Power Generation
Perspectives in Pure Water Analytics

20 News

THORNTON
Leading Pure Water Analytics

Sodium Analyzer Lowers Operating Costs in China Cogeneration Plant

The high maintenance workload and operating costs of a sodium analyzer were unacceptable at a Chinese cogeneration facility. Installation of a self-calibrating sodium analyzer has provided a marked decrease in maintenance requirements, and is more reliable.

Energy conservation at Chinese power plant

Jiahua Energy Chemical Industry Co., Ltd. in Zhejiang Province, China operates multiple coal-fired generating units to supply electric power and up to 550 tons / hr of steam. Their mission is to provide energy to support the many businesses in the region.

In response to a national call for energy conservation and improved operating efficiency, Jiahua Energy Chemical Industry has focused on recycling as much of the steam as possible. At the same time, they need to protect the turbine / generator sets and condensate recycling systems from corrosion. As a result, plant engineers have very strict requirements on condensate quality. For this reason, continuous real-time measurements are made of conductivity, sodium, pH, TOC, and other process parameters.

Problem of sodium contamination

For Jiahua Energy Chemical Industry, monitoring the sodium ion content in the recovered steam is critical and has been challenging. Too high a sodium content leads to increased corrosion of the components of the turbine, and can result in serious accidents in production. It could cause unplanned outages costing Jiahua Energy and its customers hundreds of millions of dollars in lost production. Therefore, Jiahua Energy must maintain very strict control of the quality of the condensate returned to the feedwater train.

Sodium, as one of the most common ionic

METTLER TOLEDO

METTLER TOLEDO condensate-quality monitoring systems, including 2300Na Sodium Analyzers, at Jiahua Energy.

contaminants, is a very sensitive and accurate indicator of the quality of water and can be an early indicator of process leaks from heat exchangers.

Time-consuming maintenance for original analyzer

For the detection of sodium content in steam, Jiahua Energy's original sodium analyzer maintenance workload was significant:

- In order to ensure that the instrument was working properly, the sodium analyzer required calibration every two-weeks, each requiring two to three hours.
- Electrode activation required manual treatment with each calibration.
- Every month, calibration standard reagents were required.
- Every two months, it was necessary to add alkaline reagent.
- Every six months, the equipment supplier had to come on-site for parts replacement, which entailed a substantial service fee.

In addition, the old analyzer had difficulty dosing the alkaline reagent accurately, showed poor signal stability, and had leaking components.

New analyzer ensures correct reagent delivery

For ion-selective sodium measurement, control of sufficient sample alkalization is critical to analyzer performance to prevent hydrogen ion interference. But adding an excess of alkaline reagent adds to costs as well as frequency of reagent replenishment, and delivers no benefit. Accordingly, measurement of the adjusted sample pH value to monitor the alkalizing process can ensure proper dosing of reagent, thereby giving accurate and reliable measurement results.

In the METTLER TOLEDO Thornton 2300Na Sodium Analyzer, a controlled amount of diisopropylamine (DIPA) reagent is added to the sample by its vapor permeating through a length of silicone diffusion tubing carrying the sample. Because the vapor pressure of reagent is constant, regardless of the level of liquid reagent in the bottle, the rate of addition is consistent.

Also, because DIPA is used at 100 % concentration, its level in the bottle is a clear indication of its consumption rate. The 2300Na Analyzer includes continuous monitoring of the sample pH after DIPA addition, to ensure interference-free sodium measurement.

Up to six hours saved in conditioning and calibration

For Jiahua Energy steam customers, the sodium concentration in the sample is usually only a few ppb or less. This low concentration requires frequent conditioning of the sodium electrode to obtain satisfactory response. In the 2300Na Analyzer's automatic calibration process, exposure to a high concentration of sodium is automatically performed as the first step of every calibration. This conditions the electrode to maintain its response.

During conditioning and calibration, a sodium analyzer measures higher concentrations of sodium than the actual sample. The residual left in the electrode flow chamber and fittings can take a very long time to flush out when the sample flow is resumed. With the manually calibrated analyzer Jiahua Energy had been using, the electrode conditioning, two-point calibration, plus full rinse down time took field instrument maintenance engineers three to six hours.

The Thornton 2300Na provides electrode conditioning as the first step of automatic calibration. The calibration is completely unattended: Users can set the calibration time interval for days or weeks to automatically execute the electrode conditioning, double known addition calibration,

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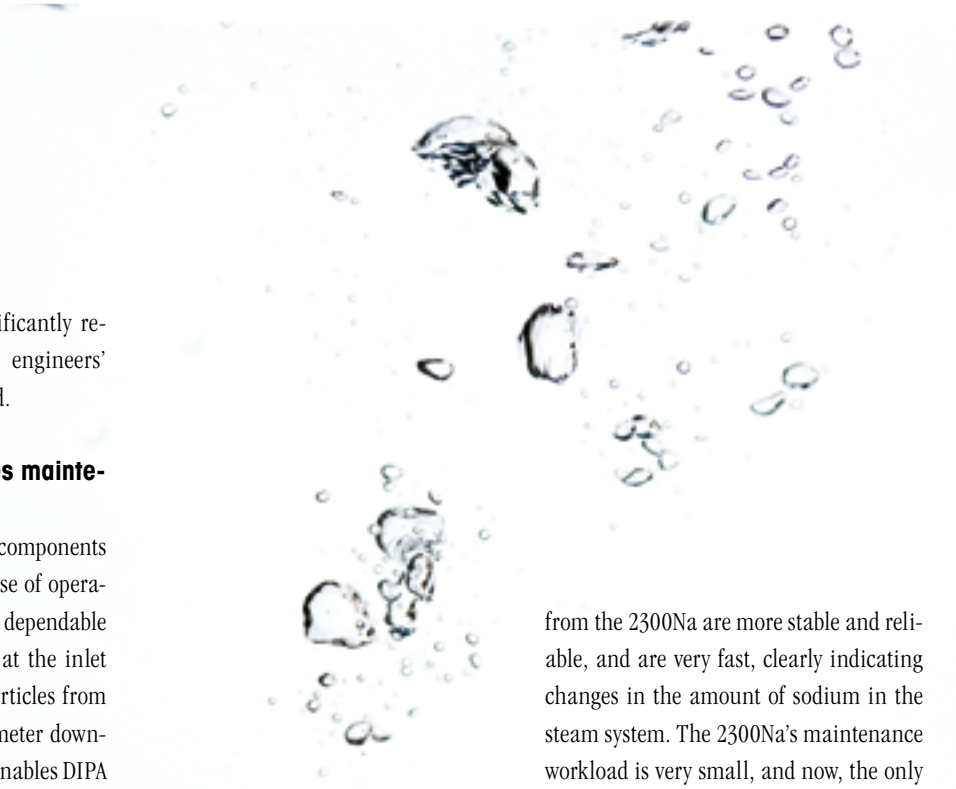


and system rinse down; significantly reducing the instrumentation engineers' on-site maintenance workload.

2300Na Analyzer reduces maintenance and labor costs

The 2300Na uses a number of components designed to provide overall ease of operation, long-term durability, and dependable performance. A sample filter at the inlet prevents corrosion product particles from clogging the valves and flowmeter downstream. The diffusion tubing enables DIPA reagent addition with no moving or metal parts that could wear, leak, or corrode.

The combination pH and reference electrode uses self-contained pressurized gel electrolyte without an external reservoir and tubing. This electrode design eliminates the need to refill electrolyte and possible spills or leaks that could cause corrosion inside the analyzer. These design factors significantly reduce the potential for leakage and corrosion problems due to aging of components and moving parts, while effectively lowering instrument maintenance and labor costs.

In industrial field environments, electromagnetic interference sometimes causes unstable readings from high impedance sensors such as sodium and pH electrodes. In addition, measurement ground loop interference can occur. These problems are virtually eliminated using the proven METTLER TOLEDO Intelligent Sensor Management (ISM®) technology. In the 2300Na Analyzer, sodium concentration, pH, reference, and temperature are all measured with built-in circuits within the sensors that provide robust two-way digital communication to the transmitter in the Analyzer. This design significantly improves the 2300Na's measurement accuracy and performance beyond conventional electrode systems.

"Stable and reliable"

Jiahua Energy and Chemical Co., Ltd. has substantially reduced sodium measurement operating costs and on-site technician workload by using the automatic, on-line 2300Na Sodium Analyzer. The company's field instrumentation engineer stated, "Compared with the original sodium analyzer, the measurement results from the 2300Na are more stable and reliable, and are very fast, clearly indicating changes in the amount of sodium in the steam system. The 2300Na's maintenance workload is very small, and now, the only thing we have to do is to add reagent every two to three months and replace the diffusion tube every six to eight months. The rest of the time, the 2300Na runs automatically! The analyzer frees us from burdensome instrument maintenance, and we have more time available for more important work."

Find out more about the 2300Na at:
► **www.mt.com/Thornton-sodium**

2300Na Sodium Analyzer

Analytical Measurements
Support Materials Research

France's AREVA NP operates a technical center where the company researches the effects of aging on nuclear power plant pressurized water reactors. To ensure measurement integrity, AREVA NP employs METTLER TOLEDO Thornton instrumentation.

Global leader in nuclear power plants

AREVA NP, based in Paris, France is the world leader in the design and construction of nuclear power plants. At their technical center at Creusot, AREVA conduct research that contributes to advances in the field of nuclear power generation.

The center's Department of Corrosion and Chemicals has developed expertise and R&D programs which investigate the areas of corrosion, materials, electrochemistry, physical chemistry, chemistry, and metallurgy. This effort results in advancements for AREVA NP operations (Reactor, Fuel, Nuclear Services and Facilities) and for its clients such as EDF, EPRI, and Andra.

Equipment at the center can create accelerated aging effects under conditions encountered in nuclear power plants. This includes control of temperature, pressure, and chemical environment of the primary and secondary circuits. Highly sophisticated electrochemical and other analytical equipment is used to characterize any changes to exposed surfaces, such as oxidation or deposit formation.

Tests for pressurized water reactors

Corrosion Department staff create simulations of the primary and secondary circuits of pressurized water reactors (PWRs). These tests, conducted in the absence of radioactivity and within different circulation loops, allow varying chemical and thermodynamic parameters of the environment and examination of the effects on the materials under evaluation. Among the parameters monitored, pH, dissolved oxygen, and conductivity are key factors responsible for degradation of circuit materials.

Sensors are located in parallel loops of cooled samples, where pressure and temperature measurements are also made. These measurements are taken continuously throughout the typical 1,500 hour (approximately 2 months) duration of an experiment.

Challenging measurement requirements

Numerous details must be considered in order to provide valid analytical measurements. One of the difficulties lies in the installation of the sensors due to the constraints of temperature and pressure. Sensors, especially for dissolved oxygen, must be installed in a sealed system to maintain sample integrity. Measurements are very sensitive, requiring careful control of the installation environment. Electrical interference and sample flow variations can disrupt otherwise stable measurements. The first analytical instrumentation in the system used individual transmitters with attendant complexity and difficulty of configuring the wide variety of sensors and transmitters.

Instrumentation requirements

Testing conducted by the Department of Corrosion and Chemical AREVA NP has great significance to the proper operation and safety of nuclear power plants. The materials used must meet the requirements for the quality and precision specified. Measurement accuracy was not the only requirement; AREVA NP also expected stability and reproducibility of measurements, plus reliability and ease of sensor installation. Easy and infrequent maintenance of equipment is essential for AREVA NP, as is simple configuration and continuity of on-line monitoring.

Uncompromising solution

METTLER TOLEDO France provided AREVA NP with an analytical solution for the monitoring and control of the pure water applications, including a single Thornton multi-channel, multi-parameter 770MAX transmitter with multiple SMART sensor inputs, for: 2-electrode conductivity, High Performance dissolved oxygen and a pHure pH electrode for high purity water applications.

METTLER TOLEDO Thornton system:

770MAX multi-channel, multi-parameter transmitter

- Four analytical sensor inputs for maximum flexibility and simplicity
- High accuracy for pure water measurements

SMART 2-electrode conductivity sensor

- Calibration data stored in sensor memory
- Wide measuring range from raw water to ultrapure water with one sensor

SMART pHure pH sensor

- Accurate pH measurement in challenging low conductivity samples
- Waterproof VP sensor connector to ensure reliability

SMART High Performance dissolved oxygen sensor

- Low maintenance requirement
- Excellent long-term measurement stability

According to AREVA NP, the recommendation of the 770MAX transmitter allowed them to simplify the installation by reducing the number of transmitters, making configuration and operation much easier. It also offered the possibility of conveniently coupling the transmitter to LabVIEW™ software for graphics.

Future prospects

AREVA NP is very satisfied with the 770MAX platform and testing results offered by METTLER TOLEDO, and the installation has now grown to six, complete 770MAX systems. Future systems will make use of the new M800 transmitter platform (see left), which includes all the multi-channel, multi-parameter capabilities of the 770MAX plus digital sensor integrity and Intelligent Sensor Management (ISM®) technology.

Find out more at:

► **www.mt.com/pro_power**

M800 Multi-parameter, Multi-channel Transmitter

Simple operation through intuitive user interface

Thanks to the intuitive menus and touch screen display, all operations from installation to system diagnostics are greatly simplified.

Lower cost of measurement point

Up to four sensors can be monitored with a single M800, significantly reducing installation costs and cost per measurement point.

Predictive diagnostics and improved maintenance management

The unique iMonitor concept allows you to monitor the actual status of every sensor at a glance and offers predictive maintenance information to improve sensor maintenance management and avoid unplanned production shutdowns.

Reliable On-line Sampling
Meet the Challenge

Accurate on-line measurements require that representative samples reach the sensors. To obtain dependable results, effects of sample delay, sample line interaction, and air contamination must be minimized. This article looks at recommendations for maintaining sample integrity.

Sample source

METTLER TOLEDO Thornton instrumentation has been optimized to supply accurate measurements of power plant high purity water. However, as they can only measure the samples delivered to them, obtaining representative measurements relies on supplying sensors with unsullied samples.

Portable on-line pure water instrumentation

Isokinetic sampling is best

Where two-phase flow (steam / water droplet mixture) is to be sampled, the sample should contain the same ratio of steam and water as the process line. A sample nozzle should be located near the center of the process pipe, facing into the flow. The sample flow velocity should be isokinetic, i.e., with the same velocity inside the nozzle as in the surrounding process pipe. This will prevent the pulling-in of excessive steam at too high a sample velocity or accumulating too many water droplets at too low a velocity.

Using reducing agents

Where reducing agents such as hydrazine or reducing amines are used, the sample should be cooled as close to the sampling point as possible to prevent continued reaction with dissolved oxygen along the length of the hot sample line.

Minimizing deposits

Corrosion product particles that accumulate on sample tube walls create a large active surface area along the length that can adsorb and desorb materials in the sample. A sample line with a lot of deposits can act like an ion chromatograph and delay the passage of ions through the line much longer than a simple calculation from flowrate, diameter, and length would predict. It has been found that a flow velocity of 2 m / s produces the least accumulation of particles in horizontal sample lines and is recommended wherever possible. This high velocity is only practical using very small diameter tubing for the long lengths of the sample line. The sample is then divided for measurement by multiple sensors, some of which require much lower flow rates.

Select the right flowrate

The appropriate sample flowrate at the sensor depends on the particular measurement. For example, cation (acid) conductivity requires a high flowrate to obtain good ion exchange. ASTM standard D 6504 Cation Conductivity recommends a flow velocity through the resin of at least 300 mm / min. Lower flow tends to reduce turbulence and allows channeling through the resin, resulting in incomplete exchange. On the other hand, to yield a stable pH measurement in low conductivity samples requires low flowrates to minimize electrostatic pickup and reference junction potentials.

Filtration requirements

Placing a filter in the sample line upstream of optical analyzers can protect them from particulate contaminants and errors. However, the filter elements must be changed frequently to prevent accumulation of sediment that slows the response to true sample changes. Electrochemical measurements, such as conductivity, pH, ORP, and dissolved oxygen, are not directly affected by particles. Our sensors for these parameters have flow housings designed with a very small volume that encourages

any particles to flow on through the housing and down the drain. In this way, the delays and maintenance of filters and the cleaning of larger bowl-shaped flow chambers are eliminated and better overall measurements result.

During initial startups, when very high particulate concentrations are expected, all sample lines should be diverted to drain. Pressure regulators and flowmeters, as well as sensors with or without filters, should not be subjected to heavy loads of corrosion products that could clog tubing and fittings.

Avoiding air leaks

Dissolved oxygen samples at ppb levels are especially vulnerable to air inleakage. Although samples are pressurized and flowing, it has been observed that a loose rotameter, valve or compression fitting seal that leaves a path through a thin film of water can allow a trace amount of oxygen to diffuse into the sample. At ppb levels, no bubbles will be present but a significant change in readings can occur. A quick test for this is to increase the sample flowrate. If the dissolved oxygen reading falls, it is an indication there is a leak and the higher flow is diluting it. The readings should be fairly insensitive to flow.

Air can also pass through polymer sample tubing and have the same effect as a leak; therefore, stainless steel should be used for all dissolved oxygen samples. In the event that flexible tubing is required, it should be as short as possible and be made of PVDF or nylon, which have especially low gas permeability. The same precautions should also be used for low conductivity measurements where CO_2 from the air can contaminate a sample and raise the conductivity due to increased bicarbonate and hydrogen ion concentrations.

Portable instrumentation is better than grab samples

Off-line samples are inevitably subject to contamination from the air and the container.

Whenever possible, it is always preferable to take a portable instrument and sensor to the flowing sample rather than taking a grab sample to the laboratory. However, there are virtually no laboratory or portable instruments for conductivity and pH that have temperature compensation suitable for high purity measurement. They do not take into account the changing dissociation of water and ammonia or amines with temperature, which is a major factor at low concentrations.

Much better results are obtained by using on-line pure water instrumentation in a portable mode. Shown left is a two-wheeled portable system using METTLER TOLEDO Thornton multi-parameter instrumentation that can be moved around the plant to confirm measurements of specific conductivity, cation conductivity, pH, dissolved oxygen, and TOC with the same capability and quality as permanent on-line measurements.

Find out more at:
▶ **www.mt.com/pro_power**

Hot Stuff!

High-performance, Multi-parameter Transmitter

Where other analytical instruments failed to withstand environmental conditions, the M800 Transmitter provided reliable measurements and became the preferred instrument platform.

Southwestern US is a harsh environment for equipment

One of the United States' largest public power utilities provides a reliable supply of electricity and water to more than two million people in the Southwestern US. METTLER TOLEDO Thornton was asked to provide a solution when the utility became frustrated with a lack of support from their instrumentation supplier and when another supplier's measurement equipment failed in the extreme temperature and intense sunlight exposure typical of this part of the country.

Plant dilemma

After their past experience, personnel at this utility had concerns regarding whether any transmitter display could withstand the desert sun and temperature swings. In addition, the wide range of measurement parameters needed in a steam/water panel often forces users to select multiple instrument suppliers, each with their own operating system, in order to achieve a complete installation. This complicates system design, user training, general operation, maintenance, and spare parts inventory.

Intelligent transmitter provides the solution

The environmental challenges and multiple parameter measurement requirement presented us with the opportunity to install a solution based around our multi-channel, multi-parameter M800 Transmitter. The M800 functions reliably in temperatures up to 50 °C (122 °F), allowing its installation in direct sunlight on the cooling towers at our customer's plant.

The M800 operates with our Intelligent Sensor Management (ISM®) sensors. ISM offers a number of advanced features, including sensor calibration away from the measurement point, Plug and Measure start up, and predictive sensor diagnostics for improved maintenance planning.

Utility technicians were impressed with the simplicity of the ISM platform for calibration and installation, the simultaneous pH/ORP measurement from our InPro 4260i sensor, and METTLER TOLEDO's local service and support.

Transmitter copes in high temperatures

Throughout summer testing at the utility, the M800 performed flawlessly and maintained its clear, easily-read display. As a result, the utility decided to replace the existing sample panel instruments and sensors with our solution, in addition to the cooling tower equipment. Shortly thereafter, the M800 was specified as a plant standard. Multiple ISM sensors for pH/ORP, dissolved oxygen and conductivity have now been installed with M800s, in various locations at the utility. This has allowed the power plant to organize on-line, analytical measurements around one instrument; which simplifies operator use, personnel training, future maintenance, and technical support.

ISM solution becomes a standard

Other plants owned by this utility in the Southwestern US are also now standardizing on the M800 Transmitter platform with ISM sensors in order to benefit from the flexibility and savings provided by METTLER TOLEDO Thornton solutions.

To find out more about the M800 and ISM, see:

▶ **www.mt.com/pro_power**

M800 Transmitter

Online Resource

Keep Up to Date
Power Generation Competence Center

METTLER TOLEDO Thornton is dedicated to continuous improvement in producing instruments for the detection of impurities in power plant water systems. An online resource keeps you informed as to our latest developments in monitoring and measuring pure water and steam in power generating facilities.

Essential monitoring of high purity water

The life-blood of the power plant requires careful surveillance to guard against corrosive and depositing conditions, especially on turbine blades and in boiler tubes. Long-term efficient power generation depends on minimizing corrosion and deposition within the steam / water cycle. Controlling high purity water treatment is only possible using sensitive and accurate analytical instrumentation. We are recognized as the industry leader for on-line measurements for makeup water treatment and is growing rapidly for cycle chemistry monitoring.

The latest information

We have extensive expertise in power applications, with proven capabilities for measurements of specific and cation (acid) conductivity, pH, oxidation reduction potential (ORP), dissolved oxygen, and total organic carbon (TOC) for makeup water, cycle chemistry, and stator cooling. Sodium and silica measurements are now also available for these applications. Learn more about on-line measurement solutions, featuring the unique Intelligent Sensor Management (ISM®) concept for Plug and Measure convenience, at our competence center.

Featured on the website are resources to help you choose instrumentation for:

- Makeup water treatment – including pre-treatment, reverse osmosis, and deionization.
- Cycle chemistry – Our expertise for these measurements includes intuitive multi-parameter transmitters and sensors, easy calibration, and low-volume sensor housings that help prevent accumulation of corrosion products.
- Other water uses – Auxiliary water uses present challenges in maintenance of sensors while obtaining results that satisfy regulatory requirements and corrosion constraints.

Also highlighted are:

- Products and solutions – Find out how Thornton provides accuracy, flexibility, and low cost of operation for water chemistry measurements.
- Documentation and know-how – Download documents related to power generation and pure water measurement.
- Watch informative 2300Na Sodium, 2800Si Silica, and pHure sensor product videos.

Visit the resource site "Process Analytics for Efficient Power Generation" at:

▶ **www.mt.com/pro_power**

Exceptional Measurement Accuracy
pH Electrode for Low Conductivity Waters

Ensuring the purity of boiler feedwater demands the use of highly capable pH electrodes. pHure Sensor™ LE provides the most accurate pH measurement available for low conductivity waters.

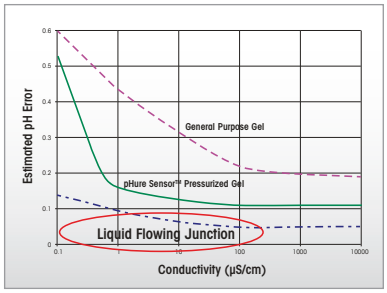
The higher the water purity, the lower is its conductivity. As pH electrodes require some conductance to make measurements, establishing precise pH levels in pure waters requires the use of specialized sensors.

Thornton's pHure Sensor LE has been designed to provide reliable, continuous, on-line pH monitoring in power plant cycle chemistry. The sensor conforms to the requirements of ASTM Standard D5128, Test Method for On-Line pH Measurement of Water of Low Conductivity.

pHure Sensor LE is available with Intelligent Sensor Management (ISM®). This technology offers a number of valuable features including Plug and Measure for fast error-free startup, embedded measurement circuitry for greater signal integrity, and on-board storing of factory and user calibration data.

Find out more at:
▶ **www.mt.com/pHure**

Your benefits



Highest accuracy
Liquid electrolyte provides exceptional measurement precision by maintaining a steady electrolyte flow through the diaphragm.

Fast response - always
Uses a very low volume housing to prevent corrosion product particles from accumulating and slowing response.

Intelligent Sensor Management
ISM provides simple sensor handling, and predictive diagnostics for proactive maintenance.

pHure Sensor LE pH electrode
and housing

Get in-line with METTLER TOLEDO

Water Calculator App
for Mobile Devices

A water calculator application for smart phones and mobile devices enables water specialists to perform water calculations and unit conversions using an iPhone®, iPod touch®, iPad®, or Android™-compatible smart phone or mobile device.

This FREE application calculates:

- Conductivity, resistivity, and total dissolved solids (TDS) conversions
- Flow rate and flow velocities for various pipe sizes
- Temperature versus resistivity and conductivity of ultrapure water
- Sample and process flow rate unit conversions
- Temperature conversion between °C and °F

For more information, visit:

► **www.mt.com/pro-watercalc**

See METTLER TOLEDO Thornton at …

VGB Chemistry in Power Plants Conference	Leipzig, Germany	October 30 – 31, 2013
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