

## New Products



### INPRO Seals

By maintaining bearings under optimal operating conditions, up-time on your Goulds ANSI pump can be extended significantly. Operating and maintenance costs will also be significantly decreased, while productivity and reliability is increased. Once installed, the VBXX-D not only isolates the bearing from its environment but it keeps it properly lubricated, uncontaminated and allows it to operate the length of its intended design-life. Protected bearings have proven to run 50,000 hours (5.7 years) or more, eliminating the need for continual maintenance and repair. Documented case studies show that a plant can more than double the mean-time-between-failure (MTBF) and reduce maintenance costs by at least half, with users reporting extremely high Return On Investment (ROI).

The addition of INPRO VBXX-D Isolators to the the Goulds ANSI family makes these leading process pumps an even better value. It is one of the factors that have allowed Goulds Pumps to offer an extended (5) five year warranty on the following ANSI Pump Models: the 3196, CV 3196, HT 3196, LF 3196, 3996, 3796 and the NM 3196. ■

### Goulds New Close-Coupled Product Range Saves Space and Installation Costs

Goulds Pumps is now offering certain sizes/ models of its popular ANSI Process Pump range in a new close-coupled configuration. The new Close-Coupled design is intended primarily for general industrial service where space is limited, alignment not desirable, maintenance needs to be reduced and where the cost associated with a conventional frame mounted pump is too



high. While the Close-Coupled product range is not specifically designed to meet ANSI B 73.1, it will inherently meet some of the dimensional requirements due to the fact that the models use Goulds standard ANSI liquid end components. This means dimensionally an ANSI Close-Coupled pump can be retrofitted to an existing ANSI installation and piping arrangement - only the motor support would need to be addressed for a perfect fit!

The close-coupled design is compact and lightweight making it ideal for many OEM skid applications including heating/cooling loops, water filtration, cart-mounted transfer services and marine applications where space is a primary consideration. Being truly close-coupled it requires no alignment on site. In fact, the units can even be bolted directly to an existing foundation or old baseplate avoiding the costly civil work typically associated with pump replacement. The open impeller design of the Close-Coupled range is ideal for pumping solids and offers up to two times more wear area than enclosed impeller pumps. A labyrinth isolator in front of the conventional motor lip seal helps eliminate motor failure due to fluid ingress (a common mode of failure in close-coupled pumps) by providing double protection. And, because the Close-Coupled product range liquid end parts are interchangeable with Goulds standard ANSI family, there are savings to be had on inventory.

Also unique to the Close-Coupled family is an external impeller adjustment which has been specifically designed for ease of maintenance. Impeller clearances can be restored to "as new" condition in minutes without any disassembly. This maintains operating efficiencies high, thereby lowering overall costs. The Close-Coupled also features a back pullout design, which means that all of the pump operating parts can be removed without disturbing the suction or discharge piping. ■

## Material Matters

### Understanding Your Water Analysis Report (A Water Quality Primer)

Steve Morrow

Global Manager of Materials Technology

#### Part II

In the first part of this article (Fall 2003 issue of *Pumplines*) we briefly reviewed some various types of waters and discussed several important factors affecting water quality. The significance of dissolved solids and conductivity, gases, pH, hardness, and alkalinity were reviewed.

To determine the corrosion potential of water, a few additional quality factors must be reported on the water analysis report, in order to calculate the corrosivity index. We will now look at how these additional water data are used to predict water's corrosivity.

#### Calcium Carbonate

Related to water alkalinity and pH, the primary chemical system present in natural waters is one where carbonate ( $\text{CO}_3^{2-}$ ), bicarbonate ( $\text{HCO}_3^-$ ), hydroxide or hydroxyl ( $\text{OH}^-$ ) ions and free carbon dioxide ( $\text{CO}_2$ ) are in balance within the system. However, the ratio of these ions is a function of temperature, pH, concentration and ionic strength.

As shown in Figure 1 (pg. 4), the distribution of these components can be determined from the pH of the system, which provides ratio estimates for most water analyses. Below a pH of 4.4 carbon dioxide gas quickly escapes into the environment, and there is no bicarbonate. In the pH range of 4.4-8.2, the bicarbonate alkalinity ions dominate and are in balance with carbon dioxide in most natural waters. Above this pH, free carbon dioxide ceases to exist in measurable quantities, and the carbonate ion dominates. In the pH 8.2 -9.6 range, bicarbonate exists together with carbonate, without significant quantities of carbon dioxide or hydroxide.

Adjusting the pH of the water upward or downward redistributes the ratio of dissolved carbonic species. Carbonic acid will dissociate to form bicarbonate ions ( $\text{HCO}_3^-$ ) and subsequently dissociate further to carbonate ions ( $\text{CO}_3^{2-}$ ) as the pH is raised upward.

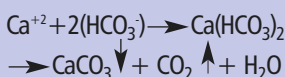
The bicarbonate ion ( $\text{HCO}_3^-$ ) is the predominant alkaline species in natural waters within the approximate pH range of 6.5 to 9.5. Its reaction with calcium ions is rather evident, yielding a

## Material Matters...

continued from page 3

precipitation of calcium carbonate once saturation is reached. Increasing the bicarbonate concentration past the calcium carbonate saturation point can be damaging to iron and steel parts as it reacts to form a non-protective iron carbonate (FeCO<sub>3</sub>) film.

In open circulating water systems, the pH is usually controlled within the 7.0 to 8.5 range. Within this range, only the free CO<sub>2</sub> to bicarbonate (HCO<sub>3</sub><sup>-</sup>) alkalinity ratio is important since the carbonate (CO<sub>3</sub><sup>2-</sup>) alkalinity concentration is negligible. This is where calcium ions (Ca<sup>+2</sup>) in the water combine with bicarbonate (HCO<sub>3</sub><sup>-</sup>) to form calcium carbonate (CaCO<sub>3</sub>). This salt has a low solubility at most temperatures and will easily precipitate out as a suspended solid or tenacious scale. The reactions can be shown as follows:



### Temperature Effects

An increase in water temperature can increase corrosion rate by speeding up reaction rates and enhancing the dissolving ability of most minerals and salts. The normal solubility of precipitates generally increases with temperature, but some behave differently. The solubility of the alkaline earth minerals, such as calcium carbonate (CaCO<sub>3</sub>), calcium sulfate (CaSO<sub>4</sub>), magnesium carbonate (MgCO<sub>3</sub>) and several others is reduced with an increase in temperature and/or pH.

Calcium carbonate is the most common scale found in water systems. An increase in temperature and/or pH will cause the bicarbonate ions to decompose to calcium carbonate and carbon dioxide as indicated above. Although the bicarbonate salt is moderately soluble in water, the carbonate salt has a very low solubility at most temperatures and precipitates out of solution. The greatest concentration of calcium carbonate is usually found crystallized at the hottest heat transfer regions in water service equipment.

### Corrosion or Saturation Indices

The "Langelier or Ryznar Saturation Indices" are used to gauge a water's potential to precipitate scale, and aid in determining if a water is corrosive or scale forming. These values are based upon the thermodynamic balance of carbonic acid and alkalinity corrected for by temperature and the dissolved solids conductivity.

In order to calculate the saturation index, the total dissolved solids (TDS), pH, calcium hardness, total alkalinity, and temperature are needed from the water analysis report. As a minimum, these data should be reported on all water analysis reports.

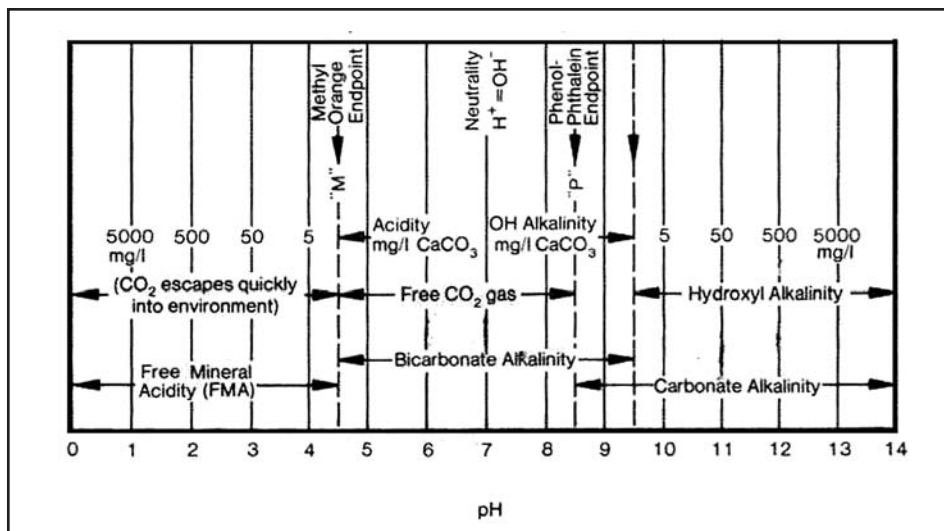


Figure 1. Acidity and various types of alkalinity and their pH ranges. (Source: Ref. 2)

Once these parameters are known, the saturation index can then be determined by comparing the actual pH to the calculated theoretical pHs of saturation.

**The Langelier Saturation Index (LSI) is defined as:**  $LSI = (pH) - (pHs)$

Where (pH) is the actual measured pH of the water, and (pHs) is the calculated theoretical pH of saturation. This pHs value correlates the effects of total dissolved solids, pH, calcium hardness, alkalinity, and temperature as they relate to the calcium carbonate solubility.

The equation (not discussed here) developed by Langelier makes it possible to determine the saturation pHs, and predict a water's tendency to either precipitate or dissolve calcium carbonate. The more complex calculations of pHs have been simplified through use of various nomographs such as one illustrated in Figure 2.

Water that dissolves calcium carbonate is highly corrosive and damaging to most irons and low alloy steel. If the index value is positive, calcium carbonate tends to deposit as a protective scale and the water tends to be scale forming. If it is negative, calcium carbonate tends to dissolve and the water is regarded as corrosive and non-scale forming. If it is zero, the water is at equilibrium and considered to be "neutral" or "balanced."

It should be noted that all water data are guide indicators, and we may need to still consider other important water conditions. For example, the presence of elevated levels of dissolved oxygen or chlorine in the water can cause water with a "balanced" Index to act corrosively rather than "balanced". Since there might also be other considerations that influence the end service application such as changes in operational conditions, use of chemical conditioning treatments and chlorination, caution should be exercised when evaluating corrosion indices.

Table 1 (pg. 5) illustrates ranges of Langelier Saturation Index values that may be encountered and some general condition comments.

**The Ryznar Stability Index (RSI)** is another expression that examines scaling tendencies based on field studies comparing operating conditions with various saturation indices. Ryznar modified the Langelier Index to better predict the likelihood of scale formation or corrosion using the following expression:

$$RSI = 2(pHs) - (pH)$$

Where pH and pHs have the same meaning as previously described above. This index is often reported to improve the accuracy in scaling or corrosion predictions. Table 2 (pg. 5) indicates how these values may be understood.

### Suspended Solids and Turbidity

Water may carry suspended solids such as organic debris, silica, silt, clays, precipitated salts, and corrosion products, which can make water appear murky or "turbid." Insoluble solids do not dissociate into dissolved ions, but rather, remain

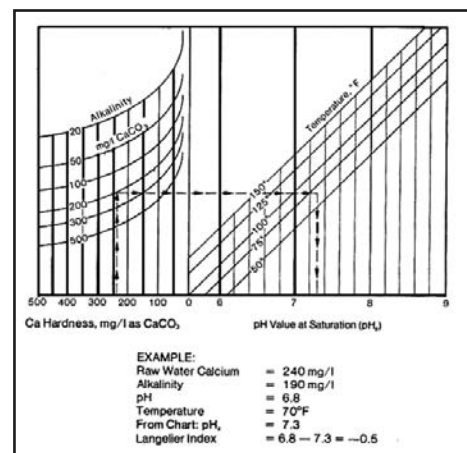


Figure 2. Determination of pHs and Langelier Index from calcium hardness, bicarbonate alkalinity and water temperature. (Source: Ref. 2)

## Material Matters...

continued from page 4

in water as suspended solid matter. If these solids are large or heavy enough they may settle out as sediment. As such they can form physical barriers or crevice deposits, that quickly establish differential aeration corrosion cells, as discussed earlier in the first part of this article.

Most suspended solids are soft (like gypsum) and non-abrasive, but others like silica may be hard and abrasive. Waters containing substantial amounts of suspended solids can provide erosive/abrasion mechanisms which, in combination with water's corrosive properties, can result in erosion-corrosion damage at any accelerated velocity regions of pumping equipment. The combined effects of corrosion with erosion are highly damaging to most pump materials. The removal of solids by filtering is recommended.

Turbidity is a measurement quantifying the degree to which light travels through a column of water and relates to the reduction in transparency due to the presence of suspended solids. Turbidity is commonly reported in Nephelometric Turbidity Units (NTU), and refers to how clear a water is. Good quality drinking water typically has turbidity values less than 1 NTU. As suspended solids levels increase water becomes murkier and turbidity values increase.

### Microorganisms

Microbiological growths often present special problems. Microorganisms are found in many environments and are widely spread throughout nature. There are numerous types that can be present in water systems. Some microbes are beneficial while others are not.

For example, bacteria utilized in wastewater treatment are beneficial and aid in reducing wastewater pollution and odors, while others induce corrosion in otherwise relatively mild environments and create offensive odors. The mechanism of microbiological influenced corrosion or MIC, is associated with the metabolic waste by-products of the microbes, which induce corrosion. In many instances, the corrosion appears in the form of localized damage.

Aerobic sulfur bacteria can oxidize sulfur and sulfides in the environment to sulfates or corrosive sulfuric acid. Often colonies of aerobic bacteria complement anaerobic sulfate-reducing bacteria (SRB) bacteria, which may also be present. SRB are capable of reducing the sulfate ( $\text{SO}_4^{2-}$ ) in water to sulfide ( $\text{S}^{2-}$ ) and/or hydrogen sulfide ( $\text{H}_2\text{S}$ ). Since the sulfate ion is common in many environments, the potential damage caused by SRB is cause for concern in

**Table 1**  
**Interpretation of Langelier Saturation Index Test Results**

Index	Appearance	Water Condition Quality Issues
- 4.00	Very Severe Corrosion	Conditioning Required
- 3.00	Severe Corrosion	Conditioning Usually Recommended
- 2.00	Moderate Corrosion	Some Conditioning Is Recommended
-1.00	Mild Corrosion	Need Some Conditioning
-0.50	Slight Corrosion	Should Not / May Need Some Conditioning
0.00	Balanced	Conditioning Usually Not Needed
0.50	Faint Scale Coating	Conditioning Usually Not Needed
1.00	Slight Scale/Encrustation	Some Visual Appearance Concerns
2.00	Mild Scale/Encrustation	Should Consider Some Conditioning
3.00	Moderate Scale/Encrustation	Should Use Some Conditioning
4.00	Severe Scale/Encrustation	Conditioning Usually Is Required

**Table 2**  
**Interpretation of Ryznar Saturation Index Test Results**

Saturation Index	Appearance/Description	Water Condition Comments
4.0 – 5.0	heavy scaling	non-aggressive, non-corrosive
5.0 – 6.0	moderate scaling	non-aggressive, non-corrosive
6.0 – 7.0	little scaling	slight corrosion, balanced saturation
7.0 – 7.5	non-scaling, corrosive	aggressive, under-saturated
7.5 – 9.0	heavy corrosion	very aggressive, moderate corrosion
9.0 and more	severe corrosion	extremely aggressive, highly corrosive

untreated biologically active waters. Water reports that list hydrogen sulfide presence indicate microbiological activity.

### Summary

Water treatment and corrosion is a complex phenomenon between water chemistry and the materials it contacts. Within water systems, a number of chemical and physical variables have been shown to influence corrosion reactions and water quality. Nearly all metals will corrode to some degree. The rate and extent of corrosion depends on the degree of dissimilarity of the metals in contact within the system, and the physical and chemical characteristics of the environment. Complete analysis data for any water service report should be available and should include:

- Water service types, and indicate if it flows continuously or intermittently.
- Full composition analysis of major and minor constituent concentrations used to calculate the corrosivity index: pH, total dissolved solids (TDS), hardness, total alkalinity, dissolved oxygen content or other gases, micro-organisms if present and use of biocides or oxidants such as chlorine, etc. should be indicated.
- Amount, type and size of erosive solids if present.

Some waters can be very corrosive to iron and steel because of the dissolved gases they contain;

oxygen and carbon dioxide being the most common, hydrogen sulfide in polluted or biologically active waters, and chlorine in disinfected or treated waters. Effects of gas content in water and pH that can accelerate the corrosion of steel are indicated Table 3 (pg. 6).

In water that is soft, corrosion can be accelerated because of the lack of beneficial dissolved solids, such as calcium and magnesium in the water. In harder scale forming water, a precipitate or coating of calcium or magnesium carbonate forms a protective barrier that reduces corrosion attack. Waters with increased levels of sodium, chloride, or other ions that increase the conductivity of the water promote corrosion.

In general, some conditioning of aggressive waters can be accomplished by increasing hardness and/or alkalinity, and raising the pH. These increase scale forming, which results in protective barrier films. It is important to know that the corrosiveness of water can be aggravated through use of water softeners, aeration devices, heaters, chlorinators, or coupling to dissimilar metals in water systems with good conductivity.

Softeners can remove protective calcium and magnesium ions, and introduce more highly conductive sodium ions into the water. Aeration devices used to remove certain elements such as

continued on page 6

## Material Matters...

continued from page 5

iron, manganese, sulfur or unpleasant odors add oxygen, which increases water corrosivity. Biocides used to control microbiological activity can also increase corrosion by introducing strong oxidizers such as chlorine, which shift corrosion potentials to more positive values. In general corrosion is accelerated in waters that report:

- high conductivity / dissolved solids (uS/cm x .67 ≈ total dissolved solids > 1000 mg/l)
- dissolved corrosive gases (O<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>)
- acidic pH < 5.5, or addition of strong acids
- chloride (Cl) and/or sulfate (SO<sub>4</sub><sup>2-</sup>) ions greater than 50mg/l each
- free chlorine(Cl<sub>2</sub>) or use of other strong oxidizing biocide
- low calcium hardness less than 50 mg/l
- alkalinity less than 100 mg/l
- increased temperature > 120 °F
- erosive/abrasive suspended solids
- accelerated velocity / turbulent flowing conditions

Finally, as I stated in the beginning, the suitability of water for any particular service is based upon its specific chemical makeup, and the service requirements. A proper materials selection can only be attempted after careful review of all crucial water variables has been conducted. Since many water factors have been shown to work together and influence each other, the combined synergistic effects are often more severe than predicted from a review of each variable separately.

The importance of complete waters testing and reporting, monitoring, and conditioning control can not be overemphasized, as this affects materials selection and the avoidance of costly corrosion related problems. Often the selection of more highly alloyed materials is required to overcome certain water conditions that can not be economically controlled. These decisions of course can only be made with the aid of a complete and detailed water analysis report. ■

Select Water Fundamental References:

1. *Principles of Industrial Water Treatment*, Drew Industrial Division, Ashland Chemical Co., Eleventh Edition, 1994
2. Frank N. Kemmer, *Water: The Universal Solvent*, *Nalco Water Handbook*, Nalco Chemical Company, Second Edition, 1979
3. Bennett P. Boffardi, *Fundamentals of Cooling Water Treatment*, Calgon Corporation, Booklet number 11-431

**Table 3**  
Effects of Various Gases and pH on Water Reactivity with Steel  
Reactivity of Steel to Corrosive Waters

Water Parameter	Water Quality	Effect Expected
pH	Less than 5.5	Corrosive
pH	5.5 to 7.0	Marginal/Corrosive
O <sub>2</sub>	Less than 1 mg/L	Acceptable/Non Corrosive
O <sub>2</sub>	1 to 4 mg/L	Marginal/Corrosive
O <sub>2</sub>	More than 4 mg/L	Corrosive
CO <sub>2</sub>	Less than 50 mg/L	Acceptable/Non Corrosive
CO <sub>2</sub>	50 to 100 mg/L	Marginal/Corrosive
CO <sub>2</sub>	More than 100 mg/L	Corrosive
H <sub>2</sub> S	Less than 1 mg/L	Acceptable/Non Corrosive
H <sub>2</sub> S	1 to 5 mg/L	Marginal/Corrosive
H <sub>2</sub> S	More than 5 mg/L	Corrosive
Cl <sub>2</sub>	Less than 1 mg/L	Marginal/Corrosive
Cl <sub>2</sub>	More than 1 mg/L	Corrosive



### Review of the 2003 Pump & System Fair at Shanghai, China, October 22-25

**Jenny Yu Qin**, Marketing Officer,  
Goulds Pumps - Shanghai

It was the first time that so many ITT companies (Goulds, Bell & Gossett, Flygt, Lowara, Sanitaire, Jabsco and Robot) worked together as an ITT family to participate in a fair in China. Due to the team effort, we were awarded the "Best in Show" prize from the organizer.

With 46 exhibits, ITT showed its ability to provide a full range of products from its fluid technology group. A press conference was

held on the first day and our brands were "flagged" along streets around the exhibition hall. Most visitors were very impressed by the ITT promotional campaign during the show.

Along with PumpSmart, we displayed the IC and 3700 cutaways from Goulds. Large numbers of both domestic and foreign customers were interested in our products and were crowding around our 120 square meter booth. We received more than 800 registered visitors over the four days. Bjorn von Euler, Director – Corporate Communications for ITT Fluid Technology commented, "We have found a winning concept for joint booth participation that we will benefit from throughout the organization." ■