Quantum NXT

Water & Energy Savings with Stop Flow & Recirculation Technology
For over 40 years, Trebor has served high purity markets with a focus on customers, relationships, and product innovation. Our customer is our priority.

We manufacture high purity quartz heaters for deionized water and chemical applications, in addition to high purity, non-corrosive plastic pumps for chemical applications. Our products can be used in multiple industries that require purity, process control, high temperatures, and small equipment footprints.
Quantum NXT DI Water Heater

The Trebor Advantage

- Heating technology
- Patented Thin-film on Quartz technology
- No O-ring seals
- Models available in 20kW up to 288kW
- Exceptional temperature control
- Industry leading responsiveness
- Temperature control +/- 0.3 degrees
- Low thermal mass element provides agile performance
- Lower Cost of Ownership
- No consumable lamps
- No heated DI water waste
- Virtually maintenance free
- Element lifespan > 44,000hrs
- Efficient water usage
- No minimum flow requirements
- Global support network
The Trebor Difference

Thin Film Technology

- **VERTICAL ORIENTATION**
  - eliminates dead legs and overheating of residual liquid

- **THIN FILM RESISTIVE MEDIA ON QUARTZ ELEMENT**
  - Places the heat in close proximity to the fluid for faster response.

- **QUARTZ ELEMENT**
  - No IR bulbs to replace & no coils to cause pressure drop

Sealing Technology

- **NO O-RINGS IN FLUID PATH**
  - eliminates risk of process contamination

- **LOW THERMAL MASS**
  - allows fast ramp to temperature; high heating efficiency of >98%

- **SEALING**
  - Capable of handling thermal shock and thermal cycling without leaks or breaks

- **ELEMENT THICKNESS**
  - Average Element thickness is 7 micron. Quartz thickness is 1.5mm.
The Trebor Difference

In this example, the Quantum NXT reaches >90% of a 70°C process temperature in ~30 seconds with water flowing at 22 lpm. Minimal variation is provided in ~90 seconds. Temperature is measured at the element output, internal to the heater.

The industry leading response time from our thin film element allows a process with large flow changes to be tractable. Temperature measurements are taken at the element outlet. Downstream measurements show increased temperature stability.
Stop Flow Functionality

Quantum NXT Thin Film on Quartz Technology enhances process control

For a more demanding example, a 72kW QNXT heater was used to heat 12 lpm water from ~23°C to 95°C. Temperature ramps to within 10% of setpoint in less than 40 seconds. In less than 100 seconds the QNXT achieves the 95°C setpoint and has minimal variation. Stop flow functionality is shown in the center of the chart with flow going from 12 lpm to 0 lpm. When flow is shut off the temperature rises less than 5°C and slowly dissipates the residual energy. When flow is restored after 3 minutes of idle time, the temperature is already at setpoint and it takes less than 70 seconds to obtain minimal variation.
Stop Flow Technology

When to Use Stop Flow

- To eliminate the need for water to be sent to drain/waste/reclaim to account for slow heater response
- To eliminate the need to ramp to temperature from ambient
- If the process requires high overall equipment effectiveness
- Single wafer cleaning tools with multiple chambers
- Tank fill applications
Stop flow vs Continuous flow

Assuming a tool requiring 6 lpm is continuously running at 80% OEE (Overall Equipment Effectiveness), the heater would be idle 72% of the time. In this scenario, water savings would be approximately 2.2 million liters annually per tool with the Quantum NXT.

For certain applications and due to the performance of the heater being used, it may be necessary to run the heater continuously at the desired flow or above the desired flow for multi-chamber systems and divert the water from the process to drain and back again to maintain process control. This chart illustrates the difference that wet process engineers can expect to observe between a continuously running heater and the Quantum NXT in a typical RCA cleaning process.

Considering the Cost:
- 2.2 million liters wasted annually
- Cost of wasted UPW ~ $8k annually
- Cost of wasted energy ~ $22k annually
- Equivalent to 10 average American households
**Environmental Impact - Water & Electricity**

- **WHY:**
  - Limited availability of clean water is one of our greatest global challenges.
  - Water is a precious life-giving resource for our planet.
  - Industry Environmental Requirements continue to increase, 100% Water restoration/Reclamation.
  - Cost of water and water reclamation continue to increase.

**SEMICONDUCTOR Challenges:**

- Water is still one of the best/cleanest solvents.
- Water needed per unit of production continues to increase as requirements for product purity continue to rise.
- Industry push for Larger Wafers 300MM and Greater.
- Reduced Process Nodes < 5 NM.
Recirculation Technology

When to Use Recirculation

- To eliminate wasted water on start-up
- To eliminate the need for water to be sent to drain/waste/reclaim to account for slow heater response
- If the process requires high overall equipment effectiveness
- Single wafer cleaning tools with multiple chambers
- When the process requires continuous flow for maximized filtration
Recirculation Heater Performance

This chart was created to show the normal running conditions for a recirculating Quantum NXT system.

1. Recirculation only. Flow rate is increased to full dispense flow (four chambers open) and temperature is allowed to stabilize
2. Normal running cycle is 1 valve / 1 chamber opening and closing continuously during production
3. Transitioning from full dispense flow back to recirculation only

Similar or better performance can be expected when more chambers are opened sequentially up to full dispense of 48LPM
Pure Innovation

Inlet Filtration

Outlet Filtration

Designed to address the bad actors

Designed to address the bad actors that increase in volume as temperature increases
Conclusion

• Industry Leading Response Time – Trebor heaters provide the fastest response time in Semiconductor UPW heating applications. This includes temperature maintenance in the event of a flow change and fast response during initial ramp periods.

• No Minimum Flow Requirement – No need to continuously flow water to drain.

• Stop Flow & Recirculation – Trebor heaters allow fabs to eliminate their dependence on heated UPW loops to support the rinse steps in their wet process applications.

• Low Cost of Ownership – Rapid responding elements ensure that waste water can be eliminated. Heating elements are greater than 98% efficient. No purge air required.

• Virtually Maintenance Free – Trebor Heaters do not require any scheduled maintenance. Heating elements are replaced as needed and these can be acquired from local distribution.

• Signature Service/Global Support – Customer Satisfaction is what we strive for at Trebor. We are committed to maintaining collaborative, long term relationships with our customers.
Thank you
### Stop Flow - Environmental Impact

#### Heated Water Cost Calculator

<table>
<thead>
<tr>
<th>Cost of Wasted Water</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of UPWater per 1000 Liters</td>
<td>$3.83/m³</td>
</tr>
<tr>
<td>Required Flow Rate per minute</td>
<td>6 liter</td>
</tr>
<tr>
<td>Idle Time in percent</td>
<td>65%</td>
</tr>
<tr>
<td>Loss of Water per Day</td>
<td>5,616 liter</td>
</tr>
<tr>
<td>Loss of Water per Year</td>
<td>2,049,840 liter</td>
</tr>
<tr>
<td>Cost of Lost Water Annually</td>
<td>$7,850.89</td>
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</tbody>
</table>

#### Environmental Waste

<table>
<thead>
<tr>
<th># of Heaters</th>
<th>Total Cost Annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$22,199.77</td>
</tr>
</tbody>
</table>

- **6 liters**
- **65%**
- **5,616 liters**
- **2,049,840 liters**

- **2.0 million liters wasted annually**