Innovations in Ultrapure Water Instrumentation

THORNTON History
Industries Served
THORNTON Products
Services Offered
THORNTON is the recognized leader in resistivity and conductivity measurements of high purity water. We work closely with international organizations (such as ASTM, USP and SEMI) in establishing their standards. The company, founded in 1964, is based on the research of Dr. Richard D. Thornton, professor of electrical engineering and computer science at the Massachusetts Institute of Technology (MIT). The first products were resistivity meters and titanium concentric cells manufactured for the US Navy.

THORNTON created the in-line resistivity market and is now recognized as the leader for ultrapure water applications and measurement expertise throughout the world. In the semiconductor industry, THORNTON is the leading supplier for ultrapure water resistivity measurements. In the pharmaceutical market, THORNTON is the recognized leading supplier of conductivity instrumentation and sensors to meet the United States, European and Japanese Pharmacopoeia (USP, EP and JP) requirements. THORNTON's innovations in the power industry are generating new concepts for measurement, which incorporate unique temperature compensation technology.

In January 2001, METTLER TOLEDO acquired THORNTON and merged their analytical process businesses, creating a unique partnership between two experts in their relative fields. THORNTON's expertise in conductivity and TOC measurement and innovative instrumentation complements METTLER TOLEDO INGOLD's expertise in pH, dissolved oxygen and turbidity measurements for industrial process control.

By joining forces, THORNTON and METTLER TOLEDO enhanced their capabilities and value through expanded instrumentation and applications solutions; helping to better serve customer needs worldwide in all key process applications. The combined businesses offer customers production centers on four continents and over 250 dedicated sales and service specialists in more than 45 countries (see back cover).
Product & Corporate Capabilities

SEMICONDUCTOR & MICROELECTRONICS PROCESSING:
• Sensitive resistivity measurements in ultrapure water systems
• High purity temperature compensation
• Precision accuracy and repeatability
• Reclaim/Reuse water system measurement
• High purity chemical delivery control
• Dissolved Oxygen measurement
• Online TOC measurement

PHARMACEUTICAL WATER MONITORING:
• Meet or exceed USP <645> and EP 2.2.38
• Accurate, validated, non-temperature compensated conductivity measurements plus the temperature value
• Certified sanitary, stainless steel sensors
• Traceable calibration to ASTM and NIST standards

POWER PLANT CYCLE CHEMISTRY:
• Specialized temperature compensation for cation conductivity and ammonia/amine treated specific conductivity measurements
• Online measurements for makeup water, boiler feed, condensate polishing and stator cooling
• Dissolved Oxygen measurement

WATER & PANEL SYSTEM FABRICATORS:
• Integrated, customized systems providing maximum flexibility
• Versatile software for various configurations
• Technical support provided through all levels of design, implementation, calibration, validation and use

SERVICES:
• Start-up support
• Training seminars and workshops
• Application and field support
• Traceable instrument calibration
• See page 11 for more details

THORNTON Capabilities

The 200CR is often used in Reverse Osmosis systems

Multiparameter 770 Series meters monitor Reverse Osmosis systems for industrial water pre-treatment. This particular system uses RO to pretreat and DI to polish.

THORNTON's 770 Series is often used for bio-pharmaceutical control. Stainless steel sensors prevent contamination.
770MAX Multiparameter Analyzer/Transmitter with Smart Sensor Technology

Features
- 6 channels: multiparameter input of 4 Smart Sensors, including conductivity/resistivity, temperature, flow, pH, ORP, level and pressure, plus 2 pulse flow sensors
- Metric, S.I., and English units for direct measurements; calculated values for % Rejection, % Recovery, difference, sum, ratio and DI capacity. Custom names identify all measurements
- THORNTON’s highest accuracy with lowest limits of detection system for UPW resistivity
- Unique 4-wire resistance measurement technique for highest installed accuracy
- THORNTON’s temperature compensation provides highest accuracy for UPW, cation and ammonia conductivity
- Direct one and two-point sensor calibration
- pH automatic buffer recognition, during calibration
- Compact Size. 1/4 DIN cutout, case only 12 cm deep
- Water resistant panel mount is standard, entire unit sealed with optional back cover
- Panel, wall, pipe mounting options are available
- UL and cUL listed, CE compliant

Benefits
- Display 16 measurements on 4 line screen with auto or manual scrolling
- NIST-traceable automatic meter calibration system
- Smart Sensors retain factory and user calibration data
- Low cost per measurement point, with 6 sensor inputs
- One panel cutout replaces 6 for single function instruments
- One instrument - reduces training and parts

Alarm/Control and Outputs
- 16 Setpoints for high, low, USP and reset (for totalizers) alarms
- 4 SPDT relay option within the 1/4 DIN case with individual hysteresis and time delay (optional)
- 2 Discrete outputs for logic circuits
- 4 powered analog outputs (0/4-20 mA) standard, 8 optional
- RS232 serial output / 2 discrete inputs
200CR Conductivity Resistivity System

Features
- Two channels of conductivity/resistivity/TDS, with temperature, using two-electrode sensors
- Calibration with NIST traceability. Wide rangeability enables high purity sensor calibration in ASTM standard solutions
- Field-selectable, application-specific temperature compensation. Non-compensated measurement also standard to meet USP <645> requirements
- High purity to % concentration ranges from the same model
- 200 foot sensor-to-instrument cable length
- Backlit LCD alphanumeric display
- Two optional powered current outputs plus RS232
- Up to 4 relays with individually selectable parameter, setpoint, hysteresis and delays
- Selectable function security
- Sealed, IP65 enclosure with back cover
- Meets CSA/NRTL and CE requirements, UL listed

Benefits
- Conductivity/Resistivity
- Temperature
- Total Dissolved Solids (ppm/ppb)
- % Rejection
- Difference
- Ratio
- % Chemical Concentration for HCl, H₂SO₄, NaOH

The 200CR is part of the 200 Family of THORNTON products

THORNTON’s 200CR system includes sanitary sensors that withstand steam and/or chemical cleaning

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Conductivity (μS/cm)

<table>
<thead>
<tr>
<th>Conductivity (μS/cm)</th>
<th>0.01</th>
<th>0.1</th>
<th>1</th>
<th>10</th>
<th>100</th>
<th>1k</th>
<th>10k</th>
<th>100k</th>
<th>1M</th>
<th>10M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistivity (ohm-cm)</td>
<td>100M</td>
<td>10M</td>
<td>1M</td>
<td>100k</td>
<td>10k</td>
<td>1k</td>
<td>10k</td>
<td>100k</td>
<td>100k</td>
<td>1M</td>
</tr>
</tbody>
</table>

Application Ranges
- Pure water
- Distilled water
- Drinking water
- Cooling tower water
- Waste water
- Brackish/sea water
- DI Regeneration acids/ bases

200CR Instrument Cell Ranges

0.1/ cm
10/ cm
50/ cm
2000 Two Channel Multiparameter Measurement System

Features
- Two channels for one or two measurement parameters
- Calibration with NIST and ASTM traceability
- Dual parameter display with back-lit LCD
- Plain text menus - no codes to memorize
- Two 4-20 mA analog outputs plus RS232
- Four alarm setpoints freely assignable to 2 or 4 relays
- Accurate, selectable, application-specific temperature compensation modes plus non-compensated measurement to meet USP <645> conductivity requirements
- Direct % concentration readout for NaOH, HCl and H₂SO₄
- Dissolved Oxygen readout to low ppb levels
- Plug-in connectors for convenient wiring
- Enclosure suitable for sealed panel mounting; back cover available for wall or pipe mounting - both rated IP65
- UL and cUL listed, CE compliant
- Selectable security levels

Benefits
- Single instrument model for broad choice of measurements
- Wide conductivity/resistivity rangeability enables sensor calibration in ASTM standard solutions even for high purity applications
- Unique dissolved oxygen sensor provides extremely low-maintenance and long life
- Variety of pH/ORP preamp connections enable wide choice of sensors

THORNTON's 2000 system requires no probe maintenance for several years.

The 2000 can be used with detachable pH sensors, offering more flexibility and lower costs for electrode replacement.
200pH & ORP System

Features

- Two channels, allowing two measurements of pH plus temperature, and/or ORP (Oxidation-Reduction/Redox Potential)
- Combination sensors include measuring and reference electrodes plus RTD for temperature compensation of pH with:
  - Dual threads for insertion or submersion mounting
  - Flat membrane to resist fouling
  - No-maintenance, double-junction reference electrode
  - Stainless steel flow-through design for high purity water
- Preamp accessories accept virtually any pH electrode with VP, BNC or K9 connection
- Conventional electrode temperature compensation plus adjustable solution temperature compensation for high purity water ionization effects
- 200 foot sensor-to-instrument cable length
- Backlit LCD alphanumeric display
- Two optional powered current outputs plus RS232
- Up to 4 relays with individually selectable parameter, setpoint, hysteresis and delay
- Selectable function security
- Optional Sealed, IP65 enclosure and connectors
- Meets CSA/NRTL and CE requirements, UL listed.

Benefits

- Single instrument for pure water, industrial process and wastewater measurements with appropriate sensors
- Low cost per measurement point
- Rapid startup with pre-calibrated, low maintenance sensors
- Complimentary to 200 Series Conductivity, Resistivity and Flow instrumentation

200pH Sensors

Process pH and ORP sensors are designed for easy mounting with dual NPT threaded ends for in-line, submersion, or, with a pipe tee, flow through mounting. The flat surface and sealed double junction reference electrode greatly reduce maintenance.

The high purity pH sensor provides a sealed flow chamber to prevent carbon dioxide contamination from the air. Stainless steel construction shields the electrode and eliminates flow sensitivity. A combination pH sensor with reservoir-fed, flowing junction reference electrode gives stable performance in high purity water and buffer solutions.
200FLOW 4-Channel Measurement System

Features
- Four inputs from any combination of paddle wheel, vortex, turbine, or other pulse output flow sensors
- Total flow, difference and/or % recovery computations
- Up to four relays with individually selectable setpoint(s), hysteresis and delay
- Batch control capabilities
- Two optional, powered 0/4-20 mA output circuits can be time-shared to give four measurement values
- RS232 or RS422 digital outputs are standard to transmit up to eight flow, total flow, and % recovery values.
- Sealed, IP65 enclosure with back cover
- Meets CSA/NRTL and CE requirements, UL listed.

Benefits
- Lowest cost per measurement point
- Simplified batch control with multi-stages in a single instrument
- Easy start up and operation with text-based menus
- Compatibility with existing sensors
- Complementary to 200 Series conductivity, resistivity, pH and ORP instrumentation

Virtually all pure water and chemical flow applications can be handled more efficiently with THORNTON's 200FLOW.

The 200FLOW can be used in conjunction with a variety of sensors such as the flat paddlewheel flow sensor (above) and the insertion vortex sensor (right).
502P Total Organic Carbon Analyzer

Features
• Continuous 15-second analysis with 2-second display updates
• Display TOC, Conductivity (compensated or uncompensated) and Temperature simultaneously
• 4-20 mA analog output for TOC, Conductivity or Temperature
• RS232 digital output for TOC, Conductivity (compensated or uncompensated) and Temperature
• Two high/low setpoint alarms
• UV Lamp alarm and diagnostics
• Stored history of last 255 data points taken
• Password lockout of maintenance menus

Benefits
• Real-time continuous monitoring
• No time-consuming batch measurements
• Obtain real data as it happens and react with alarms when necessary
• Wide dynamic operating range of 0.05 MΩ-cm to 18.2 MΩ-cm
• Point-of-use or portable monitoring
• Low maintenance: no gases or reagents to handle, store or replace. No membranes or moving parts.
• Easy access to UV Lamp with diagnostics and lamp expiration alarm
• Small, flexible, versatile: use as an on-line monitor or to profile TOC, Conductivity & Temperature throughout the system
7100 Inductive Conductivity System

Features
- Continuous sensor diagnostics
- Instrument self-monitoring
- Simple calibration
- 0/4 to 20 mA current output
- 4 alarm relays
- UL/CSA and CE

Benefits
- Offers wide measuring range 0-2000 mS/cm
- Ease of use with simultaneous readings
- SensoCheck® and GainCheck® monitor system for any disruptions
- Quick connection and start-up with plug-in connectors
- Choice of sensors

Sensor Features
- Non-fouling insertion or submersion mounted sensors
- No wetted metal parts
- Chemically resistant PEEK or polypropylene
- High-temperatures to 200 °C (392 °F)
- Wide measuring range to 2000 mS/cm
- Unaffected by severe fouling
- Simple installation of sensors and accessories
- Robust sensor design for maintenance-free operation
- Integrated temperature probe for direct temperature compensation

These sensors can withstand high-temperatures to 200 °C (392 °F)
On-Site Instrument Operation & Calibration Training Workshops
THORNTON's Operator Training Courses are tailored to each customer's requirements. The course is conducted in a classroom setting where interaction between instructor and participants is encouraged. Each attendee is supplied with a binder of material detailing the course content and instruments are available for hands-on participation. The areas covered in this training program focus on THORNTON instrumentation, calibration, and maintenance specific to your facility. Additional topics may be added or substituted per customer request.

Traceable Instrument Calibration
THORNTON offers instrument calibration traceable to national standards. Calibrations are available at our facilities in Waltham, Massachusetts, or to minimize down time, calibrations may be performed at your facility. Each calibrated instrument is supplied with a Certificate of Calibration that provides “as found” and “as left” data that enables the operator to track instrument performance. Instruments returned to THORNTON are upgraded to latest revisions of hardware and software at no additional cost to the customer.

Specialized Conductivity Calibrations
Choose one of seven unique conductivity calibrations to fit your application needs. Choose from standard calibrations to unique, customer-specified temperature and ASTM verification points. System calibrations are also available where the instrument and sensors are calibrated as a single unit, optimizing system accuracy.

Service & Calibration Contracts
THORNTON will travel to the Customer's site for those items covered under this agreement, and will provide labor and travel time for the on-site service. Service shall include, but is not limited to:
• Calibration/Verification of equipment listed in the contract
• Issuance of a “Certificate of Calibration” for each instrument listed in the contract
• Placement of Calibration Stickers on each instrument listed on the contract
• Verification of instrument performance
• Identification and verification of all software revisions
• Minor repairs and/or adjustment of instruments at a discounted labor rate

THORNTON offers custom training, which means that you’ll never spend time learning material you won’t use.

We’ll come to you for instrument calibration, minimizing application down-time and maximizing productivity.
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