0.00

Strontium (as Sr) 660.00 Boron (as B) 0.00 Fluoride (as F) 0.00

Sodium (as Na) 30200 Chloride (as Cl) 53000 Nitrate (as NO3) 0.00

Potassium (as K) 430.00 Sulfate (as SO4) 0.00 Temperature (as °C) 100.00

Lithium (as Li) 0.00 Acidity (as CO2) 0.00 Density (g/mL) 1.00

pH (pH Units) 7.80 M Alkalinity (as HCO3) 360.00 Pressure (fBars) 300.00

Residence time (sec) 180.00 P Alkalinity (as CO3) 0.00 pCO2 (fBars) 0.0003162

Comments

OK Change Units Recalculate Cancel

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface Print Surface Temperature Profile	Select Product Input Product	ANALYSIS INPUT Input Lab Data	Choose Graphs Input Units Print Mode	Technical Manual
Open Workspace Save Workspace Save Workspace As	WATERFLOOD	Vary Temperature Graph vs Temperature	Print Surface pH Profile Print Injection Print Formation Print Produced Print All Available		EDIT CORRELATION Edit Coefficients Browse Correlations Browse Inhibitors	3D Graph Types CO3 Calc's Plot pH or pCO2 Mineral Name/Chemical Name Constant Values	
Printer Setup What's Stored About DownHole SAT	Formation Water Analysis	Vary pH Graph vs pH 3D Profile					
Quit	MULTI-MIX	Select Parameters					
	<b>Water Analysis</b>	WATERFLOOD					
	Input pH Curve	Mix 2D Graph vs % 3D Temperature - pH 3D Temperature - % 3D pH - % Select Injection Parameters					

### MULTI-MIX WATER ANALYSIS

**SELECTION PURPOSE:** The *Multi-mix Water Analysis* module in the INPUT pulldown menu generates a form on the screen for input of formation water analyses for mixing in the WATERFLOOD modules.

**WHEN SHOULD IT BE USED?** Select *Multi-mix Water Analysis* to enter a series of waters for mixing and calculate DownHole SAT indicators of scale potential. This module is also a prerequisite for running the MIX module for Multi-mix *What-if Scenarios*.

**WHAT DOES IT DO:** The *Multi-mix Water Analysis* module accepts water chemistry input and percentage via a user friendly form, and runs simple validation tests on the values entered. Calculated values are displayed after entry is complete. You can change analytical units by pressing the UNITS button.

**PREREQUISITES:** There are no prerequisites for the *Formation Water Analysis* module. Be sure to set up analytical units in the *Input Units* form found on the PREFERENCES pulldown menu, or by clicking the UNITS button when the form is displayed.

## DownHole SAT™ Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	Vary pH	Print Injection		Edit Coefficients	3D Graph Types	
	Formation Water Analysis	Graph vs pH	Print Formation		Browse Correlations	CO3 Calc's	
Quit	MULTI-MIX	3D Profile	Print Produced		Browse Inhibitors	Plot pH or pCO2	
	Water Analysis	Select Parameters	Print All Available			Mineral Name/Chemical Name	
	<b>Input pH Curve</b>	WATERFLOOD				Constant Values	
		Mix					
		2D Graph vs %					
		3D Temperature - pH					
		3D Temperature - %					
		3D pH - %					
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

**Input pH-Alkalinity Relationship** ✕

	M Alkalinity	Actual	Predicted pH		M Alkalinity	Actual	Predicted pH
1)	<input type="text" value="300."/>	<input type="text" value="8.55"/>	<input type="text" value="8.524"/>	6)	<input type="text" value="0."/>	<input type="text" value="0."/>	<input type="text" value="0."/>
2)	<input type="text" value="120."/>	<input type="text" value="7.9"/>	<input type="text" value="7.931"/>	7)	<input type="text" value="0."/>	<input type="text" value="0."/>	<input type="text" value="0."/>
3)	<input type="text" value="40."/>	<input type="text" value="7.2"/>	<input type="text" value="7.221"/>	8)	<input type="text" value="0."/>	<input type="text" value="0."/>	<input type="text" value="0."/>
4)	<input type="text" value="20."/>	<input type="text" value="6.8"/>	<input type="text" value="6.773"/>	9)	<input type="text" value="0."/>	<input type="text" value="0."/>	<input type="text" value="0."/>
5)	<input type="text" value="0."/>	<input type="text" value="0."/>	<input type="text" value="0."/>	10)	<input type="text" value="0."/>	<input type="text" value="0."/>	<input type="text" value="0."/>

OK
Model
Graph
Help
Cancel

### INPUT pH CURVE

**SELECTION PURPOSE:** The *Input pH Curve* module, in the **INPUT CHEMISTRY** pulldown menu, accepts a user defined pH-Alkalinity relationship for use in predicting the pH of water from alkalinity in other modules. Values entered are converted to a mathematical model which can be selected as the pH-Alkalinity prediction method..

**WHEN SHOULD IT BE USED?** Select *Input pH Curve* to replace the default pH-Alkalinity curve with an empirical relationship you feel is more applicable to the system under study. NOTE: Once input, you must select the User Defined Curve method for pH prediction in the Select Parameters module.

**WHAT DOES IT DO?** The *Input pH Curve* module accepts pH-"M" Alkalinity pairs and converts them to a formula for use by other modules which predict chemistry and pH. Simple curve fit statistics are displayed as well as a simple Actual - Predicted comparison. You can also display a pH-Alkalinity graph by pressing the **Graph** button.

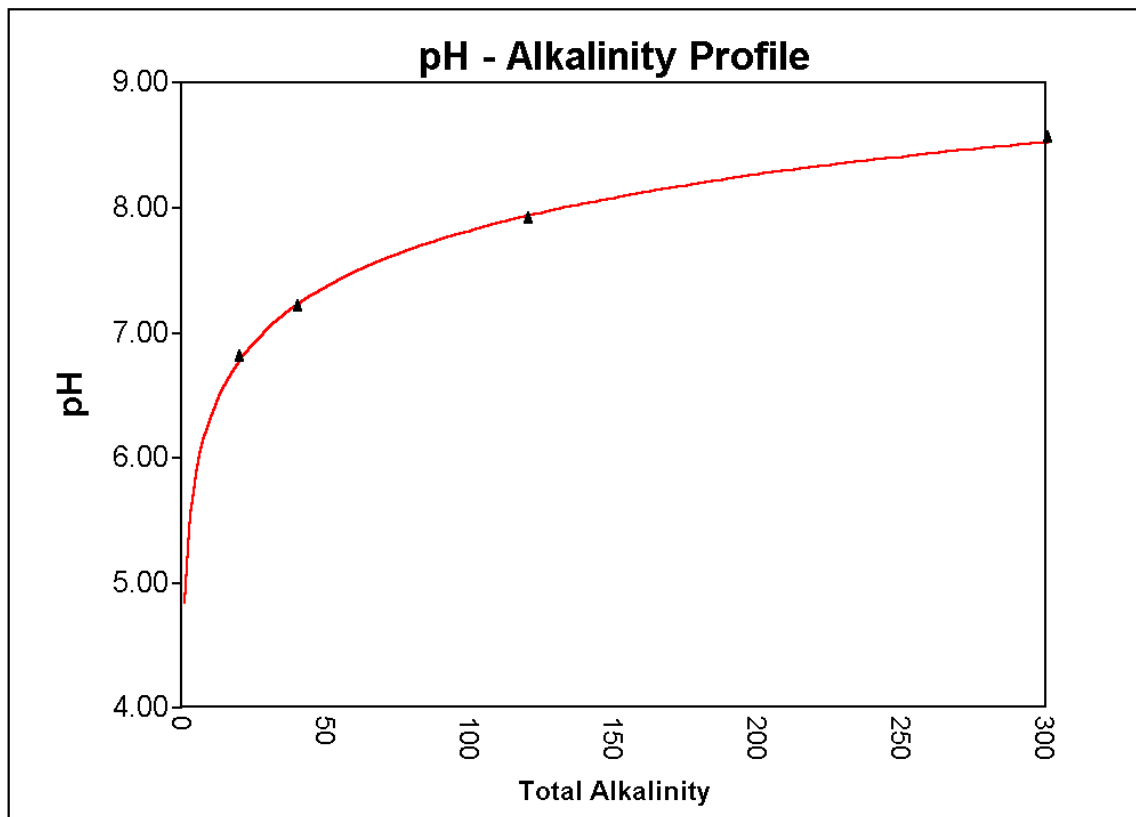
**WHAT DO YOU NEED?** A minimum of five (5) pH-"M" Alkalinity pairs should be on hand for entry. The input form will accept a maximum of ten (10) pairs. Select pairs that cover the alkalinity range expected. Extrapolate if you must! Unusual results may be encountered if your model was developed from data in an alkalinity range of 20 to 100 mg/l as CaCO3 and you attempt to evaluate a pH at an alkalinity of 400! If your data does not cover a broad enough range to encompass your **WHAT-IF's**, please use the default pH-Alkalinity curves.

*TRICK - the program will accept a single point. If you enter a single pH - Alkalinity pair, the model will use the slope of the Default (Kunz) curve and translate the intercept based upon the value entered.*

**PREREQUISITES:** There are no prerequisites for the *Input pH Curve* module.

**Input pH-Alkalinity Relationship** [X]

	M Alkalinity	Actual	Predicted pH		M Alkalinity	Actual	Predicted pH
1)	300.	8.55	8.524	6)	0.	0.	0.
2)	120.	7.9	7.931	7)	0.	0.	0.
3)	40.	7.2	7.221	8)	0.	0.	0.
4)	20.	6.8	6.773	9)	0.	0.	0.
5)	0.	0.	0.	10)	0.	0.	0.



# DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	<b>Vary Temperature</b>	Print Surface Temperature Profile Print Surface pH Profile	Input Product	Input Lab Data	Input Units Print Mode	
Printer Setup What's Stored About DownHole SAT	WATERFLOOD Injection Water Analysis Formation Water Analysis	Graph vs Temperature Vary pH Graph vs pH 3D Profile					
Quit	MULTI-MIX Water Analysis	Select Parameters					
	Input pH Curve	WATERFLOOD Mix					

## VARY TEMPERATURE

**SELECTION PURPOSE:** The Vary Temperature module, in the WHAT-IF SCENARIOS pulldown menu, models the impact of temperature upon indicators of scale and corrosivity potential. Temperature trends are presented as tables (*Vary Temperature*) and in graphical form (*Graph vs Temperature*).

**WHEN SHOULD IT BE USED?** Select *Vary Temperature* to evaluate the indicators of scale and corrosivity potential over the expected operating temperature range for the brine. Include the minimum and maximum expected temperatures to assure, for example, that both the salts whose solubility decreases with temperature, and those whose solubility increase with temperature are modeled under their harshest expected conditions.

**WHAT DOES IT DO?** The *Vary Temperature* module evaluates the water chemistry at seven (7) temperatures evenly spaced from the minimum temperature you selected to the maximum. Default values are a 70 F° minimum and 130 F° maximum. Profiles are calculated at the Typical pH entered. A popup menu for selecting display and output options is displayed across the top of the window. Tables can be "grabbed" and moved by holding down the left mouse button while the cursor is in the window and dragging. Up and Down arrow keys can also be used to move the table windows.

**PREREQUISITES:** There are no prerequisites for the *Vary Temperature* module, other than the input of *Source Water* chemistry. It is recommended that the minimum and maximum temperature and pH be entered or verified in the *Select Parameters* module.

WATER CHEMISTRY VERSUS TEMPERATURE							
OPTIONS							
Sample ID:	0	Report Date:	02-11-1997	Sampled:	02-11-1997	at 1626	
TEMPERATURE (°C)							
	27.00	35.50	44.00	52.50	61.00	69.50	78.00
<b>CATIONS</b>							
Calcium(as Ca)	400						
Magnesium(as Mg)	1272						
Barium(as Ba)	0						
Strontium(as Sr)	13						
Sodium(as Na)	1056						
Potassium(as K)	380						
Lithium(as Li)	0						
Iron(as Fe)	0						
Ammonia(as NH3)	5						
Aluminum(as Al)	0						
Boron(as B)	4						
Manganese(as Mn)	0						
Zinc(as Zn)	0						
Lead(as Pb)	0						
<b>ANIONS</b>							
Chloride(as Cl)	1806						
Sulfate(as S04)	265						
Bromine(as Br)	0						
Acidity	2						
"M" Alkalinity	0						
"P" Alkalinity	0						
Silica(as Si02)	0						
Phosphate(as P04)	0						
H2S (as H2S)	0						
Fluoride(as F)	1						
Nitrate(as N03)	0						
<b>PARAMETERS</b>							
pH	7						
Temperature(°C)	27						
Pressure(psia)	14						
Density(g/mL)	1						
Calculated T.D.S.	3346						

DEPOSITION POTENTIAL INDICATORS VERSUS TEMPERATURE							
OPTIONS							
Sample ID:	0	Report Date:	02-11-1997	Sampled:	02-11-1997	at 1626	
TEMPERATURE (°C)							
	27.00	35.50	44.00	52.50	61.00	69.50	78.00
<b>SATURATION LEVEL</b>							
Calcite (CaCO3)	0.30	0.37	0.42	0.47	0.50	0.52	0.52
Aragonite (CaCO3)	0.26	0.31	0.36	0.39	0.41	0.42	0.42
Witherite (BaCO3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Strontianite (SrCO3)	0.03	0.03	0.02	0.02	0.02	0.02	0.01
Magnesite (MgCO3)	0.85	1.17	1.50	1.84	2.16	2.44	2.66
Anhydrite (CaSO4)	0.30	0.32	0.35	0.37	0.39	0.41	0.42
Gypsum (CaSO4*2H2O)	0.45	0.40	0.36	0.33	0.29	0.26	0.24
Barite (BaSO4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Celestite (SrSO4)	0.20	0.19	0.18	0.17	0.16	0.15	0.14
Tricalcium phosphate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroxylapatite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorite (CaF2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silica (Si02)	0.06	0.05	0.04	0.03	0.03	0.02	0.02
Brucite (Mg(OH)2)	0.00	0.00	0.00	0.01	0.03	0.08	0.18
Magnesium silicate	0.01	0.03	0.08	0.17	0.35	0.71	1.36
Ferric hydroxide	0.66	0.98	1.41	1.94	2.57	3.22	3.71
Siderite (FeCO3)	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Strengite (FePO4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Halite (NaCl)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Therandite (Na2SO4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iron sulfide (FeS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>SAMPLE INDICES</b>							
Langelier Saturation	-0.3	-0.2	-0.1	-0.0	0.1	0.2	0.2
Ryznar Stability	8.2	8.0	7.8	7.6	7.4	7.3	7.1
Odde-Tomson	-0.9	-0.8	-0.6	-0.5	-0.3	-0.2	0.0
Stiff-Davis	-0.8	-0.6	-0.4	-0.1	0.1	0.4	0.7
Puckorius(Practical)	8.7	8.4	8.2	8.0	7.9	7.7	7.5
Larson-Skold	922.9	915.7	908.8	901.1	892.7	884.1	874.8
<b>TOTAL VERSUS FREE IONS</b>							
Total Calcium	400.0	400.0	400.0	400.0	400.0	400.0	400.0
Total Magnesium	1272.0	1272.0	1272.0	1272.0	1272.0	1272.0	1272.0

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	<b>Graph vs Temperature</b>	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As			Injection Water Analysis	Print Injection		Browse Correlations	3D Graph Types
Printer Setup	Formation Water Analysis	Vary pH	Print Formation		Browse Inhibitors	CO3 Calc's	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced			Plot pH or pCO2	
About DownHole SAT		Water Analysis	3D Profile	Print All Available			Mineral Name/Chemical Name
Quit	Input pH Curve	Select Parameters				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
						Surface Water Windows To Display	
						Mixed Water Windows To Display	
						Choose Ions To Print	
						Choose Scales To Print	

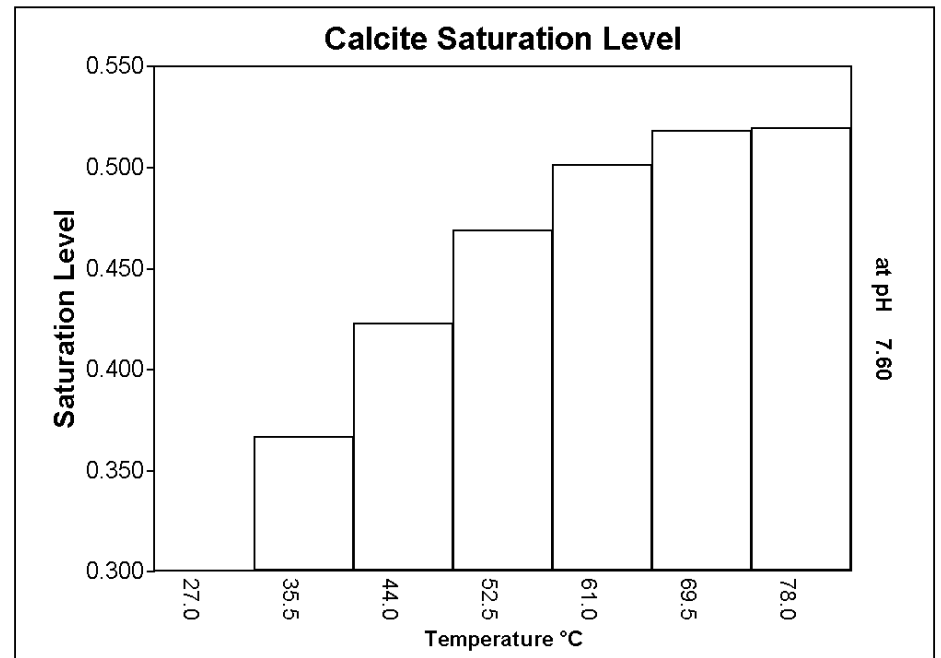
### GRAPH vs TEMPERATURE

**SELECTION PURPOSE:** The *Graph vs Temperature* module, in the WHAT-IF SCENARIOS pulldown menu, models the impact of temperature upon indicators of scale and corrosivity potential. Temperature trends are presented as tables (*Vary Temperature*) and in graphical form (*Graph vs Temperature*).

**WHEN SHOULD IT BE USED?** Select *Graph vs Temperature* to evaluate the indicators of scale and corrosivity potential over the expected operating temperature range for the brine. Include the minimum and maximum expected temperatures to assure, for example, that both the salts whose solubility decreases with temperature, and those whose solubility increase with temperature are modeled under their harshest expected conditions.

**WHAT DOES IT DO?** The *Graph vs Temperature* module evaluates the water chemistry at seven (7) temperatures evenly spaced from the minimum temperature you selected to the maximum. Default values are a 70 F° minimum and 130 F° maximum. Profiles are calculated at the Typical pH entered. A popup menu for selecting display and output options is displayed across the top of the window. Tables can be "grabbed" and moved by holding down the left mouse button while the cursor is in the window and dragging. Up and Down arrow keys can also be used to move the table windows.

**PREREQUISITES:** There are no prerequisites for the *Graph vs Temperature* module, other than the input of *Source Water* chemistry. It is recommended that the minimum and maximum temperature and evaluation pH be entered or verified in the *Select Parameters* module.





## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile			Print Mode	
Save Workspace As		Injection Water Analysis	<b>Vary pH</b>				
Printer Setup	Formation Water Analysis	Graph vs pH					
What's Stored	MULTI-MIX	3D Profile					
About DownHole SAT		Water Analysis	Select Parameters				
Quit	Input pH Curve	WATERFLOOD					
		Mix					

### VARY pH (Vary pCO<sub>2</sub>)

**SELECTION PURPOSE:** The *Vary pH* module, in the WHAT-IF SCENARIOS pulldown menu, models the impact of temperature upon indicators of scale and corrosivity potential. Trends are presented as tables (*Vary pH*) and in graphical form (*Graph vs pH*).

**WHEN SHOULD IT BE USED?** Select *Vary pH* to evaluate the indicators of scale and corrosivity potential over the expected pH (or pCO<sub>2</sub>) range for the brine. Include the minimum and maximum expected pH (or pCO<sub>2</sub>) to assure, for example, that both the salts whose solubility decreases with pH, and those whose solubility increase with pH are modeled under their harshest expected conditions.

**WHAT DOES IT DO?** The *Vary pH* module evaluates the water chemistry at seven (7) pH or pCO<sub>2</sub> values evenly spaced from the minimum temperature you selected to the maximum. Default values are a pH 6.0 minimum and 9.0 maximum. Profiles are calculated at the Typical temperature entered. A popup menu for selecting display and output options is displayed across the top of the window. Tables can be "grabbed" and moved by holding down the left mouse button while the cursor is in the window and dragging. Up and Down arrow keys can also be used to move the table windows.

**PREREQUISITES:** There are no prerequisites for the *Vary pH* module, other than the input of *Source Water* chemistry. It is recommended that the minimum and maximum pH (or pCO<sub>2</sub>) and the evaluation temperature be entered or verified in the *Select Parameters* module. Switch between pH and pCO<sub>2</sub> profiles using the *Plot pH or pCO<sub>2</sub>* module in the PREFERENCES pulldown menu.

WATER CHEMISTRY VERSUS pH							
OPTIONS							
Sample ID:	0	Report Date:	02-11-1997	Sampled:	02-11-1997	at 1626	
pH							
6.00    6.50    7.00    7.50    8.00    8.50    9.00							
CATIONS							
Calcium(as Ca)							
Magnesium(as Mg)							
Barium(as Ba)							
Strontium(as Sr)							
Sodium(as Na)							
Potassium(as K)							
Lithium(as Li)							
Iron(as Fe)							
Ammonia(as NH3)							
Aluminum(as Al)							
Boron(as B)							
Manganese(as Mn)							
Zinc(as Zn)							
Lead(as Pb)							

DEPOSITION POTENTIAL INDICATORS VERSUS pH							
OPTIONS							
Sample ID:	0	Report Date:	02-11-1997	Sampled:	02-11-1997	at 1626	
pH							
6.00    6.50    7.00    7.50    8.00    8.50    9.00							
SATURATION LEVEL							
Calcite (CaCO3)	0.01	0.03	0.12	0.40	1.14	2.60	4.34
Aragonite (CaCO3)	0.00	0.02	0.10	0.33	0.94	2.15	3.59
Witherite (BaCO3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Strontianite (SrCO3)	0.00	0.00	0.00	0.02	0.04	0.10	0.17
Magnesite (MgCO3)	0.02	0.13	0.51	1.70	4.85	11.04	18.21
Anhydrite (CaSO4)	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Gypsum (CaSO4*2H2O)	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Barite (BaSO4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Celestite (SrSO4)	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Tricalcium phosphate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroxylapatite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorite (CaF2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silica (SiO2)	0.03	0.03	0.03	0.03	0.03	0.02	0.01
Brucite (Mg(OH)2)	0.00	0.00	0.00	0.02	0.17	1.68	16.58
Magnesium silicate	0.00	0.00	0.02	0.21	1.95	16.44	103.40
H2S (as H2S)	0.00	0.02	0.17	1.61	12.55	31.52	17.00
Siderite (FeCO3)	0.00	0.00	0.00	0.01	0.02	0.01	0.00
Strengite (FePO4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Halite (NaCl)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thenardite (Na2SO4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iron sulfide (FeS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SIMPLE INDICES							
Langelier Saturation	-2.0	-1.2	-0.6	-0.0	0.5	1.1	1.7
Ryznar Stability	10.0	8.9	8.2	7.6	7.0	6.3	5.5
Odde-Tomson Index	-2.3	-1.6	-1.0	-0.4	0.1	0.7	1.3
Stidd-Davis Index	-1.9	-1.2	-0.6	-0.0	0.5	1.1	1.7
Puckorius(Practical)	9.4	8.5	8.1	7.9	7.7	7.5	7.1
Larson-Skold	2418.6	1392.8	1056.5	916.2	797.3	658.8	549.7
TOTAL VERSUS FREE IONS							
Total Calcium	400.0	400.0	400.0	400.0	400.0	400.0	400.0
Total Calcium	400.0	400.0	400.0	400.0	400.0	400.0	400.0

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Vary pH	Print Injection		Edit Coefficients	3D Graph Types
Printer Setup	Formation Water Analysis	<b>Graph vs pH</b>	Print Formation	Print Produced		Browse Correlations	CO3 Calc's
What's Stored	MULTI-MIX	3D Profile	Print All Available		Browse Inhibitors	Plot pH or pCO2	
About DownHole SAT	Water Analysis	Select Parameters				Mineral Name/Chemical Name	
Quit	Input pH Curve	WATERFLOOD				Constant Values	
		Mix				DISPLAY/PRINT OPTIONS	
						Output Size On Screen	
						Surface Water Windows To Display	
						Mixed Water Windows To Display	
						Choose Ions To Print	
						Choose Scales To Print	

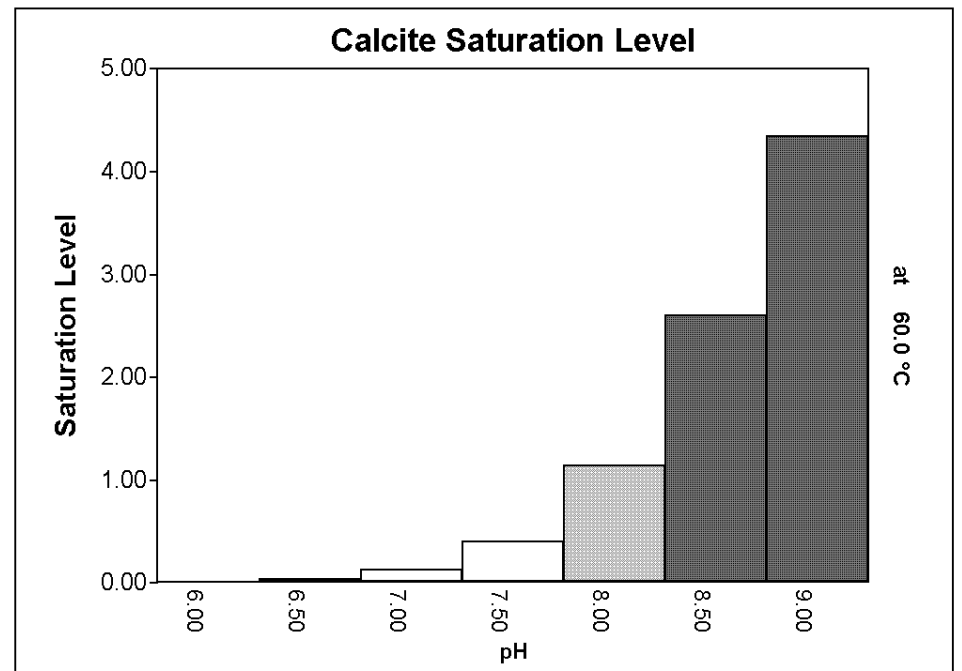
### GRAPH vs pH (GRAPH vs pCO<sub>2</sub>)

**SELECTION PURPOSE:** The *Graph vs pH* module, in the WHAT-IF SCENARIOS pulldown menu, models the impact of temperature upon indicators of scale and corrosivity potential. Trends are presented as tables (*Vary pH*) and in graphical form (*Graph vs pH*).

**WHEN SHOULD IT BE USED?** Select *Graph vs pH* to evaluate the indicators of scale and corrosivity potential over the expected pH (or pCO<sub>2</sub>) range for the brine. Include the minimum and maximum expected pH (or pCO<sub>2</sub>) to assure, for example, that both the salts whose solubility decreases with pH, and those whose solubility increase with pH are modeled under their harshest expected conditions.

**WHAT DOES IT DO?** The *Graph vs pH* module evaluates the water chemistry at seven (7) pH or pCO<sub>2</sub> values evenly spaced from the minimum temperature you selected to the maximum. Default values are a pH 6.0 minimum and 9.0 maximum. Profiles are calculated at the Typical temperature entered. A popup menu for selecting display and output options is displayed across the top of the window. Tables can be "grabbed" and moved by holding down the left mouse button while the cursor is in the window and dragging. Up and Down arrow keys can also be used to move the table windows.

**PREREQUISITES:** There are no prerequisites for the *Vary pH* module, other than the input of *Source Water* chemistry. It is recommended that the minimum and maximum pH (or pCO<sub>2</sub>) and the evaluation temperature be entered or verified in the *Select Parameters* module. Switch between pH and pCO<sub>2</sub> profiles using the *Plot pH or pCO<sub>2</sub>* module in the PREFERENCES pulldown menu.





## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation		Edit Coefficients	CO3 Calc's	
What's Stored		Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT	MULTI-MIX	<b>3D Profile</b>	Print All Available		Browse Inhibitors	Mineral Name/Chemical Name	
Quit	Water Analysis	Select Parameters				Constant Values	
	Input pH Curve	WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
						Surface Water Windows To Display	
						Mixed Water Windows To Display	
						Choose Ions To Print	
						Choose Scales To Print	

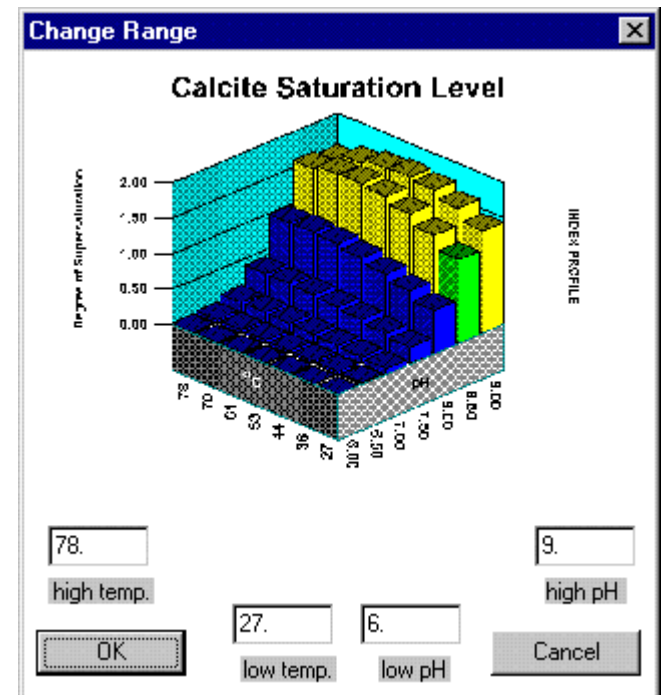
### 3D PROFILE

**SELECTION PURPOSE:** The *3D Profile* module, in the WHAT-IF SCENARIOS pulldown menu, models the impact of temperature and pH (or pCO<sub>2</sub>) upon indicators of scale and corrosivity potential. Trends are presented as 3D contour or bar graphs.

**WHEN SHOULD IT BE USED?** Select *3D Profile* to evaluate the indicators of scale and corrosivity potential over the expected pH (or pCO<sub>2</sub>) and temperature range for the brine. Include the minimum and maximum expected temperature and pH (or pCO<sub>2</sub>) to assure, for example, that both the salts whose solubility decreases with temperature, and those whose solubility increase with temperature are modeled under their harshest expected conditions.

**WHAT DOES IT DO?** The *3D Profile* module evaluates the water chemistry at seven (7) pH or pCO<sub>2</sub> values and seven (7) temperatures evenly spaced from the minimums you selected to the maximums. A popup menu for selecting display and output options is displayed across the top of the window.

**PREREQUISITES:** There are no prerequisites for the *3D Profile* module, other than the input of *Source Water* chemistry. It is recommended that the minimum and maximum pH (or pCO<sub>2</sub>) and temperatures be entered or verified in the *Select Parameters* module. Switch between pH and pCO<sub>2</sub> profiles using the *Plot pH or pCO<sub>2</sub>* module in the PREFERENCES pulldown menu.



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation			CO3 Calc's	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Browse Inhibitors	Mineral Name/Chemical Name
Quit	Input pH Curve	<b>Select Parameters</b>				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

### SELECT PARAMETERS

**SELECTION PURPOSE:** The **Select Parameters** module, in the WHAT-IF SCENARIOS pulldown menu sets up the ranges for pH profiles, pCO2 profiles, and temperature profiles of surface water.

**WHEN SHOULD IT BE USED?** **Select Parameters** should be run prior to doing a tabular or graphic profile of the surface water.

**WHAT DOES IT DO?** The **Select Parameters** module accepts minimum and maximum values for pH, temperature, and pCO2 profiles. It divides the range into seven (7) equal steps for tables and graphs. The pH (or pCO2) range specified, and the temperature range selected will be used for 3D surface water profiles.

**PREREQUISITES:** There are no prerequisites for the **Select Parameters** module.

**Surface Water What-if Scenarios**

**Temperature Selection**

Low Temp  High Temp  Evaluation Temp

**pH Selection**

Low pH  High pH  Evaluation pH

**pCO2 Selection**

Low pCO2  High pCO2  Evaluation pCO2

**pH Prediction Method**

Extrapolated pH-Alk     
  User Defined     
 Theor. pH-pCO2

Lawrence-Caldwell     
  Default     
 Oddo-Tomson

OK Cancel

# DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature Graph vs Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units Print Mode	
Printer Setup What's Stored About DownHole SAT	WATERFLOOD Injection Water Analysis Formation Water Analysis	Vary pH Graph vs pH 3D Profile					
Quit	MULTI-MIX Water Analysis	Select Parameters					
	Input pH Curve	WATERFLOOD					

Mix
2D Graph vs %
3D Temperature - pH
3D Temperature - %
3D pH - %
Select Injection Parameters
MULTI-MIX
Mix

## MIX

**SELECTION PURPOSE:** The **Mix** module, in the WATERFLOOD WHAT-IF SCENARIOS pulldown menu prepares a mixing zone profile in tabular format.

**WHEN SHOULD IT BE USED?** **Select Injection Parameters** should be run prior to doing a tabular or graphic profile of the graphic

**PREREQUISITES:** **Select Parameters** module.

**MIXED WATER DEPOSITION POTENTIAL INDICATORS**

OPTIONS

Sample ID: 0 Report Date: 05-26-1994 Sampled: 05-26-1994 at 1703

		% INJECTION		% FORMATION			
SATURATION LEVEL	100.00	83.33	66.67	50.00	33.34	16.67	0.00
Calcite (CaCO3)	20.45	13.10	7.62	3.99	1.83	0.68	0.16
Aragonite (CaCO3)	16.28	10.43	6.06	3.17	1.46	0.55	0.13
Witherite (BaCO3)	0.23						
Strontianite (SrCO3)	1.61						
Magnesite (MgCO3)	12.20						
Anhydrite (CaSO4)	0.00						
Gypsum (CaSO4*2H2O)	0.00						
Barite (BaSO4)	0.00						
Celestite (SrSO4)	0.00						
Tricalcium phosphate	0.00						
Hydroxylapatite	0.00						
Fluorite (CaF2)	0.00						
Silica (SiO2)	0.00						
Brucite (Mg(OH)2)	1.99						
Magnesium silicate	0.00						
Ferric hydroxide	0.00						
Siderite (FeCO3)	0.00						
Strengite (FePO4)	0.00						
Halite (NaCl)	0.01						
Thenardite (Na2SO4)	0.00						
Iron sulfide (FeS)	0.00						

**MIXED WATER CHEMISTRY**

OPTIONS

Sample ID: 0 Report Date: 05-26-1994 Sampled: 05-26-1994 at 1703

		% INJECTION		% FORMATION			
	100.00	83.33	66.67	50.00	33.34	16.67	0.00
<b>CATIONS</b>							
Calcium(as Ca)	3110.00	2658.85	2207.70	1756.55	1305.41	854.26	403.00
Magnesium(as Mg)	480.00	619.99	759.99	899.98	1039.98	1179.97	1320.00
Barium(as Ba)	250.00	208.33	166.67	125.00	83.34	41.67	0.00
Strontium(as Sr)	660.00	550.00	440.01	330.01	220.02	110.02	0.00
Sodium(as Na)	30200.0	27000.1	23800.2	20600.3	17400.5	14200.6	11000.0
Potassium(as K)	430.00	415.00	400.00	385.00	370.00	355.00	340.00
Lithium(as Li)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iron(as Fe)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia(as NH3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aluminum(as Al)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boron(as B)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manganese(as Mn)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zinc(as Zn)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lead(as Pb)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>ANIONS</b>							
Chloride(as Cl)	53000.0	47466.9	41933.8	36400.7	30867.6	25334.4	19800.0
Sulfate(as SO4)	0.0	413.3	826.6	1240.0	1653.3	2066.6	2480.0
Bromine(as Br)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dissolved CO2	6.5	9.1	11.8	14.4	17.1	19.7	22.4
Bicarbonate	213.3	216.4	211.7	197.4	174.1	144.1	109.5
Carbonate	138.5	96.0	61.1	35.8	19.1	9.1	3.6
Silica(as SiO2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate(as PO4)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H2S (as H2S)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fluoride(as F)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate(as NO3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>PARAMETERS</b>							
pH	7.80	7.67	7.53	7.38	7.23	7.06	6.87
Temperature(°C)	100.00	100.00	100.00	100.00	100.00	100.00	100.00
pCO2(bars)	3.16E-4	0.00104	0.00176	0.00248	0.00321	0.00393	0.00465
Pressure(bars)	300.00	300.00	300.00	300.00	300.00	300.00	300.00
Density(g/mL)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Calculated T.D.S.	88496.1	79660.7	70824.9	61989.3	53153.4	44318.0	35480.3

## DownHole SAT™ Menu Quick Reference

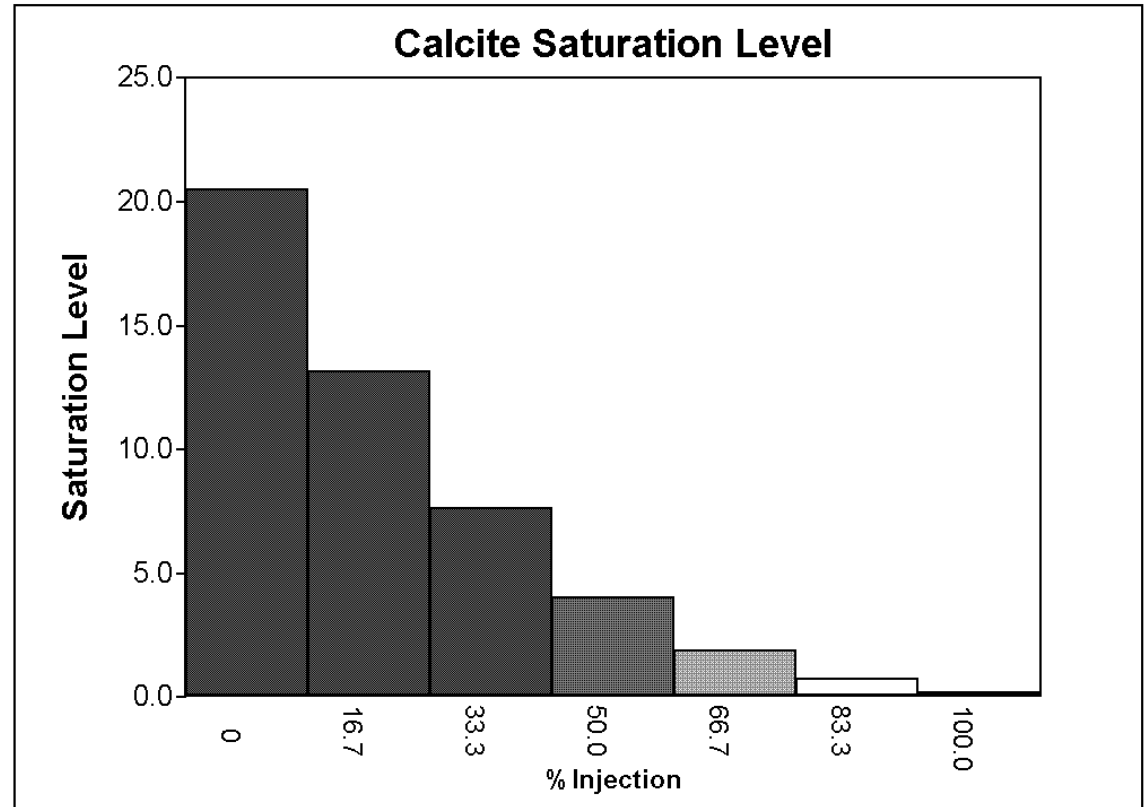
FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Graph vs pH	Print Formation		Edit Coefficients	CO3 Calc's	
What's Stored		3D Profile			Browse Correlations	Plot H <sub>2</sub> O - CO <sub>2</sub>	
About DownHole SAT	MULTI-MIX	Select Parameters					
Quit	Water Analysis	WATERFLOOD					
	Input pH Curve	Mix					
		<b>2D Graph vs %</b>					
		3D Temperature - pH					
		3D Temperature - %					
		3D pH - %					
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

### 2D GRAPH vs %

**SELECTION PURPOSE:** The **2D Graph vs %** module, in the WATERFLOOD WHAT-IF SCENARIOS pulldown menu prepares a mixing zone profile in graphical format. This module plots the values from the table produced by the **Mix** module.

**WHEN SHOULD IT BE USED?** **Select Injection Parameters** should be run prior to doing a tabular or graphic profile of the graphic

**PREREQUISITES:** **Select Parameters** module.



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation		Edit Coefficients	CO3 Calc's	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Browse Inhibitors	Mineral Name/Chemical Name
Quit	Input pH Curve	Select Parameters				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		<b>3D Temperature - pH</b>				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					

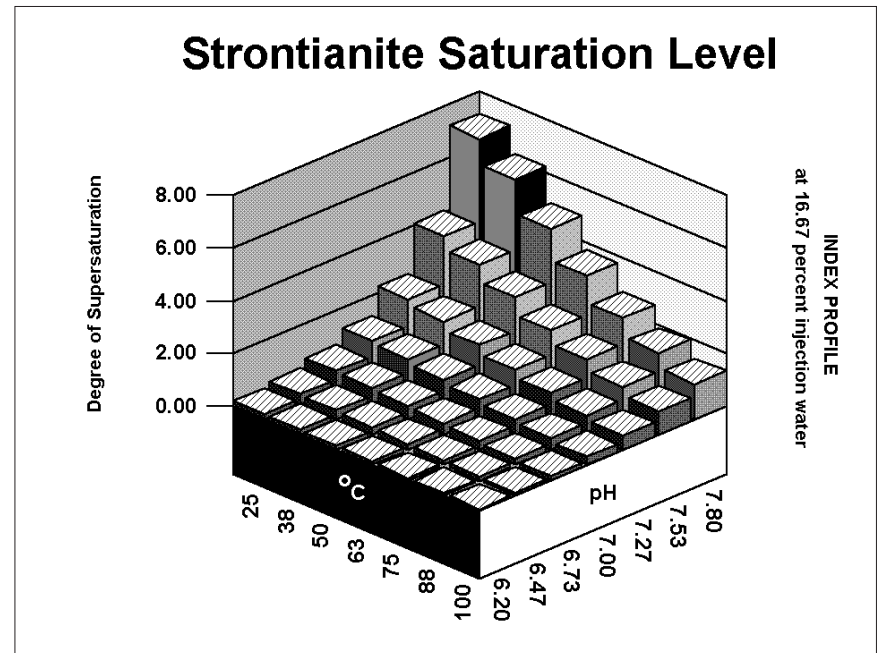
### 3D Temperature - pH PROFILE

**SELECTION PURPOSE:** The *3D Temperature - pH Profile* module, in the WHAT-IF SCENARIOS pulldown menu, models the impact of temperature and pH (or pCO<sub>2</sub>) upon indicators of scale and corrosivity potential. Trends are presented as 3D contour or bar graphs. Profiles are evaluated at the typical percent injection water entered in the *Select Injection Parameters* module.

**WHEN SHOULD IT BE USED?** Select *3D Temperature - pH Profile* to evaluate the indicators of scale and corrosivity potential over the expected pH (or pCO<sub>2</sub>) and temperature range for the mixed water. Include the minimum and maximum expected temperature and pH (or pCO<sub>2</sub>) to assure, for example, that both the salts whose solubility decreases with temperature, and those whose solubility increase with temperature are modeled under their harshest expected conditions.

**WHAT DOES IT DO?** The *3D Temperature - pH Profile* module evaluates the water chemistry at seven (7) pH or pCO<sub>2</sub> values and seven (7) temperatures evenly spaced from the minimums you selected to the maximums. A popup menu for selecting display and output options is displayed across the top of the window.

**PREREQUISITES:** There are no prerequisites for the *3D Temperature - pH Profile* module, other than the input of *Source Water* chemistry. It is recommended that the minimum and maximum pH (or pCO<sub>2</sub>) and temperatures be entered or verified in the *Select Injection Parameters* module. Switch between pH and pCO<sub>2</sub> profiles using the *Plot pH or pCO<sub>2</sub>* module in the PREFERENCES pulldown menu.





## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation			CO3 Calc's	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Browse Inhibitors	Mineral Name/Chemical Name
Quit	Input pH Curve	Select Parameters				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		<b>3D Temperature - %</b>				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					

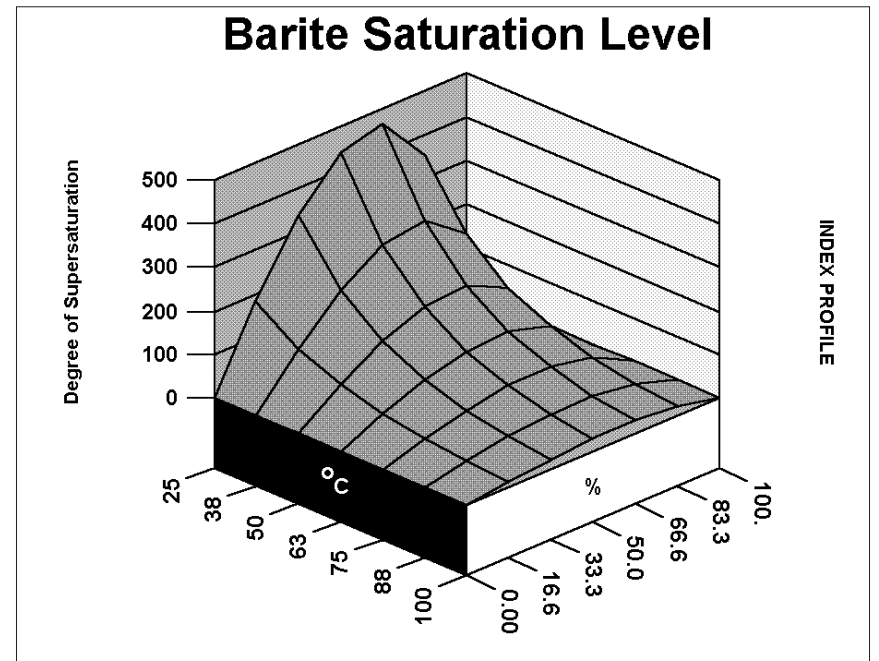
### 3D Temperature - % PROFILE

**SELECTION PURPOSE:** The *3D Temperature - % Profile* module, in the WHAT-IF SCENARIOS pulldown menu, models the impact of temperature and the percentage injection water in the mix upon indicators of scale and corrosivity potential. Trends are presented as 3D contour or bar graphs. Profiles are evaluated at the predicted pH for the mixture at the ratio indicated by the percent injection.

**WHEN SHOULD IT BE USED?** Select *3D Temperature - % Profile* to evaluate the indicators of scale and corrosivity potential over the expected injection percentage and temperature range for the mixed water. Include the minimum and maximum expected temperature to assure, for example, that both the salts whose solubility decreases with temperature, and those whose solubility increase with temperature are modeled under their harshest expected conditions.

**WHAT DOES IT DO?** The *3D Temperature - % Profile* module evaluates the water chemistry at seven (7) % injection values and seven (7) temperatures evenly spaced from the minimums you selected to the maximums. A popup menu for selecting display and output options is displayed across the top of the window.

**PREREQUISITES:** There are no prerequisites for the *3D Temperature - % Profile* module, other than the input of *Injection* and *Formation Water* chemistry. It is recommended that the minimum and maximum percent injection and temperatures be entered or verified in the *Select Injection Parameters* module.



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation			CO3 Calc's	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO <sub>2</sub>	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Browse Inhibitors	
Quit	Input pH Curve	Select Parameters				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		<b>3D pH - %</b>				Choose Scales To Print	
		Select Injection Parameters					

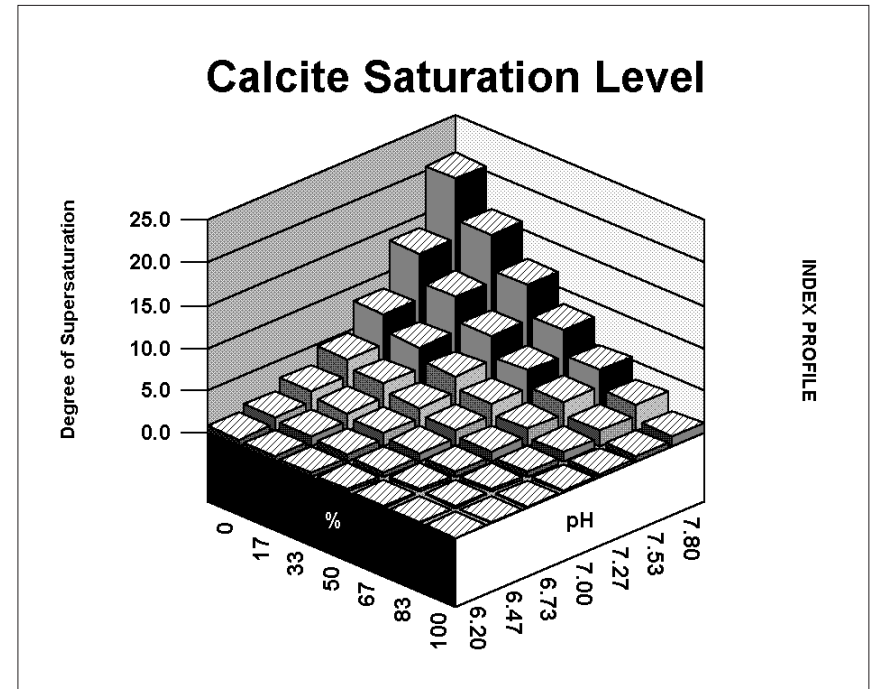
### 3D pH - % PROFILE

**SELECTION PURPOSE:** The *3D pH - % Profile* module, in the WHAT-IF SCENARIOS pulldown menu, models the impact of temperature and pH (or pCO<sub>2</sub>) upon indicators of scale and corrosivity potential. Trends are presented as 3D contour or bar graphs.

**WHEN SHOULD IT BE USED?** Select *3D pH - % Profile* to evaluate the indicators of scale and corrosivity potential over the expected pH (or pCO<sub>2</sub>) and percent injection water range for the mixed water. Include the minimum and maximum expected % injection and pH (or pCO<sub>2</sub>).

**WHAT DOES IT DO?** The *3D pH - % Profile* module evaluates the water chemistry at seven (7) pH or pCO<sub>2</sub> values and seven (7) injection water percentages evenly spaced from the minimums you selected to the maximums. A popup menu for selecting display and output options is displayed across the top of the window.

**PREREQUISITES:** There are no prerequisites for the *3D pH - % Profile* module, other than the input of *Injection* and *Formation Water* chemistry. It is recommended that the minimum and maximum pH (or pCO<sub>2</sub>) and injection water percentages be entered or verified in the *Select Injection Parameters* module. Switch between pH and pCO<sub>2</sub> profiles using the *Plot pH or pCO<sub>2</sub>* module in the PREFERENCES pulldown menu.



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface Print Surface Temperature Profile	Select Product Input Product	ANALYSIS INPUT Input Lab Data	Choose Graphs Input Units Print Mode	Technical Manual
Open Workspace Save Workspace Save Workspace As	WATERFLOOD	Vary Temperature Graph vs Temperature Vary pH Graph vs pH 3D Profile	Print Surface pH Profile Print Injection Print Formation Print Produced Print All Available		EDIT CORRELATION Edit Coefficients Browse Correlations Browse Inhibitors	3D Graph Types CO3 Calc's Plot pH or pCO2 Mineral Name/Chemical Name Constant Values	
Printer Setup What's Stored About DownHole SAT Quit	MULTI-MIX Water Analysis	WATERFLOOD				DISPLAY/PRINT OPTIONS Output Size On Screen Surface Water Windows To Display Mixed Water Windows To Display Choose Ions To Print	
	Input pH Curve	Mix 2D Graph vs % 3D Temperature - pH 3D Temperature - % 3D pH - % <b>Select Injection Parameters</b> MULTI-MIX Mix					

**SELECTION PURPOSE:** The **Select Mixing Zone Parameters** in the WHAT-IF SCENARIOS pulldown menu sets up the ranges for the mixing zone in WATERFLOOD mixing scenarios.

**WHEN SHOULD IT BE USED?** **Select Mixing Zone Parameters** should be run prior to doing a tabular or graphic profile of the mixing of injection and formation waters.

**WHAT DOES IT DO?** The **Select Mixing Zone Parameters** module accepts minimum and maximum values for the percentage of injection versus formation water. It divides the range into seven (7) equal steps for tables and graphs. The ranges specified for %, temperature, pH, and pCO2 will be used for the respective 3D smixing zone profiles.

**PREREQUISITES:** There are no prerequisites for the **Select Mixing Zone Parameters** module.

**Select Mixing Zone Specifications**

Mixing Zone % Injection Water Range (For 2D and 3D Graphs)

Low Percent  High Percent  Typical Percent

pH Prediction Method

Extrapolated pH-Alk       User Defined      Theor. pH-pCO2

Lawrence-Caldwell       Default      Oddo-Tomson

Temperature Range For 3D Graphs

Minimum  Maximum

pH Range For 3D Graphs

Low pH  High pH

pCO2 Range For 3D Graphs

Low pCO2  High pCO2



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation			Edit Coefficients	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT		Water Analysis	Print All Available		Browse Inhibitors	Mineral Name/Chemical Name	
Quit	Input pH Curve	3D Profile				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					
		MULTI-MIX					
		<b>Mix</b>					

### MIX

**SELECTION PURPOSE:** The **Mix** module, in the MULTI-MIX WHAT-IF SCENARIOS pulldown menu prepares a mixing zone profile in tabular format. Water ratios are as input by flow or weight percentage in the multi-mix water chemistry input form.

**WHAT IT DOES:** The **Mix** module predicts the properties of the mixture and displays the results in tabular format.

**WHEN SHOULD IT BE USED?** To predict the result of mixing more than two (2) waters.

**PREREQUISITES:** The **Multi-Mix Water Chemistry** input module should be run prior to mixing.

# DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	<b>Print Surface</b>	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile			Print Mode	
Save Workspace As	Injection Water Analysis	Vary pH	Print Injection		EDIT CORRELATION	3D Graph Types	
Printer Setup	Formation Water Analysis	Graph vs pH	Print Formation		Edit Coefficients	CO3 Calc's	
What's Stored	MULTI-MIX	3D Profile	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT	Water Analysis	Select Parameters	Print All Available		Browse Inhibitors	Mineral Name/Chemical Name	
Quit	Input pH Curve	WATERFLOOD				Constant Values	
		Mix				DISPLAY/PRINT OPTIONS	
		2D Graph vs %				Output Size On Screen	
		3D Temperature - pH				Surface Water Windows To Display	
		3D Temperature - %				Mixed Water Windows To Display	
		3D pH - %				Choose Ions To Print	
		Select Injection Parameters				Choose Scales To Print	
		MULTI-MIX					
		Mix					

## PRINT SURFACE

**SELECTION PURPOSE:** The **Print Surface** module, in the **REPORTS** pull down menu, outputs the tables generated in the **Surface Water** input module.

**WHEN SHOULD IT BE USED?** Use the **Print Surface** module whenever a hard copy of the projected water chemistry and indicators of scale and corrosivity is desired for the analysis entered in the **Surface Water Input** module..

**WHAT DOES IT DO?** The module adds the date, sample ID, and analysis description information to the tables generated in the **Surface Water Input** module and prints them.

**PREREQUISITES:** The **Surface Water Input** module must be run prior to the **Print Surface** module. A printer should be active (see **Printer Setup** under the **FILES** pull down menu).

DownHole SAT Rx SURFACE WATER CHEMISTRY INPUT			
Sea Water Example Report Date: 02-11-1997 Sampled: 02-11-1997 Sample ID: 0 at 1626			
CATIONS		ANIONS	
Calcium (as Ca)	400.00	Chloride (as Cl)	18080
Magnesium (as Mg)	1272	Sulfate (as SO4)	2652
Barium (as Ba)	0.00	Bromine (as Br)	0.00
Strontium (as Sr)	13.00	Dissolved CO2 (as CO2)	0.00
Sodium (as Na)	10561	Bicarbonate (as HCO3)	40.00
Potassium (as K)	380.00	Carbonate (as CO3)	0.00
Lithium (as Li)	0.00	Silica (as SiO2)	7.00
Ammonia (as NH3)	5.00	H2S (as H2S)	0.00
Aluminum (as Al)	0.160	Phosphate (as PO4)	0.00
Iron (as Fe)	0.00300	Nitrate (as NO3)	0.00100
Boron (as B)	4.60	Fluoride (as F)	1.40
Manganese (as Mn)	0.00		
Zinc (as Zn)	0.00		
Lead (as Pb)	0.00		
PARAMETERS		COMMENTS	
pH	7.00		
Temperature (°C)	25.00		
Density(mg/L)	1.02		
Pressure(psi)	14.70		
Calculated T.D.S.	33447		
Molar Conductivity	36964		
SATURATION LEVEL			
Calcite (CaCO3)	0.0798	FREE ION MOMENTARY EXCESS (ppm)	
Aragonite (CaCO3)	0.0687	Calcite (CaCO3)	-0.838
Witherite (BaCO3)	0.00	Aragonite (CaCO3)	-0.985
Strontianite (SrCO3)	0.00821	Witherite (BaCO3)	-49.90
Magnesite (MgCO3)	0.220	Strontianite (SrCO3)	-9.12
Anhydrite (CaSO4)	0.295	Magnesite (MgCO3)	-0.217
Gypsum (CaSO4*2H2O)	0.462	Anhydrite (CaSO4)	-1326
Barite (BaSO4)	0.00	Gypsum (CaSO4*2H2O)	-786.16
Celestite (SrSO4)	0.206	Barite (BaSO4)	-0.0633
Fluorite (CaF2)	0.00153	Celestite (SrSO4)	-100.74
Calcium phosphate	0.00	Fluorite (CaF2)	-37.65
Hydroxyapatite	0.00	Calcium phosphate	>-0.001
Silica (SiO2)	0.0627	Hydroxyapatite	-951.23
Brucite (Mg(OH)2)	< 0.001	Silica (SiO2)	-107.46
Magnesium silicate	< 0.001	Brucite (Mg(OH)2)	-1.02
Iron hydroxide (Fe(OH)3)	0.0391	Magnesium silicate	-296.80
Strengite (FePO4*2H2O)	0.00	Iron hydroxide (Fe(OH)3)	< 0.001
Siderite (FeCO3)	< 0.001	Strengite (FePO4*2H2O)	>-0.001
Halite (NaCl)	0.00274	Siderite (FeCO3)	-0.653
Thenardite (Na2SO4)	< 0.001	Halite (NaCl)	-507651
Iron sulfide (FeS)	0.00	Thenardite (Na2SO4)	-183692
		Iron sulfide (FeS)	-0.799
SIMPLE INDICES			
Langelier	-0.929	BOUND IONS	TOTAL FREE
Ryznar	8.86	Calcium	400.00 344.39
Puckorius	8.67	Barium	0.00 0.00
Larson-Skold Index	892.94	Carbonate	0.467 0.0436
Stiff Davis Index	-1.38	Phosphate	0.00 0.00
Oddo-Tomson	-1.56	Sulfate	2652 1589

# DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY
New	SURFACE	SURFACE	Print Surface	Select Product
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	<b>Print Surface Temperature Profile</b>	Input Product
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	Vary pH	Print Injection	
	Formation Water Analysis	Graph vs pH	Print Formation	
	MULTI-MIX	3D Profile	Print Produced	
	Water Analysis	Select Parameters	Print All Available	
		WATERFLOOD		

## Print Surface Temperature Profile

SELECTION PURPOSE: The **Print Surface Temperature Profile** module, in the **REPORTS** pull down menu, outputs the tables generated in the module **Vary Temperature**.

WHEN SHOULD IT BE USED? Use the **Print Surface Temperature Profile** module whenever a hard copy of the projected water chemistry and indicators of scale and corrosivity versus temperature is desired for the surface water.

WHAT DOES IT DO? The module adds the date, sample ID, and analysis description information to the tables generated in the **Vary Temperature** module and prints them.

PREREQUISITES: The **Vary Temperature** module must be run prior to the **Print Surface Temperature Profile** module. A printer should be active (see **Printer Setup** under the **FILES** pull down menu).

DownHole SAT Rx WATER CHEMISTRY VERSUS TEMPERATURE							
Sea Water Example Report Date: 02-11-1997 Sampled: 02-11-1997 Sample ID: 0 at 1626							
	Temperature (°C)						
	27.00	35.50	44.00	52.50	61.00	69.50	78.00
CATIONS							
Calcium (as Ca)	400.00	400.00	400.00	400.00	400.00	400.00	400.00
Magnesium (as Mg)	1272	1272	1272	1272	1272	1272	1272
Barium (as Ba)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Strontium (as Sr)	13.00	13.00	13.00	13.00	13.00	13.00	13.00
Sodium (as Na)	10561	10561	10561	10561	10561	10561	10561
Potassium (as K)	380.00	380.00	380.00	380.00	380.00	380.00	380.00
Lithium (as Li)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iron (as Fe)	0.00300	0.00300	0.00300	0.00300	0.00300	0.00300	0.00300
Ammonia (as NH3)	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Aluminum (as Al)	0.160	0.160	0.160	0.160	0.160	0.160	0.160
Boron (as B)	4.60	4.60	4.60	4.60	4.60	4.60	4.60
Manganese (as Mn)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zinc (as Zn)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lead (as Pb)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DownHole SAT Rx DEPOSITION POTENTIAL INDICATORS VERSUS TEMPERATURE							
Sea Water Example Report Date: 02-11-1997 Sampled: 02-11-1997 Sample ID: 0 at 1626							
	Temperature (°C)						
	27.00	35.50	44.00	52.50	61.00	69.50	78.00
SATURATION LEVEL							
Calcite	0.305	0.373	0.430	0.476	0.509	0.526	0.527
Aragonite	0.262	0.317	0.361	0.397	0.421	0.431	0.428
Witherite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Strontianite	0.0295	0.0278	0.0251	0.0221	0.0189	0.0158	0.0130
Magnesite	0.866	1.19	1.52	1.87	2.20	2.48	2.71
Anhydrite	0.301	0.327	0.350	0.372	0.391	0.408	0.423
Gypsum	0.451	0.406	0.365	0.328	0.294	0.264	0.237
Barite (BaSO4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Celestite (SrSO4)	0.204	0.195	0.185	0.175	0.165	0.155	0.145
Tricalcium phosphate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroxylapatite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorite (CaF2)	0.00144	0.00110	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica (SiO2)	0.0593	0.0481	0.0394	0.0325	0.0271	0.0226	0.0190
Brucite (Mg(OH)2)	< 0.001	0.00137	0.00406	0.0114	0.0301	0.0757	0.181
Magnesium silicate	0.0142	0.0343	0.0786	0.172	0.358	0.714	1.37
Ferric hydroxide	0.658	0.981	1.41	1.95	2.58	3.23	3.71
Siderite	0.00365	0.00494	0.00625	0.00752	0.00860	0.00934	0.00965
Strengite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Halite (NaCl)	0.00271	0.00256	0.00243	0.00231	0.00220	0.00209	0.00199
Thénardite (Na2SO4)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Iron sulfide (FeS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SIMPLE INDICES							
Langelier	-0.309	-0.190	-0.0884	0.00605	0.0947	0.178	0.258
Ryznar	8.22	7.98	7.78	7.59	7.41	7.24	7.08
Oddo-Tomson	-0.933	-0.776	-0.619	-0.462	-0.305	-0.147	0.0103
Stiff-Davis	-0.749	-0.571	-0.376	-0.138	0.137	0.390	0.699
Puckorius	8.65	8.41	8.21	8.02	7.84	7.67	7.51
Larson-Skold	913.76	906.63	899.87	892.24	883.88	875.37	866.16
Ca Total	400.00	400.00	400.00	400.00	400.00	400.00	400.00
Free	344.52	345.26	346.33	347.63	349.14	350.83	352.62
Ba Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Free	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO3 Total	1.76	2.04	2.33	2.64	3.00	3.38	3.78
Free	0.162	0.177	0.184	0.186	0.183	0.176	0.165
PO4 Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Free	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO4 Total	2652	2652	2652	2652	2652	2652	2652
Free	1567	1480	1398	1321	1251	1187	1130

DownHole SAT Rx DEPOSITION POTENTIAL INDICATORS VERSUS TEMPERATURE							
Sea Water Example Report Date: 02-11-1997 Sampled: 02-11-1997 Sample ID: 0 at 1626							
	Temperature (°C)						
	27.00	35.50	44.00	52.50	61.00	69.50	78.00
FREE ION							
MOMENTARY EXCESS (ppm)							
Calcite	-0.615	-0.497	-0.408	-0.341	-0.294	-0.264	-0.247
Aragonite	-0.761	-0.637	-0.543	-0.472	-0.421	-0.388	-0.368
Witherite	-50.07	-50.80	-50.57	-50.37	-50.33	-50.43	-50.68
Strontianite	-9.15	-10.23	-11.41	-12.69	-14.06	-15.55	-17.15
Magnesite	-0.0354	0.0391	0.0891	0.122	0.140	0.148	0.146
Anhydrite	-1288	-1148	-1032	-937.20	-858.48	-793.62	-740.14
Gypsum	-813.90	-934.36	-1058	-1185	-1315	-1448	-1584
Barite	-0.0693	-0.101	-0.146	-0.207	-0.292	-0.407	-0.560
Celestite	-101.88	-107.37	-113.79	-121.07	-129.22	-138.24	-148.08
Calcium phosphate	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001
Hydroxylapatite	-969.91	-1052	-1138	-1228	-1324	-1424	-1530
Fluorite	-38.13	-40.22	-42.36	-44.54	-46.78	-49.09	-51.48
Silica	-113.38	-140.84	-172.56	-208.88	-250.12	-296.59	-348.60
Brucite	-1.01	-1.04	-1.06	-1.05	-1.02	-0.936	-0.776
Magnesium silicate	-302.94	-329.69	-357.54	-386.49	-416.57	-447.81	-482.00
Ferric hydroxide	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Siderite	-0.537	-0.460	-0.400	-0.354	-0.318	-0.290	-0.270
Strengite	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001
Halite	-51128	-525885	-540651	-555461	-570351	-585362	-600535
Thénardite	-183703	-183903	-184344	-185024	-185943	-187122	-188550
Iron sulfide	-0.401	-0.405	-0.410	-0.415	-0.421	-0.428	-0.435

DownHole SAT Rx DEPOSITION POTENTIAL INDICATORS VERSUS TEMPERATURE							
Sea Water Example Report Date: 02-11-1997 Sampled: 02-11-1997 Sample ID: 0 at 1626							
	Temperature (°C)						
	27.00	35.50	44.00	52.50	61.00	69.50	78.00
PARAMETERS							
pH	7.60	7.60	7.60	7.60	7.60	7.60	7.60
Temperature (°C)	27.00	35.50	44.00	52.50	61.00	69.50	78.00
Pressure (psia)	14.70	14.70	14.70	14.70	14.70	14.70	14.70
Density (g/mL)	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Calculated TDS	33441	33442	33441	33442	33442	33442	33443

# DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY
New	SURFACE	SURFACE	Print Surface	Select Product
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature Graph vs Temperature	Print Surface Temperature Profile	Input Product
	WATERFLOOD	Vary pH Graph vs pH	<b>Print Surface pH Profile</b>	
Printer Setup What's Stored	Injection Water Analysis	3D Profile	Print Injection	
	Formation Water Analysis	Select Parameters	Print Formation Print Produced Print All Available	
	MULTI-MIX			

## Print Surface Water pH Profile

SELECTION PURPOSE: The **Print Surface Water pH Profile** module, in the **REPORTS** pull down menu, outputs the tables generated in the module **Vary pH**.

WHEN SHOULD IT BE USED? Use the **Print Surface Water pH Profile** module whenever a hard copy of the projected water chemistry and indicators of scale and corrosivity versus pH is desired.

WHAT DOES IT DO? The module adds the date, sample ID, and analysis description information to the tables generated in the **Vary pH** module and prints them.

PREREQUISITES: The **Vary pH** module must be run prior to the **Print Surface Water pH Profile** module. A printer should be active (see **Printer Setup** under the **FILES** pull down menu).

DownHole SAT Rx WATER CHEMISTRY VERSUS pH							
Report Date: 01-01-1980 Sampled: 01-01-1980 Sample ID: 0 at 1200							

CATIONS	pH						
	6.00	6.50	7.00	7.50	8.00	8.50	9.00
Calcium (as Ca)	400.00	400.00	400.00	400.00	400.00	400.00	400.00
Magnesium (as Mg)	1272	1272	1272	1272	1272	1272	1272
Barium(as Ba)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Strontium(as Sr)	13.00	13.00	13.00	13.00	13.00	13.00	13.00
Sodium (as Na)	10561	10561	10561	10561	10561	10561	10561
Potassium (as K)	380.00	380.00	380.00	380.00	380.00	380.00	380.00
Lithium(as Li)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iron (as Fe)	0.00300	0.00300	0.00300	0.00300	0.00300	0.00300	0.00300
Ammonia (as NH3)	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Aluminum (as Al)	0.160	0.160	0.160	0.160	0.160	0.160	0.160
Boron (as B)	4.60	4.60	4.60	4.60	4.60	4.60	4.60
Manganese(as Mn)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zinc(as Zn)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lead(as Pb)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ANIONS	pH						
	6.00	6.50	7.00	7.50	8.00	8.50	9.00
Chloride (as Cl)	18080	18080	18080	18080	18080	18080	18080
Sulfate (as SO4)	2652	2652	2652	2652	2652	2652	2652
Bromine (as Br)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dissolved CO2	23.0	12.6	5.2	1.8	0.6	0.2	0.1
Bicarbonate	14.3	24.6	31.5	33.2	30.0	21.6	11.4
Carbonate	0.0	0.2	0.7	2.4	6.7	15.4	25.6
Silica(as SiO2)	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Phosphate(as PO4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2S(as H2S)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluoride(as F)	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Nitrate(as NO3)	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100

PARAMETERS	pH						
	6.00	6.50	7.00	7.50	8.00	8.50	9.00
Temperature(°C)	60.00	60.00	60.00	60.00	60.00	60.00	60.00
Pressure(psia)	14.70	14.70	14.70	14.70	14.70	14.70	14.70
Density(g/mL)	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Calculated TDS	33441	33441	33441	33442	33443	33447	33459

DownHole SAT Rx DEPOSITION POTENTIAL INDICATORS VERSUS pH							
Report Date: 01-01-1980 Sampled: 01-01-1980 Sample ID: 0 at 1200							

SATURATION LEVEL	pH						
	6.00	6.50	7.00	7.50	8.00	8.50	9.00
Calcite	0.00554	0.0301	0.122	0.405	1.16	2.64	4.41
Aragonite	0.00458	0.0249	0.101	0.335	0.956	2.18	3.64
Witherite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Strontiantate	< 0.001	0.00115	0.00463	0.0154	0.0441	0.101	0.168
Magnesite	0.0237	0.129	0.519	1.73	4.93	11.21	18.49
Anhydrite	0.389	0.389	0.389	0.389	0.389	0.389	0.391
Gypsum	0.298	0.298	0.298	0.298	0.298	0.299	0.300
Barite (BaSO4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Celestite (SrSO4)	0.166	0.166	0.166	0.166	0.167	0.167	0.168
Tricalcium phosphate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroxylapatite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorite (CaF2)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica (SiO2)	0.0286	0.0285	0.0283	0.0278	0.0263	0.0222	0.0142
Brucite (Mg(OH)2)	< 0.001	< 0.001	0.00170	0.0170	0.170	1.69	16.65
Magnesium silicate	< 0.001	0.00214	0.0213	0.209	1.97	16.59	104.36
Ferric hydroxide	0.00171	0.0171	0.169	1.61	12.59	31.65	17.08
Siderite	< 0.001	< 0.001	0.00218	0.00693	0.0155	0.00888	< 0.001
Strengite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Halite (NaCl)	0.00221	0.00221	0.00221	0.00221	0.00221	0.00221	0.00221
Thenardite (Na2SO4)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Iron sulfide (FeS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SIMPLE INDICES	pH						
	6.00	6.50	7.00	7.50	8.00	8.50	9.00
Langellier	-1.99	-1.21	-0.585	-0.0251	0.529	1.12	1.75
Ryznar	9.96	8.92	8.17	7.55	6.94	6.27	5.50
Oddo-Tomson	-2.34	-1.60	-0.986	-0.432	0.113	0.681	1.27
Stiff-Davis	-1.91	-1.17	-0.555	>-0.001	0.544	1.11	1.70
Puckorius	9.42	8.51	8.09	7.89	7.72	7.44	7.06
Larson-Skold	2395	1379	1046	907.17	789.38	652.17	544.21
Ca Total	400.00	400.00	400.00	400.00	400.00	400.00	400.00
Free	349.81	349.42	349.13	348.97	348.86	348.64	348.12
Ba Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Free	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO3 Total	0.0322	0.175	0.709	2.36	6.74	15.37	25.57
Free	0.00201	0.0109	0.0442	0.147	0.420	0.960	1.60
PO4 Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Free	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO4 Total	2652	2652	2652	2652	2652	2652	2652

DownHole SAT Rx DEPOSITION POTENTIAL INDICATORS VERSUS pH							
Report Date: 01-01-1980 Sampled: 01-01-1980 Sample ID: 0 at 1200							

FREE ION MOMENTARY EXCESS (ppm)	pH						
	6.00	6.50	7.00	7.50	8.00	8.50	9.00
Calcite	-0.601	-0.587	-0.532	-0.360	0.0949	0.994	2.07
Aragonite	-0.728	-0.714	-0.659	-0.487	-0.0323	0.867	1.94
Witherite	-50.63	-50.61	-50.56	-50.39	-49.94	-49.06	-48.03
Strontiantite	-14.22	-14.20	-14.14	-13.96	-13.48	-12.54	-11.44
Magnesite	-0.116	-0.104	-0.0575	0.0872	0.471	1.23	2.13
Anhydrite	-866.84	-867.08	-867.15	-867.02	-866.68	-865.54	-862.11
Gypsum	-1299	-1300	-1300	-1299	-1299	-1298	-1294
Barite	-0.281	-0.281	-0.281	-0.281	-0.281	-0.280	-0.278
Celestite	-128.48	-128.39	-128.31	-128.23	-128.13	-127.85	-127.07
Calcium phosphate	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001
Hydroxyapatite	-1312	-1312	-1312	-1312	-1312	-1312	-1312
Fluorite	-46.49	-46.48	-46.50	-46.51	-46.51	-46.52	-46.54
Silica	-244.77	-244.78	-244.82	-244.95	-245.34	-246.36	-248.39
Brucite	-1.22	-1.21	-1.18	-1.07	-0.723	0.369	3.82
Magnesium silicate	-412.98	-412.98	-412.97	-412.97	0.209	1.95	5.38
Ferric hydroxide	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Siderite	-0.465	-0.457	-0.426	-0.345	-0.212	-0.111	-0.0696
Strengite	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001
Halite	-566600	-566598	-566596	-566595	-566590	-566579	-566544
Thenardite	-185848	-185828	-185826	-185823	-185817	-185820	-185778
Iron sulfide	-2.66	-1.50	-0.841	-0.472	-0.265	-0.149	-0.0842

# DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	Vary pH	<b>Print Injection</b>	EDIT CORRELATION	3D Graph Types		
	Formation Water Analysis	Graph vs pH	Print Formation	Edit Coefficients	CO3 Calc's		
Quit	MULTI-MIX	3D Profile	Print Produced	Browse Correlations	Plot pH or pCO2		
	Water Analysis	Select Parameters	Print All Available	Browse Inhibitors	Mineral Name/Chemical Name		
	Input pH Curve	WATERFLOOD				Constant Values	
		Mix				DISPLAY/PRINT OPTIONS	
		2D Graph vs %				Output Size On Screen	
						Surface Water Windows To Display	
						Mixed Water Windows To Display	
						Choose Ions To Print	
						Choose Scales To Print	

## PRINT INJECTION

**SELECTION PURPOSE:** The *Print Injection* module, in the **REPORTS** pull down menu, outputs the tables generated in the *Injection Water* input module.

**WHEN SHOULD IT BE USED?** Use the *Print Injection* module whenever a hard copy of the projected water chemistry and indicators of scale and corrosivity is desired for the analysis entered in the *Injection Water Input* module..

**WHAT DOES IT DO?** The module adds the date, sample ID, and analysis description information to the tables generated in the *Injection Water Input* module and prints them.

**PREREQUISITES:** The *Injection Water Input* module must be run prior to the *Print Injection* module. A printer should be active (see *Printer Setup* under the **FILES** pull down menu).

DownHole SAT Rx  
INJECTION WATER DEPOSITION POTENTIAL INDICATORS

North Sea Water	February, 1991
SPE Production Engr	Yuan & Todd
Report Date: 05-26-1994	Sampled: 05-26-1994
Sample ID: 0	at 1703

SATURATION LEVEL	FREE ION MOMENTARY EXCESS (ppm)
Calcite (CaCO3)	0.140
Aragonite (CaCO3)	0.111
Witherite (BaCO3)	0.00
Strontianite (SrCO3)	0.00
Magnesite (MgCO3)	1.50
Anhydrite (CaSO4)	0.221
Gypsum (CaSO4*2H2O)	0.0957
Barite (BaSO4)	0.00
Celestite (SrSO4)	0.00
Fluorite (CaF2)	0.00
Calcium phosphate	0.00
Hydroxyapatite	0.00
Silica (SiO2)	0.00
Brucite (Mg(OH)2)	0.0389
Magnesium silicate	0.00
Iron hydroxide (Fe(OH)3)	0.00
Strengite (FePO4*2H2O)	0.00
Siderite (FeCO3)	0.00
Halite (NaCl)	0.00159
Thenardite (Na2SO4)	< 0.001
Iron sulfide (FeS)	0.00

SIMPLE INDICES	BOUND IONS	TOTAL	FREE
Langelier	-0.121	Calcium	403.00
Ryznar	7.04	Barium	0.00
Puckorius	5.95	Carbonate	3.10
Larson-Skold Index	319.93	Phosphate	0.00
Stiff Davis Index	1.11	Sulfate	2480
Oddo-Tomson	0.0778		957.56

FRENCH CREEK SOFTWARE, INC.

DownHole SAT Rx  
INJECTION WATER CHEMISTRY INPUT

North Sea Water	February, 1991
SPE Production Engr	Yuan & Todd
Report Date: 05-26-1994	Sampled: 05-26-1994
Sample ID: 0	at 1703

CATIONS	ANIONS
Calcium (as Ca)	403.00
Magnesium (as Mg)	1320
Barium (as Ba)	0.00
Strontium (as Sr)	0.00
Sodium (as Na)	11000
Potassium (as K)	340.00
Lithium (as Li)	0.00
Ammonia (as NH3)	0.00
Aluminum (as Al)	0.00
Iron (as Fe)	0.00
Boron (as B)	0.00
Manganese (as Mn)	0.00
Zinc (as Zn)	0.00
Lead (as Pb)	0.00

PARAMETERS	COMMENTS
pH	6.80
Temperature (°C)	100.00
Density(mg/L)	1.00
Pressure(bars)	300.00
Calculated T.D.S.	35480
Molar Conductivity	34815

FRENCH CREEK SOFTWARE, INC.

# DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			Edit Coefficients	
Printer Setup	Formation Water Analysis	Vary pH	<b>Print Formation</b>		Browse Correlations	3D Graph Types	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Inhibitors	CO3 Calc's	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Browse Correlations	Plot pH or pCO2
Quit	Input pH Curve	Select Parameters				Mineral Name/Chemical Name	
		WATERFLOOD				Constant Values	
		Mix				DISPLAY/PRINT OPTIONS	
		2D Graph vs %				Output Size On Screen	
		3D Temperature - pH				Surface Water Windows To Display	
		3D Temperature - %				Mixed Water Windows To Display	
		3D pH - %				Choose Ions To Print	
						Choose Scales To Print	

## PRINT FORMATION

**SELECTION PURPOSE:** The **Print Formation** module, in the **REPORTS** pull down menu, outputs the tables generated in the **Formation Water** input module.

**WHEN SHOULD IT BE USED?** Use the **Print Formation** module whenever a hard copy of the projected water chemistry and indicators of scale and corrosivity is desired for the analysis entered in the **Formation Water Input** module.

**WHAT DOES IT DO?** The module adds the date, sample ID, and analysis description information to the tables generated in the **Formation Water Input** module and prints them.

**PREREQUISITES:** The **Formation Water Input** module must be run prior to the **Print Formation** module. A printer should be active (see **Printer Setup** under the **FILES** pull down menu).

DownHole SAT Rx FORMATION WATER DEPOSITION POTENTIAL INDICATORS			
Forties Water	February, 1991		
SPE Production Engr	Yuan & Todd		
Report Date: 05-26-1994	Sampled: 05-26-1994		
Sample ID: 0	at 1703		
SATURATION LEVEL	FREE ION MOMENTARY EXCESS (ppm)		
Calcite (CaCO3)	Calcite (CaCO3)	20.56	2.46
Aragonite (CaCO3)	Aragonite (CaCO3)	16.37	2.43
Witherite (BaCO3)	Witherite (BaCO3)	0.233	-15.84
Strontianite (SrCO3)	Strontianite (SrCO3)	1.62	1.45
Magnesite (MgCO3)	Magnesite (MgCO3)	12.26	2.00
Anhydrite (CaSO4)	Anhydrite (CaSO4)	0.00	-847.27
Gypsum (CaSO4*2H2O)	Gypsum (CaSO4*2H2O)	0.00	-1970
Barite (BaSO4)	Barite (BaSO4)	0.00	-24.33
Celestite (SrSO4)	Celestite (SrSO4)	0.00	-755.78
Fluorite (CaF2)	Fluorite (CaF2)	0.00	-21.47
Calcium phosphate	Calcium phosphate	0.00	>-0.001
Hydroxyapatite	Hydroxyapatite	0.00	-1935
Silica (SiO2)	Silica (SiO2)	0.00	-443.26
Brucite (Mg(OH)2)	Brucite (Mg(OH)2)	2.02	0.889
Magnesium silicate	Magnesium silicate	0.00	-561.43
Iron hydroxide (Fe(OH)3)	Iron hydroxide (Fe(OH)3)	0.00	-0.588
Strenigite (FePO4*2H2O)	Strenigite (FePO4*2H2O)	0.00	>-0.001
Siderite (FeCO3)	Siderite (FeCO3)	0.00	-0.0870
Halite (NaCl)	Halite (NaCl)	0.0125	-640986
Thenardite (Na2SO4)	Thenardite (Na2SO4)	0.00	-271566
Iron sulfide (FeS)	Iron sulfide (FeS)	0.00	-0.425
SIMPLE INDICES	BOUND IONS	TOTAL	FREE
Langelier	Calcium	310	3035
Ryznar	Barium	250.00	249.98
Puckorius	Carbonate	139.29	1.55
Larson-Skold Index	Phosphate	0.00	0.00
Stiff Davis Index	Sulfate	0.00	0.00
Oddo-Tomson			

FRENCH CREEK SOFTWARE, INC.

DownHole SAT Rx FORMATION WATER CHEMISTRY INPUT			
Forties Water	February, 1991		
SPE Production Engr	Yuan & Todd		
Report Date: 05-26-1994	Sampled: 05-26-1994		
Sample ID: 0	at 1703		
CATIONS	ANIONS		
Calcium (as Ca)	Chloride (as Cl)	3110	53000
Magnesium (as Mg)	Sulfate (as SO4)	480.00	0.00
Barium (as Ba)	Bromine (as Br)	250.00	0.00
Strontium (as Sr)	Dissolved CO2 (as CO2)	660.00	0.00
Sodium (as Na)	Bicarbonate (as HCO3)	30200	360.00
Potassium (as K)	Carbonate (as CO3)	430.00	0.00
Lithium (as Li)	Silica (as SiO2)	0.00	0.00
Ammonia (as NH3)	H2S (as H2S)	0.00	0.00
Aluminum (as Al)	Phosphate (as P04)	0.00	0.00
Iron (as Fe)	Nitrate (as NO3)	0.00	0.00
Boron (as B)	Fluoride (as F)	0.00	0.00
Manganese (as Mn)		0.00	
Zinc (as Zn)		0.00	
Lead (as Pb)		0.00	
PARAMETERS	COMMENTS		
pH		7.80	
Temperature (°C)		100.00	
Density (mg/L)		1.00	
Pressure (bars)		300.00	
Calculated T.D.S.		88496	
Molar Conductivity		38031	

FRENCH CREEK SOFTWARE, INC.

# DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature Graph vs Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Vary pH Graph vs pH	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored	Injection Water Analysis Formation Water Analysis	3D Profile Select Parameters	Print Injection Print Formation <b>Print Produced</b>		Browse Correlations Browse Inhibitors	3D Graph Types CO3 Calc's Plot pH or pCO2 Mineral Name/Chemical Name Constant Values	
	MULTI-MIX	WATERFLOOD	Print All Available			DISPLAY/PRINT OPTIONS	

DownHole SAT Rx  
WATER CHEMISTRY AT VARIOUS RATIOS OF INJECTION AND FORMATION WATER

	North Sea Water February, 1991 SPE Production Engr Yuan & Todd	Forties Water February, 1991 SPE Production Engr Yuan & Todd
Sample ID	0	0
Report Date	05-26-1994	05-26-1994
Sample Date	05-26-1994 at1703	05-26-1994 at1703

DownHole SAT Rx  
DEPOSITION POTENTIAL INDICATORS AT VARIOUS INJECTION AND FORMATION RATIOS

	North Sea Water February, 1991 SPE Production Engr Yuan & Todd	Forties Water February, 1991 SPE Production Engr Yuan & Todd
Sample ID	0	0
Report Date	05-26-1994	05-26-1994
Sample Date	05-26-1994 at1703	05-26-1994 at1703

	% INJECTION						
	0.00	16.67	33.33	50.00	66.66	83.33	100.00
<b>CATIONS</b>							
Calcium (as Ca)	3110	2659	2208	1757	1305	854.26	403.00
Magnesium (as Mg)	480.00	619.99	759.99	899.98	1040	1180	1320
Barium (as Ba)	250.00	208.33	166.67	125.00	83.34	41.67	0.00
Strontium (as Sr)	660.00	550.00	440.01	330.01	220.02	110.02	0.00
Sodium (as Na)	30200	27000	23800	20600	17401	14201	11000
Potassium (as K)	430.00	415.00	400.00	385.00	370.00	355.00	340.00
Lithium (as Li)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iron (as Fe)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia (as NH3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aluminum (as Al)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boron (as B)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manganese (as Mn)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zinc (as Zn)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lead (as Pb)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>ANIONS</b>							
Chloride (as Cl)	53000	47467	41934	36401	30868	25334	19800
Sulfate (as SO4)	0.00	413.32	826.63	1240	1653	2067	2480
Bromine (as Br)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dissolved CO2	6.4	7.6	9.1	10.9	12.8	14.6	15.9
Bicarbonate	212.6	216.4	211.7	197.3	174.1	144.1	109.5
Carbonate	139.2	96.0	61.1	35.7	19.1	9.1	3.6
Silica (as SiO2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phosphate (as PO4)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2S (as H2S)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluoride (as F)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate (as NO3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>PARAMETERS</b>							
pH	7.80	7.67	7.53	7.38	7.23	7.06	6.87
Temperature (°C)	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Pressure (bars)	300.00	300.00	300.00	300.00	300.00	300.00	300.00
Density (g/mL)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Calculated TDS	88496	79659	70822	61986	53149	44313	35474

	% INJECTION						
	0.00	16.67	33.33	50.00	66.66	83.33	100.00
<b>SATURATION LEVEL</b>							
Calcite	20.55	13.09	7.62	3.98	1.83	0.685	0.164
Aragonite	16.36	10.42	6.06	3.17	1.46	0.545	0.131
Witherite	0.233	0.159	0.0973	0.0525	0.0237	0.00749	0.00
Strontianite	1.62	1.10	0.674	0.364	0.164	0.0518	0.00
Magnesite	12.25	11.49	9.61	7.29	5.06	3.19	1.76
Anhydrite	0.00	0.189	0.321	0.398	0.413	0.359	0.221
Gypsum	0.00	0.0771	0.133	0.166	0.175	0.154	0.0958
Barite (BaSO4)	0.00	12.30	22.10	28.22	28.86	21.16	0.00
Celestine (SrSO4)	0.00	0.213	0.383	0.489	0.500	0.367	0.00
Tricalcium phosphate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroxylapatite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluorite (CaF2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silica (SiO2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brucite (Mg(OH)2)	2.02	1.35	0.816	0.455	0.241	0.120	0.0540
Magnesium silicate	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferric hydroxide	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siderite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Strenigite	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Halite (NaCl)	0.0125	0.00975	0.00742	0.00548	0.00389	0.00260	0.00159
Thenardite (Na2SO4)	0.00	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Iron sulfide (FeS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>SIMPLE INDICES</b>							
Langellier	2.35	2.08	1.78	1.45	1.07	0.607	-0.0492
Ryznar	3.10	3.51	3.97	4.49	5.09	5.85	6.97
Oddo-Tomson	2.19	1.96	1.71	1.43	1.11	0.717	0.149
Stiff-Davis	3.60	3.31	3.00	2.66	2.29	1.83	1.18
Puckorius	2.19	2.56	2.97	3.45	4.04	4.79	5.95
Larson-Skold	184.02	199.77	217.94	237.84	259.31	284.31	318.39
Ca Total	3110	2659	2208	1757	1305	854.26	403.00
Free	3035	2548	2074	1615	1171	743.71	337.48
Ba Total	250.00	208.33	166.67	125.00	83.34	41.67	0.00
Free	249.98	208.32	166.66	125.00	83.34	41.67	0.00
CO3 Total	139.20	95.98	61.12	35.75	19.09	9.09	3.64
Free	1.55	1.20	0.859	0.571	0.352	0.197	0.0950
PO4 Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Free	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO4 Total	0.00	413.32	826.63	1240	1653	2067	2480
Free	0.00	144.60	297.42	457.54	623.28	791.68	957.68

DownHole SAT Rx  
DEPOSITION POTENTIAL INDICATORS AT VARIOUS INJECTION AND FORMATION RATIOS

	North Sea Water February, 1991 SPE Production Engr Yuan & Todd	Forties Water February, 1991 SPE Production Engr Yuan & Todd					
Sample ID	0	0					
Report Date	05-26-1994	05-26-1994					
Sample Date	05-26-1994 at1703	05-26-1994 at1703					
<b>%</b>							
INJECTION	0.00	16.67	33.33	50.00	66.66	83.33	100.00
FREE ION	0.00	16.67	33.33	50.00	66.66	83.33	100.00
MOMENTARY EXCESS (ppm)							
Calcite	2.46	1.84	1.24	0.714	0.266	-0.151	-0.806
Aragonite	2.43	1.80	1.20	0.652	0.184	-0.273	-1.05
Witherite	-15.85	-19.37	-23.60	-28.92	-36.23	-47.50	-66.37
Strontianite	1.45	0.263	-1.02	-2.44	-4.33	-8.44	-38.35
Magnesite	2.00	1.54	1.08	0.692	0.396	0.190	0.0574
Anhydrite	-847.27	-790.46	-761.92	-779.98	-871.50	-1070	-1404
Gypsum	-1970	-2028	-2124	-2267	-2470	-2736	-3059
Barite	-24.33	252.11	263.08	203.22	136.23	67.35	-2.31
Celestine	-755.78	-584.66	-438.41	-333.33	-283.95	-295.82	-362.82
Calcium phosphate	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001
Hydroxyapatite	-1935	-1953	-1963	-1960	-1943	-1907	-1844
Fluorite	-21.47	-23.77	-26.57	-30.16	-35.14	-43.07	-60.13
Silica	-443.26	-453.26	-463.30	-473.39	-483.52	-493.69	-503.91
Brucite	0.886	0.315	-0.173	-0.551	-0.819	-1.000	-1.11
Magnesium silicate	-561.43	-567.15	-571.50	-574.12	-574.51	-571.90	-565.06
Ferric hydroxide	-0.588	-0.587	-0.586	-0.584	-0.581	-0.577	-0.570
Siderite	-0.0871	-0.106	-0.135	-0.177	-0.229	-0.283	-0.323
Strenigite	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001	>-0.001
Halite	-640986	-660075	-677704	-693462	-706774	-716787	-722141
Thenardite	-271566	-267385	-262453	-256603	-249621	-241127	-230526



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation			Edit Coefficients	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT		Water Analysis	Select Parameters	<b>Print All Available</b>		Browse Inhibitors	
Quit	Input pH Curve	3D Profile				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					
		MULTI-MIX					
		Mix					



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	<b>Select Product</b>	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation		Edit Coefficients	CO3 Calc's	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Browse Inhibitors	Mineral Name/Chemical Name
Quit	Input pH Curve	Select Parameters				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

### SELECT PRODUCT

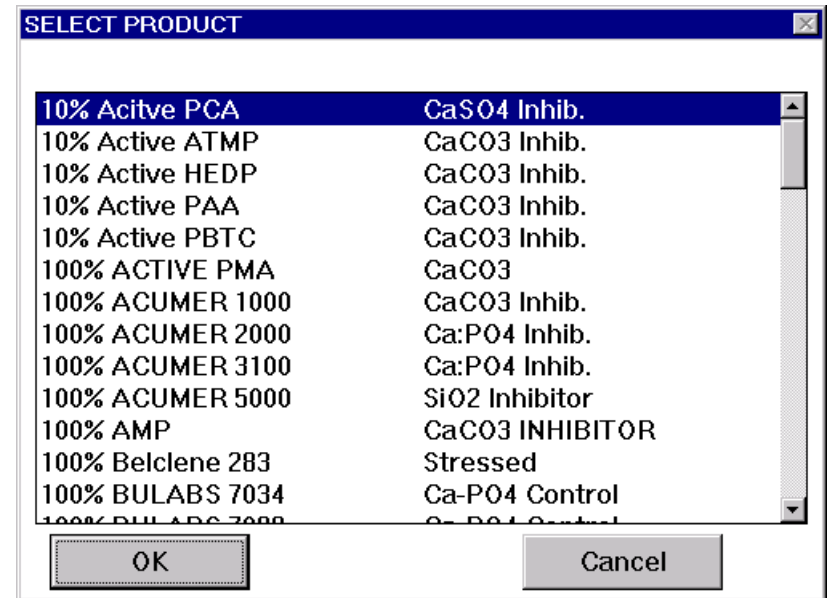
**SELECTION PURPOSE:** The **Select Product** module, in the ANTISCALANT pull down menu, lists the products on file and a description of their purpose, and allows you to select or change the product for which dosages will be calculated by the WHAT-IF SCENARIO modules.

**WHEN SHOULD IT BE USED?** Use the **Select Product** module to select a product for calculations or switch between products for calculations.

**WHAT DOES IT DO?** The module loads a product file including the mathematical correlations for the product which are used to calculate dosages from indices and operating parameters.

**PREREQUISITES:** A product file (\*.PRD) must be in the \DHSAT\INHIB\ sub directory before it can be selected.

Product files are created in the **Input Product** module of the FORMULARY pull down menu in the Formulator or Laboratory Editions.



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature Graph vs Temperature	Print Surface Temperature Profile Print Surface pH Profile	<b>Input Product</b>	Input Lab Data	Input Units Print Mode	
Printer Setup What's Stored About DownHole SAT	WATERFLOOD	Vary pH Graph vs pH 3D Profile	Print Injection Print Formation Print Produced Print All Available		EDIT CORRELATION Edit Coefficients Browse Correlations Browse Inhibitors	3D Graph Types CO3 Calc's Plot pH or pCO2 Mineral Name/Chemical Name Constant Values	
Quit	MULTI-MIX Water Analysis	Select Parameters				DISPLAY/PRINT OPTIONS Output Size On Screen Surface Water Windows To Display Mixed Water Windows To Display Choose Ions To Print Choose Scales To Print	
	Input pH Curve	WATERFLOOD					
		Mix 2D Graph vs % 3D Temperature - pH					

**SELECTION PURPOSE:** The *Input Product* module, in the **FORMULARY** pull down menu is used to create a product (.PRD) file.

**WHEN SHOULD IT BE USED?** Use the *Input Product* module to create a new product file or modify an existing product file's Product Name, Description, or Formulation. NOTE: Inhibitors should be re-loaded into a formulation sheet when an inhibitor file is updated. Product files load a copy of the inhibitor file when they are created. They DO NOT automatically re-load a new file when the inhibitor data is updated.

**WHAT DOES IT DO?** The module accepts input data for a product file, loads the mathematical correlations for the individual inhibitors in the formulation, and outputs the new or updated product file.

**PREREQUISITES:** An inhibitor file (\*.INH) must be in the \DHSAT\INHIB\ sub directory for each inhibitor which is an active ingredient.

Inhibitor files are created in the *Input Lab Data* module of the **LABORATORY** pull down menu in the Laboratory Editions. They can be created from in-house laboratory and/or field data, or obtained from raw material suppliers who use the French Creek Software Rx series programs as a technical support tool.

**NOTES:** 1) The product file name MUST end with the PRD extension, e.g. EXAMPLE.PRD

2) Enter % on an active, solids basis. e.g. If you are adding 10% of a 50% active PAA, enter 5%.

3) Push the button next to each ingredient for a list of Raw Materials (.INH) on file.

**Inhibitor Formulation Input Form**

Formulation Name:  Description:

Product File Name:

Inhibitor 1	<input type="text" value="HEDP"/>	<input type="text" value="10.000"/>	%
Inhibitor 2	<input type="text"/>	<input type="text" value="0.000"/>	%
Inhibitor 3	<input type="text"/>	<input type="text" value="0.000"/>	%
Inhibitor 4	<input type="text"/>	<input type="text" value="0.000"/>	%
Inhibitor 5	<input type="text"/>	<input type="text" value="0.000"/>	%
Inhibitor 6	<input type="text"/>	<input type="text" value="0.000"/>	%
Inhibitor 7	<input type="text"/>	<input type="text" value="0.000"/>	%

Minum Dosage:  (fml/L) % Actives:  %

Password:  % Water:  %

Buttons: OK, Calc %, Delete File, Help, Cancel

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	<b>Input Lab Data</b>	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	Vary pH	Print Injection	Edit Coefficients	3D Graph Types		
	Formation Water Analysis	Graph vs pH	Print Formation	Browse Correlations	CO3 Calc's		
Quit	MULTI-MIX	3D Profile	Print Produced	Browse Inhibitors	Plot pH or pCO2		
	Water Analysis	Select Parameters	Print All Available		Mineral Name/Chemical Name		
	Input pH Curve	WATERFLOOD			Constant Values		
		Mix			DISPLAY/PRINT OPTIONS		
		2D Graph vs %			Outout Size On Screen		

### INPUT LAB DATA

SELECTION PURPOSE: The **Input Lab Data** module, in the LABORATORY pull down menu is used to create inhibitor (.INH) files.

WHEN SHOULD IT BE USED? Use the Input Laboratory Data module to create a new inhibitor file from laboratory and/or field dosage and chemistry data, to modify an existing inhibitor file's Inhibitor Name, Description, to to add or delete water chemistry data to modify the correlation..

WHAT DOES IT DO? The module accepts input data for a inhibitor file, calculates indices for each analysis-dosage entered, and uses multiple regression techniques to develop mathematical correlations for the inhibitor, and outputs the new or updated inhibitor (.INH) file.

PREREQUISITES: Five data points should be entered at a bare-bones minimum.

HINTS: 1) Enter dosages on an active, solids basis.  
2) Simple tends to be better.

**New Inhibitor Data Input**

**Inhibitor Name**  **Raw Data File**

**Inhibitor Purpose**  **Output File**

**Property Modeled**

**Molecular Weight**  **% Orthophosphate as PO4**  **ID#**

Property	Variable	Transform	Lower Limit	Upper Limit
	<input type="text" value="Dosage"/>	<input type="text" value="LOG(X)"/>		
<b>Variable 1</b>	<input type="text" value="Calcite [CaCO3]"/>	<input type="text" value="LOG(X)"/>	<input type="text" value="-99.00"/>	<input type="text" value="-99.00"/>
<b>Variable 2</b>	<input type="text" value="Temperature"/>	<input type="text" value="1/RT"/>	<input type="text" value="-99.00"/>	<input type="text" value="-99.00"/>
<b>Variable 3</b>	<input type="text" value="Time"/>	<input type="text" value="LOG(X)"/>	<input type="text" value="-99.00"/>	<input type="text" value="-99.00"/>
<b>Variable 4</b>	<input type="text"/>	<input type="text"/>	<input type="text" value="-99.00"/>	<input type="text" value="-99.00"/>
<b>Variable 5</b>	<input type="text"/>	<input type="text"/>	<input type="text" value="-99.00"/>	<input type="text" value="-99.00"/>
<b>Variable 6</b>	<input type="text"/>	<input type="text"/>	<input type="text" value="-99.00"/>	<input type="text" value="-99.00"/>

**Water Chemistry Input** [X]

Sample Date: 07-21-2000    Time: 17:22    ID#:    Report Date: 07-21-2000

Sample Description:

Calcium (as Ca)	131.00	Iron (as Fe)	0.00	H2S (as H2S)	0.00
Magnesium (as Mg)	0.00	Ammonia (as NH3)	0.00	Silica (as SiO2)	0.00
Barium (as Ba)	0.00	Aluminum (as Al)	0.00	Phosphate (as PO4)	0.00
Strontium (as Sr)	0.00	Manganese (as Mn)	3.00	Bromine (as Zn)	0.00
Sodium (as Na)	0.00	Zinc (as Mn)	0.00	Fluoride (as F)	0.00
Potassium (as K)	0.00	Boron (as B)	0.00	Nitrate (as NO3)	0.00
Lithium (as Li)	-14.00	Chloride (as Cl)	0.00	Temperature (as °F)	1.00
pH	0.00	Sulfate (as SO4)	0.00	Density (g/mL)	0.00
Induc. time (sec)	0.00	Acidity (as CaCO3)	15.00	Pressure (Atm.)	14.00
Corrosion rate (as mpy)	1075	M Alkalinity (as CaCO3)	0.00	pCO2 (Atm)	0.00
Pitting Index (as mpy)	0.00	P Alkalinity (as CaCO3)	2.00	Dosage (mg/L)	0.00

Flows:

Brine Flow (bpd): 99.00  
Oil Flow (BPD): -238.59  
Gas Flow (MMCF/D): 0.00

C2 - C5 Acids:

C2: -0.326  
C3: -0.392  
C4: -213.79  
C5: -312.19

REC # 1 of 5

GO TO #

NEXT    Deactivate

PREVIOUS    Activate

Comments:

OK    Change Units    Correlate    Recalculate    Display Result    Print Result    Cancel

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	Vary pH	Print Injection		<b>Edit Coefficients</b>	3D Graph Types	
	Formation Water Analysis	Graph vs pH	Print Formation		Browse Correlations	CO3 Calc's	
Quit	MULTI-MIX	3D Profile	Print Produced		Browse Inhibitors	Plot pH or pCO2	
	Water Analysis	Select Parameters	Print All Available			Mineral Name/Chemical Name	
	Input pH Curve	WATERFLOOD				Constant Values	
		Mix				DISPLAY/PRINT OPTIONS	
		2D Graph vs %				Output Size On Screen	
		3D Temperature - pH				Surface Water Windows To Display	
		3D Temperature - %				Mixed Water Windows To Display	
		3D pH - %				Choose Ions To Print	
		Select Injection Parameters				Choose Scales To Print	
		MULTI-MIX					
		Mix					

### EDIT COEFFICIENTS

**SELECTION PURPOSE:** The **Edit Coefficients** module, in the LABORATORY pull down menu is used to add safety factors, iron factors, and other customizing values to inhibitor (.INH) files.

**WHEN SHOULD IT BE USED?** Use the **Edit Coefficients** module when you wish to add a 10,20,30% or other safety factor to dosages predicted by the inhibitor model. Use the module to define a rule for dealing with iron, e.g. add 1 ppm of inhibitor for every ppm of iron above 1.8 .

**WHAT DOES IT DO?** The module accepts values that are used in the inhibitor models to increase dosages. The .INH file is updated to include the rules entered.

**PREREQUISITES:** An inhibitor file must exist.

FACTORS FOR SPECIAL CASES

INHIBITOR	<input type="text" value="AMP"/>	FILENAME	<input type="text" value="amp.inh"/>
PURPOSE	<input type="text" value="CaCO3 Scale Inhib."/>		
SAFETY FACTOR	<input type="text" value="0.000000"/>	1.1 increases by 10%, 1.2 by 20%, etc.	
IRON FACTOR			
Increase inhibitor dosage by	<input type="text" value="0.000000"/>	ppm for every ppm Fe above	<input type="text" value="0.000000"/>
PHOSPHATE FACTORS			
% Orthophosphate as PO4	<input type="text" value="0.000000"/>	% Organic phosphate as PO4	<input type="text" value="0.000000"/>
<input type="button" value="OK"/>		<input type="button" value="Cancel"/>	

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface Print Surface Temperature Profile	Select Product Input Product	ANALYSIS INPUT Input Lab Data	Choose Graphs Input Units Print Mode	Technical Manual
Open Workspace Save Workspace Save Workspace As	WATERFLOOD	Vary Temperature Graph vs Temperature Vary pH Graph vs pH 3D Profile	Print Surface pH Profile Print Injection Print Formation Print Produced Print All Available		EDIT CORRELATION Edit Coefficients <b>Browse Correlations</b> Browse Inhibitors	3D Graph Types CO3 Calc's Plot pH or pCO2 Mineral Name/Chemical Name Constant Values	
Printer Setup What's Stored About DownHole SAT Quit	MULTI-MIX Water Analysis Input pH Curve	WATERFLOOD Mix 2D Graph vs % 3D Temperature - pH 3D Temperature - % 3D pH - % Select Injection Parameters				DISPLAY/PRINT OPTIONS Output Size On Screen Surface Water Windows To Display Mixed Water Windows To Display Choose Ions To Print Choose Scales To Print	
		MULTI-MIX Mix					

### BROWSE CORRELATIONS

SELECTION PURPOSE: The **Browse Correlations** module, in the LABORATORY pull down menu to see what inhibitor names and descriptions are available.

WHEN SHOULD IT BE USED? Use the **Browse Correlation** module to see what inhibitors are available with raw laboratory data.

WHAT DOES IT DO? The module lists the inhibitors for which you have raw data.

PREREQUISITES: Correlation files must exist.

RAW LAB DATA FILE BROWSE & DELETE ✕

C:\DHSAT\COR\BAYHIB.COR

AR540.COR

ASHCRFT.COR

B494.COR

BAYHIB.COR

BC161.COR

BEL200.COR

BEL283.COR

BEL500.COR

BEL575D.COR

CA.COR

C:\DHSAT\COR

Description

Bayhib AM

CaCO3 Inhib.

BAYHIB.INH

LOAD

DELETE

Cancel

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Vary pH	Print Injection	Edit Coefficients	3D Graph Types	
Printer Setup	Formation Water Analysis	Graph vs pH	Print Formation		Browse Correlations	CO3 Calc's	
What's Stored	MULTI-MIX	3D Profile	Print Produced		<b>Browse Inhibitors</b>	Plot pH or pCO2	
About DownHole SAT		Water Analysis	Select Parameters	Print All Available		Mineral Name/Chemical Name	
Quit	Input pH Curve	WATERFLOOD				Constant Values	
		Mix				DISPLAY/PRINT OPTIONS	
		2D Graph vs %				Output Size On Screen	
		3D Temperature - pH				Surface Water Windows To Display	
		3D Temperature - %				Mixed Water Windows To Display	
		3D pH - %				Choose Ions To Print	
		Select Injection Parameters				Choose Scales To Print	

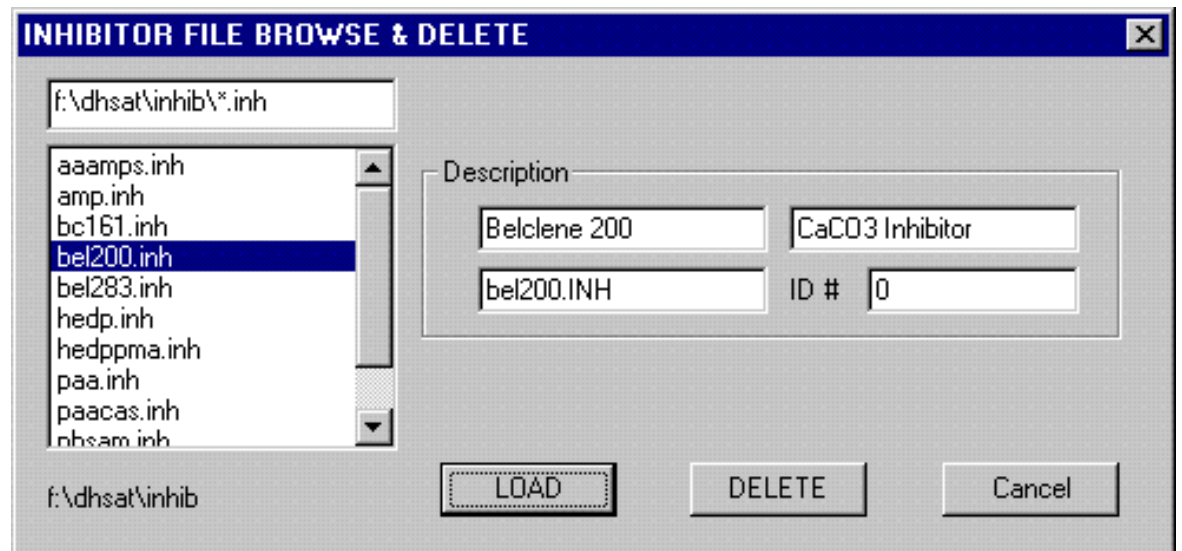
### BROWSE INHIBITORS

**SELECTION PURPOSE:** The **Browse Inhibitors** module, in the LABORATORY pull down menu to see what inhibitor names and descriptions are available.

**WHEN SHOULD IT BE USED?** Use the **Browse Inhibitors** module to see what inhibitors are available with raw laboratory data.

**WHAT DOES IT DO?** The module lists the inhibitors for which you have inhibitor files (.INH).

**PREREQUISITES:** Inhibitor files must exist.





## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface Print Surface Temperature Profile	Select Product Input Product	ANALYSIS INPUT Input Lab Data	<b>Choose Graphs</b>	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature Graph vs Temperature	Print Surface pH Profile Print Injection Print Formation Print Produced Print All Available		EDIT CORRELATION Edit Coefficients Browse Correlations Browse Inhibitors	Input Units Print Mode 3D Graph Types CO3 Calc's Plot pH or pCO2 Mineral Name/Chemical Name Constant Values	
Printer Setup What's Stored About DownHole SAT	WATERFLOOD Injection Water Analysis Formation Water Analysis	Vary pH Graph vs pH 3D Profile Select Parameters				DISPLAY/PRINT OPTIONS Output Size On Screen Surface Water Windows To Display Mixed Water Windows To Display Choose Ions To Print Choose Scales To Print	
Quit	MULTI-MIX Water Analysis	WATERFLOOD Mix 2D Graph vs % 3D Temperature - pH 3D Temperature - % 3D pH - % Select Injection Parameters					
	Input pH Curve	MULTI-MIX Mix					

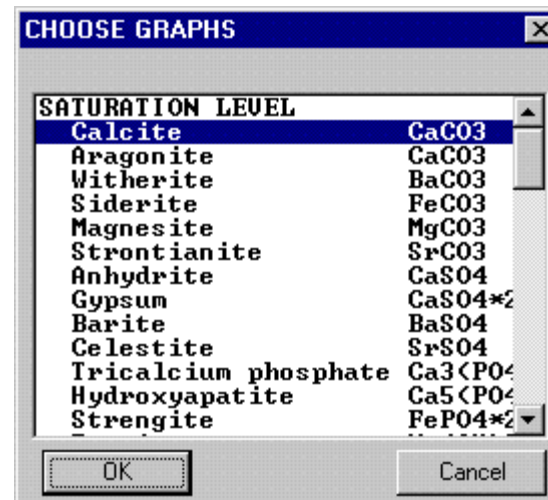
### CHOOSE GRAPHS

**SELECTION PURPOSE:** Use the *Choose Graphs* module, in the PREFERENCES pull down menu, to select the indicators of scale and corrosivity potential for graphing in the WHAT-IF SCENARIOS modules.

**WHEN SHOULD IT BE USED?** Select *Choose Graphs* prior to running any of the graph presentation modules.

**WHAT DOES IT DO?** The *Choose Graphs* module allows you to select individual graphs or re-defined groups of four (4) graphs for presentation by the appropriate modules in the WHAT-IF SCENARIO group. The graphs are selected by the vertical scrolling menu shown at the right.

**PREREQUISITES:** None. The *Choose Graphs* menu can be run at any time from the main menu or by clicking the *Choose Graphs* selection when a graph is displayed.





# DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	<b>Input Units</b>	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As	Injection Water Analysis	Vary pH	Print Injection		Edit Coefficients	3D Graph Types	
Printer Setup	Formation Water Analysis	Graph vs pH	Print Formation		Browse Correlations	CO3 Calc's	
What's Stored		3D Profile	Print Produced		Browse Inhibitors	Plot pH or pCO2	
About DownHole SAT	MULTI-MIX	Select Parameters	Print All Available			Mineral Name/Chemical Name	
						Constant Values	

## INPUT UNITS

**SELECTION PURPOSE:** The Input Units module, in the PREFERENCES pull down menu, allows you to select the units of measure for the water analyses input to DownHole SAT. Water chemistry units are mg/l by default. The units ppm (parts per million) as the ion, or ppm as CaCO<sub>3</sub> or epm (equivalents per million) as the ion can be selected in this module for input units. Alkalinity units can be specified as "M" and "P" alkalinity (as CaCO<sub>3</sub>), corrected or uncorrected HCO<sub>3</sub> and CO<sub>3</sub> in mg/l as the ions, or as milliliters of N/30 sulfuric acid. "M" and "P" alkalinity input are the default.

For example, you can select from Ca as Ca, or Ca as CaCO<sub>3</sub> on this form. Other notable types are Fe as Fe, Fe as CaCO<sub>3</sub>, or Fe as Fe<sub>2</sub>O<sub>3</sub>. Standard analytical combinations can be selected by pushing one of the major buttons, e.g. As The Ion. This menu can also be selected by pressing the INPUT UNITS button in any of the water chemistry input forms.

This form also is used to select the ions for balancing analyses that are not electroneutral as input. Sodium or potassium can be selected to balance cation deficient waters, while chloride, sulfate or nitrate can be selected for anion deficient waters.

**WHAT DOES IT DO?** The Input Units module accepts the desired units for analyses entry via a user friendly entry form. DownHole SAT performs conversions of input data to its internal format based upon the input units selected in this module. Input unit preferences are stored in DownHole SAT work files (\*.DHS).

**PREREQUISITES:** None.

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	<b>Print Mode</b>	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation			Edit Coefficients	CO3 Calc's
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Browse Inhibitors	Mineral Name/Chemical Name
Quit	Input pH Curve	Select Parameters				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				Output Size On Screen	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

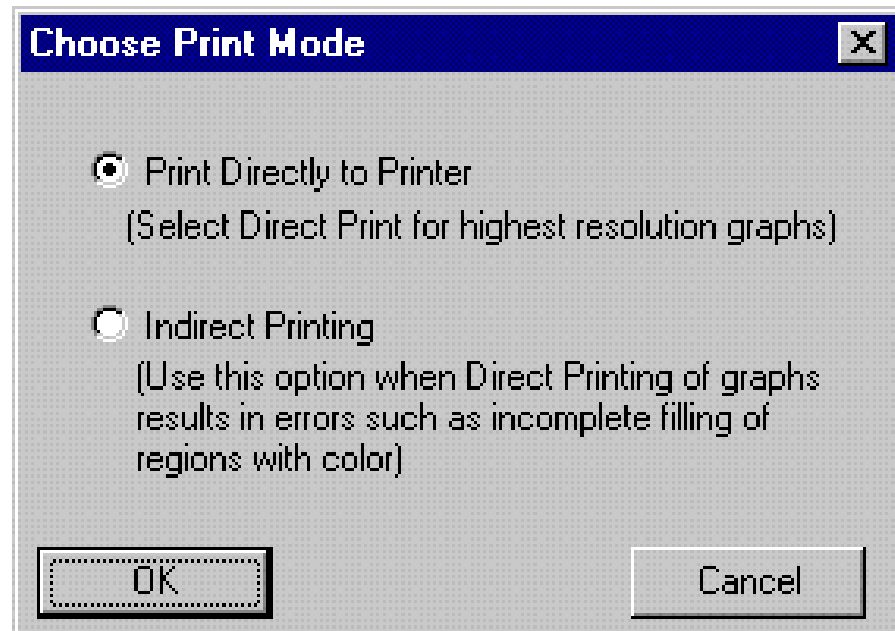
### PRINT MODE

**SELECTION PURPOSE:** Use the Print Mode module to select an alternate method for printing graphs. DownHole SAT prints graphs by two methods: direct or indirect printing.

The Direct Print option sends actual Windows graphics commands to the Printer and literally draws the graph on the printer at printer resolution. This option is acceptable and preferred for most printers.

The Indirect Print option creates a large bitmap in Windows memory and then dumps the bitmap to the printer. This option overcomes deficiencies in many printer drivers which cause mistakes when they are used as a direct Windows graphing device.

**WHEN SHOULD IT BE USED?** Select Print Mode if you encounter incomplete graphs when printed. This is typically only encountered with older HP Deskjet and Laserjet printer drivers..



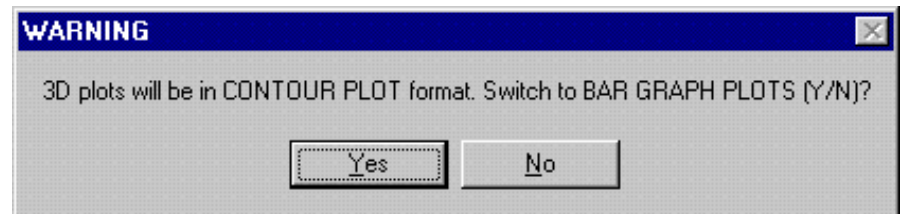
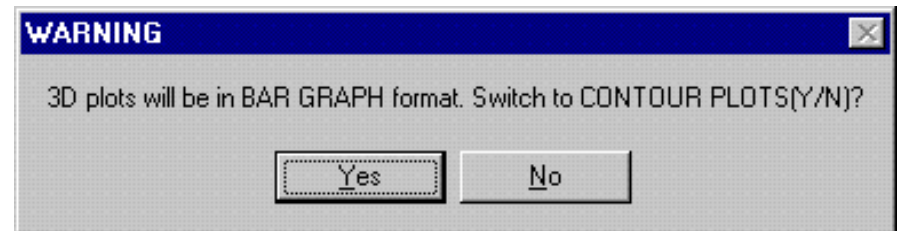
## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature Graph vs Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units Print Mode	
	WATERFLOOD	Vary pH Graph vs pH	Print Surface pH Profile		EDIT CORRELATION	<b>3D Graph Types</b>	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	3D Profile	Print Injection		Edit Coefficients	CO3 Calc's	
	Formation Water Analysis	Select Parameters	Print Formation		Browse Correlations	Plot pH or pCO2	
Quit	MULTI-MIX		Print Produced		Browse Inhibitors	Mineral Name/Chemical Name	
	Water Analysis	WATERFLOOD	Print All Available			Constant Values	
	Input pH Curve	Mix 2D Graph vs % 3D Temperature - pH 3D Temperature - % 3D pH - % Select Injection Parameters				DISPLAY/PRINT OPTIONS Output Size On Screen Surface Water Windows To Display Mixed Water Windows To Display Choose Ions To Print Choose Scales To Print	
		MULTI-MIX Mix					

### 3D GRAPH TYPES

**SELECTION PURPOSE:** The *3D Graph Type* module, in the PREFERENCES pull down menu sets the initial graph type for 3D and 4D graphs as either the Bar or Contour type.

**PREREQUISITES:** None.



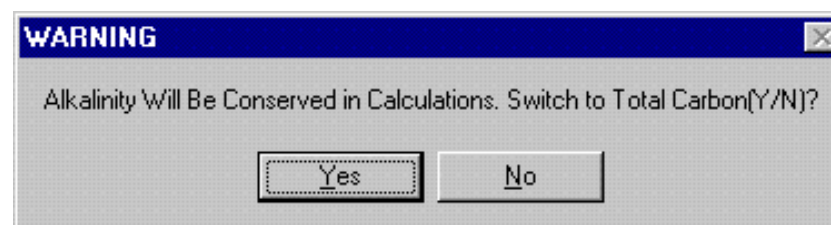
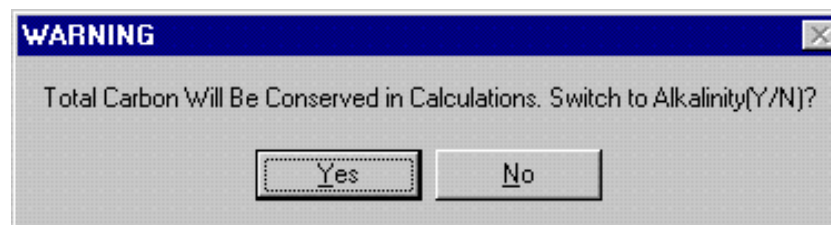
## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	Vary pH	Print Injection		Browse Correlations	3D Graph Types	
	Formation Water Analysis	Graph vs pH	Print Formation		Browse Inhibitors	<b>CO3 Calc's</b>	
Quit	MULTI-MIX	3D Profile	Print Produced			Plot pH or pCO2	
	Water Analysis	Select Parameters	Print All Available			Mineral Name/Chemical Name	
	Input pH Curve	WATERFLOOD				Constant Values	
		Mix				DISPLAY/PRINT OPTIONS	
		2D Graph vs %				Output Size On Screen	
		3D Temperature - pH				Surface Water Windows To Display	
		3D Temperature - %				Mixed Water Windows To Display	
		3D pH - %				Choose Ions To Print	
		Select Injection Parameters				Choose Scales To Print	
		MULTI-MIX					
		Mix					

### CO<sub>3</sub> CALC'S

**SELECTION PURPOSE:** The CO<sub>3</sub> Calc's module, in the PREFERENCES pull down menu allows the user to determine how the program will handle calculations involving carbon dioxide equilibrium with the atmosphere. The user can elect to conserve molar carbon in calculations or conserve alkalinity.

**WHEN SHOULD IT BE USED?** The CO<sub>3</sub> Calc's module should rarely be used. The default method for DownHole SAT is to conserve molar carbon. This would be the case in a closed system which does not exchange CO<sub>2</sub> with the atmosphere. The other option is to conserve alkalinity. This would be expected for an open system which freely exchanges CO<sub>2</sub> with the atmosphere. In many cases, only minor differences in calculated values will be observed between methods.



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection		Edit Coefficients	3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation		Browse Correlations	CO3 Calc's	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Inhibitors	<b>Plot pH or pCO<sub>2</sub></b>	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Mineral Name/Chemical Name	
Quit	Input pH Curve	Select Parameters			Constant Values	DISPLAY/PRINT OPTIONS	
		WATERFLOOD				Output Size On Screen	
		Mix				Surface Water Windows To Display	
		2D Graph vs %				Mixed Water Windows To Display	
		3D Temperature - pH				Choose Ions To Print	
		3D Temperature - %				Choose Scales To Print	
		3D pH - %					
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

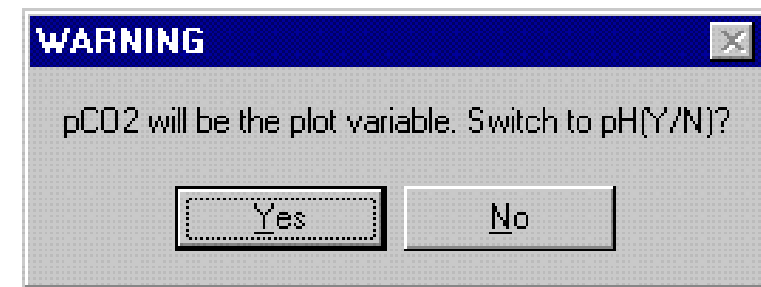
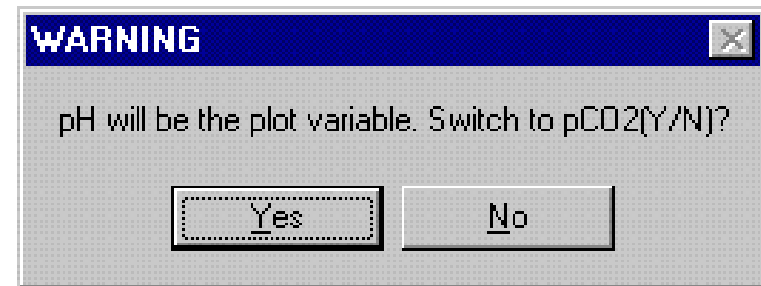
### PLOT pH or pCO<sub>2</sub>

**SELECTION PURPOSE:** The *PLOT pH or pCO<sub>2</sub>* module, in the PREFERENCES pull down menu allows the user to determine how the program will handle pH profiles - by plotting versus pH or pCO<sub>2</sub>. The method selected will be used for both tables and graphs.

**WHEN SHOULD IT BE USED?** The *PLOT pH or pCO<sub>2</sub>* module should be used, and the pCO<sub>2</sub> option selected, to simulate the decrease of the partial pressure of carbon dioxide as a brine rises to the surface.

The default is to plot versus pH.

**PREREQUISITES:** None.



## DownHole SAT<sup>tm</sup> Menu Quick Reference

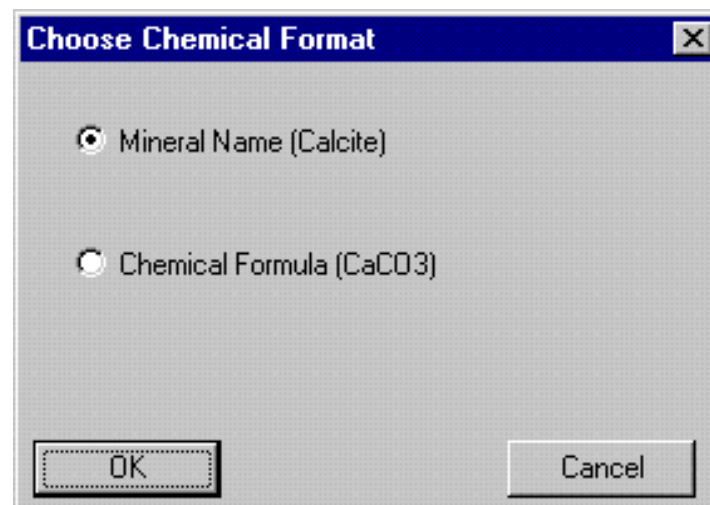
FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature Graph vs Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units Print Mode	
	WATERFLOOD	Vary pH Graph vs pH	Print Surface pH Profile		EDIT CORRELATION	3D Graph Types	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	3D Profile	Print Injection		Edit Coefficients	CO3 Calc's	
	Formation Water Analysis	Select Parameters	Print Formation		Browse Correlations	Plot pH or pCO2	
Quit	MULTI-MIX		Print Produced		Browse Inhibitors	<b>Mineral Name/Chemical Name</b>	
	Water Analysis	WATERFLOOD	Print All Available			Constant Values	
	Input pH Curve	Mix 2D Graph vs % 3D Temperature - pH 3D Temperature - % 3D pH - % Select Injection Parameters				DISPLAY/PRINT OPTIONS Output Size On Screen Surface Water Windows To Display Mixed Water Windows To Display Choose Ions To Print Choose Scales To Print	
		MULTI-MIX Mix					

### CHOOSE CHEMICAL FORMAT

**SELECTION PURPOSE:** The *Choose Chemical Format* module, in the PREFERENCES pull down menu allows the user to determine how the program will name scale forming species, by their chemical formula, or by their common name. The method selected will be used for both tables and graphs.

**WHEN SHOULD IT BE USED?** The *Choose Chemical Format* module should be used to switch the naming convention to the format with which the user and ultimate report audience is most familiar.

**PREREQUISITES:** None.



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	Vary pH	Print Injection		Edit Coefficients	3D Graph Types	
	Formation Water Analysis	Graph vs pH	Print Formation		Browse Correlations	CO3 Calc's	
Quit	MULTI-MIX	3D Profile	Print Produced		Browse Inhibitors	Plot pH or pCO2	
	Water Analysis	Select Parameters	Print All Available			Mineral Name/Chemical Name	
	Input pH Curve	WATERFLOOD				<b>Constant Values</b>	
		Mix				DISPLAY/PRINT OPTIONS	
		2D Graph vs %				Output Size On Screen	
		3D Temperature - pH				Surface Water Windows To Display	
		3D Temperature - %				Mixed Water Windows To Display	
		3D pH - %				Choose Ions To Print	
		Select Injection Parameters				Choose Scales To Print	
		MULTI-MIX					
		Mix					

### CONSTANT VALUES

**SELECTION PURPOSE:** The Constant Values module, in the PREFERENCES pull down menu allows the user to set a constant water phosphate and/or silica level. This module allows the user to over-ride the calculated value which would normally be used.

**WHEN SHOULD IT BE USED?** The Constant Values module should be used to model a where the phosphate and/or silica levels are maintained at a constant level through periodic testing and chemical feed pump adjustment, for corrosion and scale control during transport.

**WHAT IT DOES:** This module forces the water chemistry calculations to be made using the a constant phosphate concentration, and/or constant silica level.

**Select Constant Recirculating Water Concentrations** [X]

Constant Phosphate    0.    (as PO4)

Constant Silica    0.    (as SiO2)

[OK]    [Help]    [Cancel]



## DownHole SAT<sup>tm</sup> Menu Quick Reference

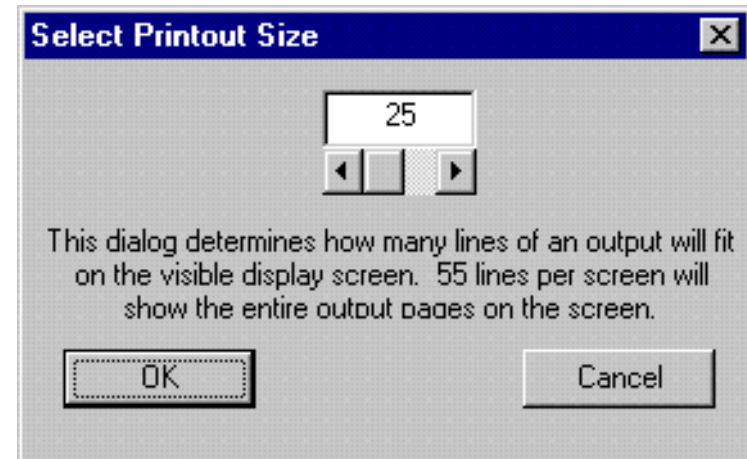
FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As		Injection Water Analysis	Print Injection			3D Graph Types	
Printer Setup	Formation Water Analysis	Vary pH	Print Formation			Edit Coefficients	
What's Stored	MULTI-MIX	Graph vs pH	Print Produced		Browse Correlations	Plot pH or pCO2	
About DownHole SAT		Water Analysis	3D Profile	Print All Available		Browse Inhibitors	
Quit	Input pH Curve	Select Parameters				Constant Values	
		WATERFLOOD				DISPLAY/PRINT OPTIONS	
		Mix				<b>Output Size On Screen</b>	
		2D Graph vs %				Surface Water Windows To Display	
		3D Temperature - pH				Mixed Water Windows To Display	
		3D Temperature - %				Choose Ions To Print	
		3D pH - %				Choose Scales To Print	
		Select Injection Parameters					
		MULTI-MIX					
		Mix					

### OUTPUT SIZE ON SCREEN

**SELECTION PURPOSE:** The Output Size On Screen module, in the PREFERENCES pull down menu allows the user to set the number of lines from the output windows which will be displayed on the screen. A value of 55 will typically assure that all of the outputs can be viewed without scrolling. This value will work with XGA (1024 x 768) resolution or above.

**WHEN SHOULD IT BE USED?** When it is desirable to resize the output windows..

**WHAT IT DOES:** This module re-sizes the windows and fonts.





## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	Vary pH	Print Injection		Edit Coefficients	3D Graph Types	
	Formation Water Analysis	Graph vs pH	Print Formation		Browse Correlations	CO3 Calc's	
Quit	MULTI-MIX	3D Profile	Print Produced		Browse Inhibitors	Plot pH or pCO2	
	Water Analysis	Select Parameters	Print All Available			Mineral Name/Chemical Name	
	Input pH Curve	WATERFLOOD				Constant Values	
		Mix				DISPLAY/PRINT OPTIONS	
		2D Graph vs %				Output Size On Screen	
		3D Temperature - pH				<b>Surface Water Windows To Display</b>	
		3D Temperature - %				Mixed Water Windows To Display	
		3D pH - %				Choose Ions To Print	
		Select Injection Parameters				Choose Scales To Print	
		MULTI-MIX					
		Mix					

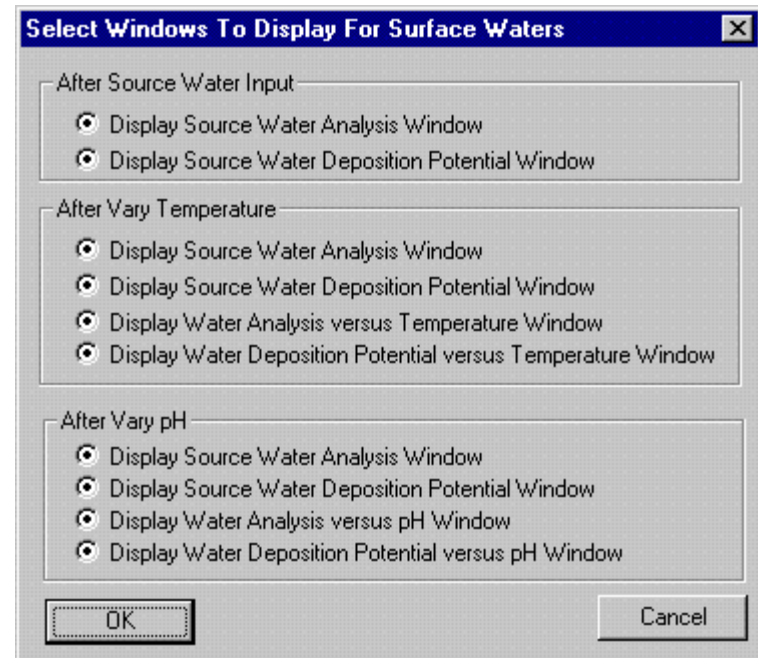
### SURFACE WATER WINDOWS TO DISPLAY

**SELECTION PURPOSE:** DownHole SAT displays output windows which summarize input chemistry and calculated values, and profiles. These windows are sometimes "in the way." This module allows the user to determine which windows will be displayed and when.

**WHEN SHOULD IT BE USED?** When it is desirable to control which output windows are displayed, and when..

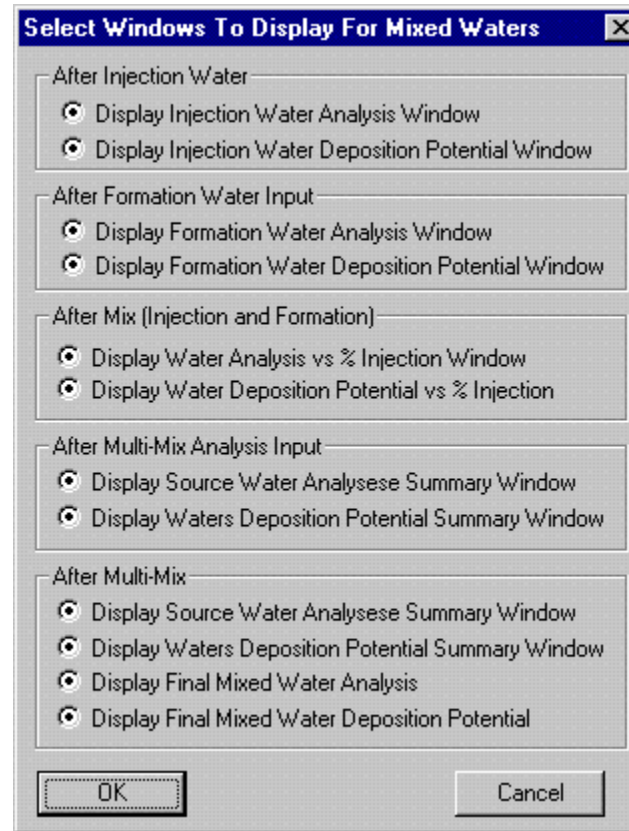
**WHAT IT DOES:** This module activates or de-activates the display of windows.

**PREREQUISITES:** None



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface Print Surface Temperature Profile	Select Product Input Product	ANALYSIS INPUT Input Lab Data	Choose Graphs Input Units Print Mode	Technical Manual
Open Workspace Save Workspace Save Workspace As	WATERFLOOD	Vary Temperature Graph vs Temperature Vary pH Graph vs pH 3D Profile	Print Surface pH Profile Print Injection Print Formation Print Produced Print All Available		EDIT CORRELATION Edit Coefficients Browse Correlations Browse Inhibitors	3D Graph Types CO3 Calc's Plot pH or pCO2 Mineral Name/Chemical Name Constant Values	
Printer Setup What's Stored About DownHole SAT Quit	MULTI-MIX Water Analysis Input pH Curve	WATERFLOOD Mix 2D Graph vs % 3D Temperature - pH 3D Temperature - % 3D pH - % Select Injection Parameters				DISPLAY/PRINT OPTIONS Output Size On Screen Surface Water Windows To Display <b>Mixed Water Windows To Display</b> Choose Ions To Print Choose Scales To Print	
		MULTI-MIX Mix					



### MIXED WATER WINDOWS TO DISPLAY

**SELECTION PURPOSE:** DownHole SAT displays output windows which summarize input chemistry and calculated values, and profiles. These windows are sometimes "in the way." This module allows the user to determine which windows will be displayed and when.

**WHEN SHOULD IT BE USED?** When it is desirable to control which output windows are displayed, and when..

**WHAT IT DOES:** This module activates or de-activates the display of windows.

**PREREQUISITES:** None

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface Print Surface Temperature Profile	Select Product Input Product	ANALYSIS INPUT Input Lab Data	Choose Graphs Input Units Print Mode	Technical Manual
Open Workspace Save Workspace Save Workspace As	WATERFLOOD	Vary Temperature Graph vs Temperature Vary pH Graph vs pH 3D Profile	Print Surface pH Profile Print Injection Print Formation Print Produced Print All Available		EDIT CORRELATION Edit Coefficients Browse Correlations Browse Inhibitors	3D Graph Types CO3 Calc's Plot pH or pCO2 Mineral Name/Chemical Name Constant Values	
Printer Setup What's Stored About DownHole SAT	MULTI-MIX	WATERFLOOD				DISPLAY/PRINT OPTIONS Output Size On Screen Surface Water Windows To Display Mixed Water Windows To Display <b>Choose Ions To Print</b>	
Quit	Input pH Curve	Mix 2D Graph vs % 3D Temperature - pH 3D Temperature - % 3D pH - % Select Injection Parameters				Choose Scales To Print	
		MULTI-MIX Mix					

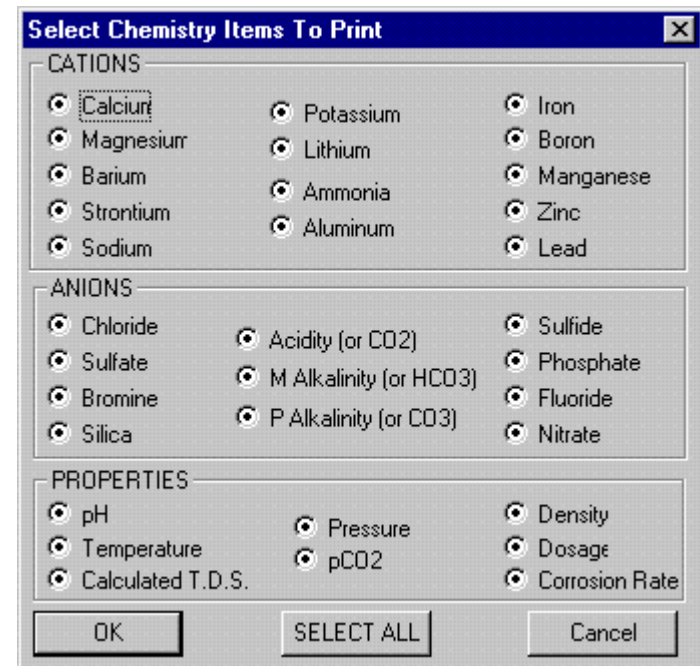
### CHOOSE IONS TO PRINT

**SELECTION PURPOSE:** DownHole SAT printouts include all ions input with a water analysis. This module allows you to limit the ions printed. Ions selected will also be included when a printout is COPIED to the Windows clipboard.

**WHEN SHOULD IT BE USED?** When it is desirable to limit which water analysis species are printed..

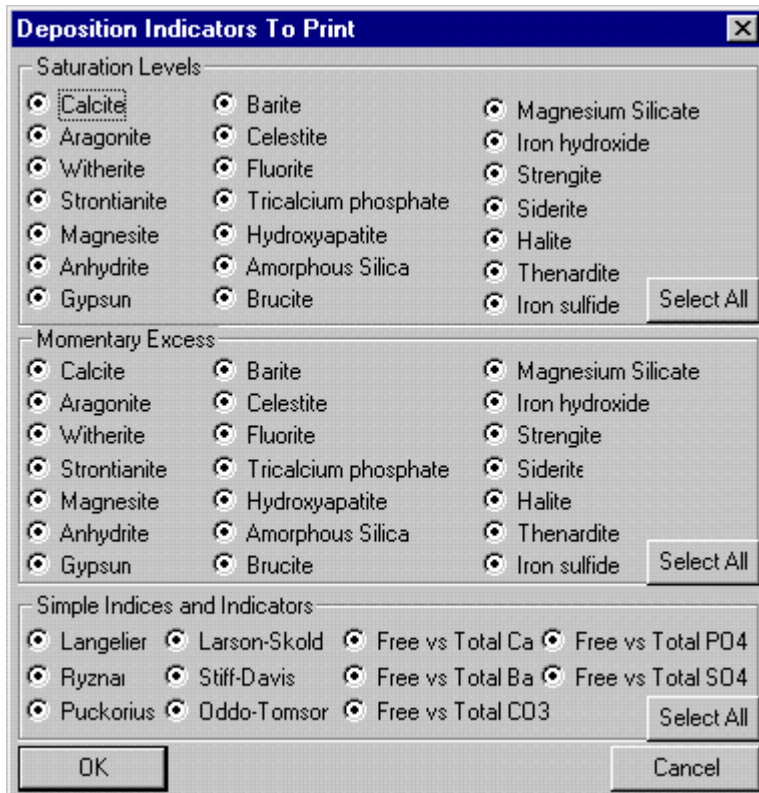
**WHAT IT DOES:** This module activates or de-activates the printing of each field in water chemistry printouts.

**PREREQUISITES:** None



## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	Technical Manual
Open Workspace Save Workspace Save Workspace As	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Printer Setup What's Stored About DownHole SAT	Injection Water Analysis	Vary pH	Print Injection	Browse Correlations	3D Graph Types	CO3 Calc's	
	Formation Water Analysis	Graph vs pH	Print Formation	Browse Inhibitors	Plot pH or pCO2	Mineral Name/Chemical Name	
Quit	MULTI-MIX	3D Profile	Print Produced		Constant Values	DISPLAY/PRINT OPTIONS	
	Water Analysis	Select Parameters	Print All Available			Output Size On Screen	
	Input pH Curve	WATERFLOOD				Surface Water Windows To Display	
		Mix				Mixed Water Windows To Display	
		3D Graph vs %				Choose Ions To Print	



## CHOOSE SCALES TO PRINT

**SELECTION PURPOSE:** DownHole SAT printouts include all indices calculated by the program. This module allows you to limit the indices printed. Scale indices selected will also be included when a printout is COPIED to the Windows clipboard.

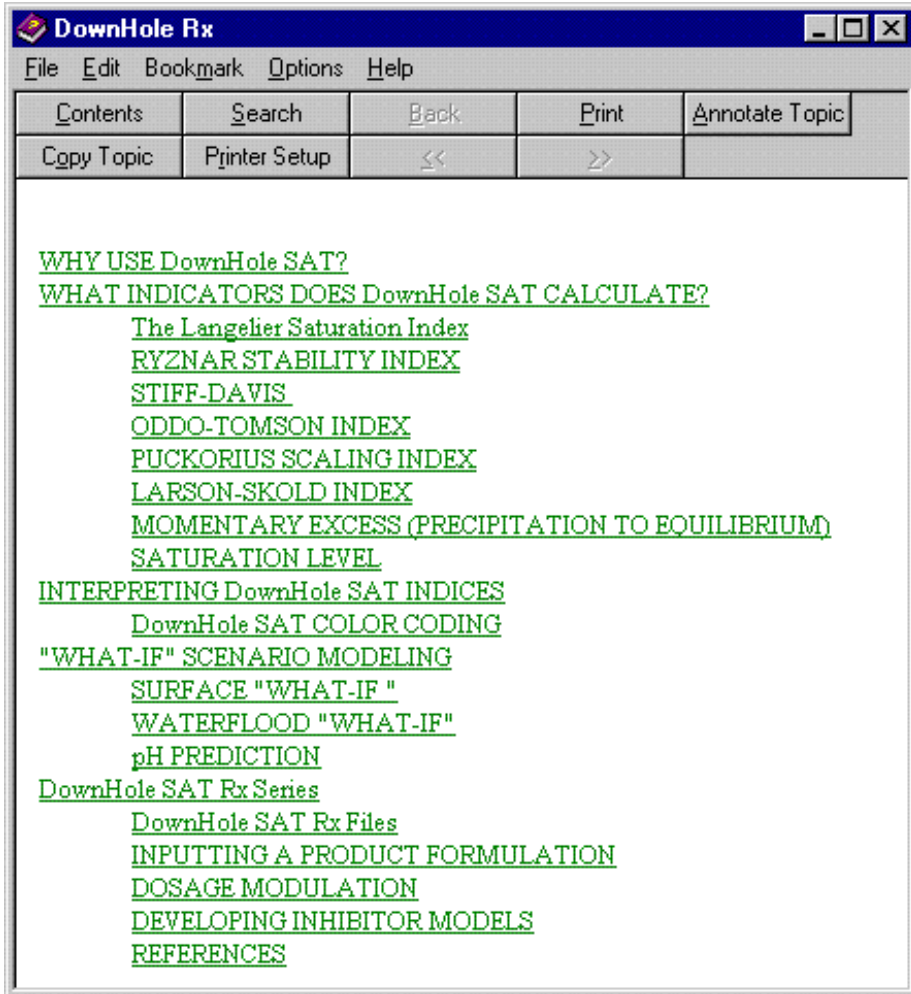
**WHEN SHOULD IT BE USED?** When it is desirable to limit which scale indices are printed..

**WHAT IT DOES:** This module activates or de-activates the printing of each field in indicators of deposition potential printouts.

**PREREQUISITES:** None

## DownHole SAT<sup>tm</sup> Menu Quick Reference

FILES	INPUT	WHAT-IF SCENARIOS	REPORTS	FORMULARY	LABORATORY	PREFERENCES	HELP
New	SURFACE	SURFACE	Print Surface	Select Product	ANALYSIS INPUT	Choose Graphs	<b>Technical Manual</b>
Open Workspace	Source Water Analysis	Vary Temperature	Print Surface Temperature Profile	Input Product	Input Lab Data	Input Units	
Save Workspace	WATERFLOOD	Graph vs Temperature	Print Surface pH Profile		EDIT CORRELATION	Print Mode	
Save Workspace As	Injection Water Analysis	Vary pH	Print Injection		Edit Coefficients	3D Graph Types	
		Graph vs nH	Print Formation		Browse Correlations	CO3 Calc's	
					Browse Inhibitors	Plot pH or pCO2	
						Mineral Name/Chemical Name	
						Constant Values	
						DISPLAY/PRINT OPTIONS	
						Output Size On Screen	
						Surface Water Windows To Display	
						Mixed Water Windows To Display	
						Choose Ions To Print	
						Choose Scales To Print	



## TECHNICAL MANUAL

**SELECTION PURPOSE:** This selection accesses an abbreviated version of this user manual using the Windows Help system.