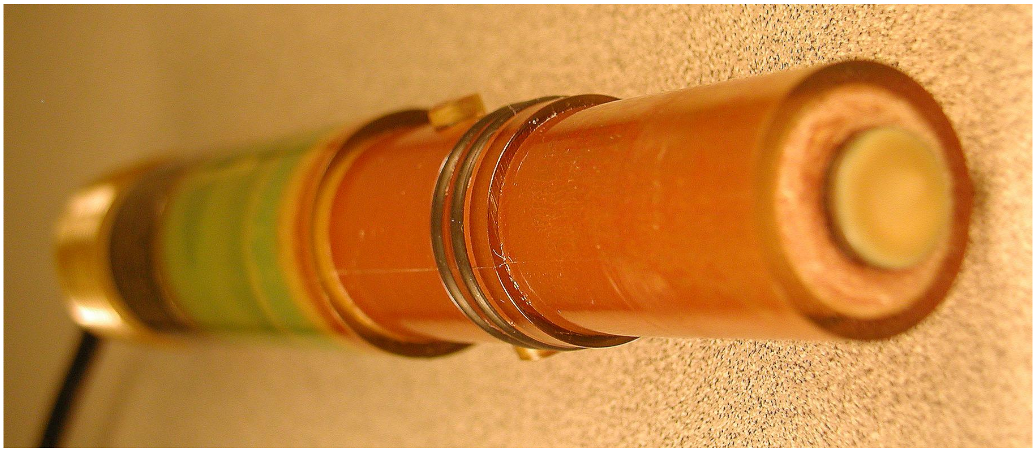
pH / ORP / ISE Process Control Systems
Case Study # 15 - Water Softener Analysis - (March 2005)

Advanced Sensor Technologies, Inc.
Orange, California USA

Superior pH / ORP / ISE Industrial Sensors

Features

- Guaranteed Longest Lasting Sensors Available with performance guarantee *
- Sensors are compatible with most existing pH/ORP Meters, Transmitters & Analyzers **
- Application Specific Engineering results in optimum Lifetime & Performance ***
- Integrated Temperature Compensation, Preamplifiers & Solution Ground Elements
- Solid State Reference System offers superior resistance to Fouling & Dehydration
- Applications such as Acid/Fluoride, Hi-Temp, Saturated Sodium and Sulfide Resistant are available as standard options
- Custom Applications are available, often at no additional charge
- Most Installation Styles are Supported Including: Immersion, Twist Lock, Valve Retractable & Sanitary
- Available in a wide range of plastics, from cost effective CPVC to thermally & chemically resilient ULTEM® and PEEK thermoplastic
- High Pressure Applications up to 100 psi for Valve Retractable & 150 psi for Inline Installations can be supported for continuous use
- Operating Temperatures from $^{-}30$ to $^{+}150$ ºC ($^{-}22$ to $^{+}302$ ºF) can be supported for continuous use



Case Study No. 15 – Sodium & Calcium Ion Analysis for Water Softener Systems

Calcium (Ca^{++}), Magnesium (Mg^{++}), Sodium (Na^{+}), Ion Analysis
Before and After Water Softener to determine Water Quality Feed to Boilers

- Industrial grade sodium ion selective membrane and application engineered solid state conductive polymer reference can withstand the rigors of industrial process lines
- Sodium calibration system has been optimized to yield reproducible results in a variety of boiler water systems

The Problem

A company wanted to automate the water quality testing on their water softener used to feed their boilers. When the softener ceased to function properly, the water softener needed to be regenerated. A delay in this service may cause damage to the boilers, eventually leading to a shutdown to clean and repair the boilers. The existing manual sampling routine or online sampling analyzers were slow and expensive, respectively. In addition, the delay caused by not having an accurate real-time online method to determine the effectiveness of the water softener could cause hard water to spread throughout the plant, leading to operational difficulties.

The Solution

ASTI's online ion selective sensors can be used to measure the effectiveness and state of the water softening system, although this measurement must be performed indirectly. The customer indicated a desire to measure the activity of calcium (Ca^{++}) ion at a point after the water softening system. This measurement is not feasible due to the degree of excess of sodium present. The permissible ratio of excess of sodium (interfering) ion to calcium (analyte) ion for our calcium ion selective sensors is 100 fold (on a molar basis), whereas the lab analysis revealed an excess of 2600 fold (also computed on a molar basis). This then indicates that the concentration of sodium is 26 times too high to perform the calcium measurement after the water softener. ASTI found an excellent and feasible method to indirectly measure calcium after the softener and determine the effectiveness of the softening system as a whole.

ASTI
Advanced Sensor Technologies, Inc.
Tel: + 1-714-978-2837
Orange, California USA
Web: www.astisensor.com

Features

- Guaranteed Longest Lasting Sensors Available with performance guarantee *
- Sensors are compatible with most existing pH/ORP Meters, Transmitters & Analyzers **
- Application Specific Engineering results in optimum Lifetime & Performance ***
- Integrated Temperature Compensation, Preamplifiers & Solution Ground Elements
- Solid State Reference System offers superior resistance to Fouling & Dehydration
- Applications such as Acid/Fluoride, Hi-Temp, Saturated Sodium and Sulfide Resistant are available as standard options
- Custom Applications are available, often at no additional charge
- Most Installation Styles are Supported Including: Immersion, Twist Lock, Valve Retractable & Sanitary
- Available in a wide range of plastics, from cost effective CPVC to thermally & chemically resilient ULTEM® and PEEK thermoplastic
- High Pressure Applications up to 100 psi for Valve Retractable & 150 psi for Inline Installations can be supported for continuous use
- Operating Temperatures from $^{-}30$ to $^{+}150$ ºC ($^{-}22$ to $^{+}302$ ºF) can be supported for continuous use

Typical Concentrations Before Softener	Typical Concentrations After Softener
Sodium - Na^+ = ~ 48 ppm	Sodium - Na^+ = ~ 300 ppm
Calcium - Ca^{++} = ~ 160-250 ppm	Calcium - Ca^{++} = ~0.200-0.600 ppm

The ion exchange system is clearly replacing calcium ions with sodium ions. If the ion exchange system fails or deteriorates, the sodium ion activity at the post softener location is changed from about 300 ppm to about 48 ppm. This is almost a step change in concentration. Measurement of such a change is an appropriate use of an inline ion selective sensor. At the post softener position, all concentrations of interfering ions for the sodium ion selective sensor are within the permissible range. The sodium ion activity as measured prior to the water softener can provide a valuable baseline sodium ion (Na^+) level. The magnesium ion (Mg^{++}) contribution to water hardness is ignored because it will be also be converted to sodium ion, which will be analyzed at the after softener measurement position. In addition, the concentration of magnesium is often five to ten (5-10) times less than calcium and usually occurs at a fixed ratio to calcium.

When the softener is functioning properly, the sodium ion (Na^+) levels as measured after the softener will be quite high (~300 ppm), corresponding to a lack of calcium ion (Ca^{++}) in the softened water (see abbreviated water analysis above). When the softener fails to work properly, the sodium ion levels at the post softener measurement point will return to the low levels as measured at the before softener measurement point (~30-50 ppm). This provides a very simple method to use the ion selective system as an alarm and indicator as to the state of the water softening system. In addition, the ion selective analyzer can automatically switch the water (via a relay) to a functioning secondary water softening system to avoid any downtime. A Rosemount 54e industrial sodium ion selective analyzer was employed to conveniently calibrate and operate in familiar ppm units. This ion selective analyzer had the necessary 4-20 mA outputs (scaled in ppm) and relays (also set in ppm) to enable the automation of this implicit water hardness (Ca^{++} & Mg^{++}) determination for water quality analysis of the water softening system.

The Industrial Sodium Ion Selective Sensor Used**:**
Model: AB 8430-100-10 Industrial Sodium Ion Selective Sensor
Description: 1" MNPT Twist Lock Quick Disconnect ULTEM Bodied Industrial Sodium Ion Selective Sensor with integrated 100 Ohm Platinum Temperature Element; 10 feet cable to connect directly to Rosemount 54e Ion Selective (ISE) Analyzer and Transmitter

Choosing the Correct pH/ORP/ISE Sensor

1. Choose a sensor body type that suits the physical parameters of the installation (refer to the ***Configurations Portion of pH/ORP and Ion Selective webpages***).
2. Choose a sensor that suits the process application, temperature, chemistry, and physical parameters of the installation (refer to ***Sensor Selection Guides and call factory or local sales agent for support***)
3. Choose a sensor housing material that is compatible with the process chemistry, temperature & pressure (refer to ***Chemical Resistance Charts as posted under the Technical Documents portion of the website***).
4. Select suitable temperature compensation element, solution ground & integrated preamplifier based upon mating pH/ORP/ISE Instrument (refer to ***Electrochemical Instrumentation Page & ask for factory support***).
5. Specify the required cable length based upon installation location (refer to ***Part Numbering Guide***).

* Subject to application qualification and review by an approved ASTI sales agent and/or factory. Performance guarantee is posted on the ASTI online application questionnaire page.
** See list of supported pH/ORP/ISE Instruments webpages as posted on the ASTI website.
*** Completion of Application Questionnaire form is required. Other restrictions may apply.

Advanced Sensor Technologies, Inc.
Tel: + 1-714-978-2837
Orange, California USA
Web: www.astisensor.com