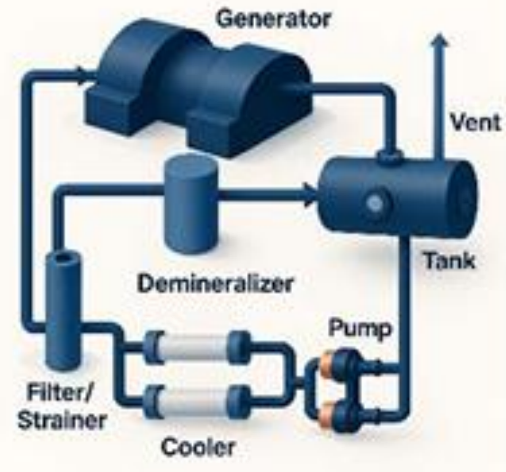
Waltron | EXPERTS IN WATER CHEMISTRY SINCE 1903

Troubleshooting Stator Coolant Chemistry Issues to Avoid Potential Failures

April 2026

Stator Coolant Chemistry

- **System Design:** Water-cooled generator stators utilize hollow conductors (copper or stainless steel) to remove excess heat during energy conversion.
- **Critical Risk:** In copper-bearing units, improper chemistry leads to corrosion/oxidation, resulting in oxide "plugging" of conductors.
- **Consequence:** Reduction in cooling flow leads to rapid overheating and potential catastrophic generator failure.



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Key Related Technical Publication

- IAPWS TGD - Chemistry Management in Generator Water Cooling during Operation and Shutdown – free to download

- Https://iapws.org/documents/techguide/Generator

Key Related Technical Publication

IAPWS TGD10-19

The International Association for the Properties of Water and Steam

Banff, Canada
October 2019

Technical Guidance Document:
Chemistry Management in Generator Water Cooling
during Operation and Shutdown

Please cite as: International Association for the Properties of Water and Steam, IAPWS TGD10-19, *Technical Guidance Document: Chemistry Management in Generator Water Cooling during Operation and Shutdown.*

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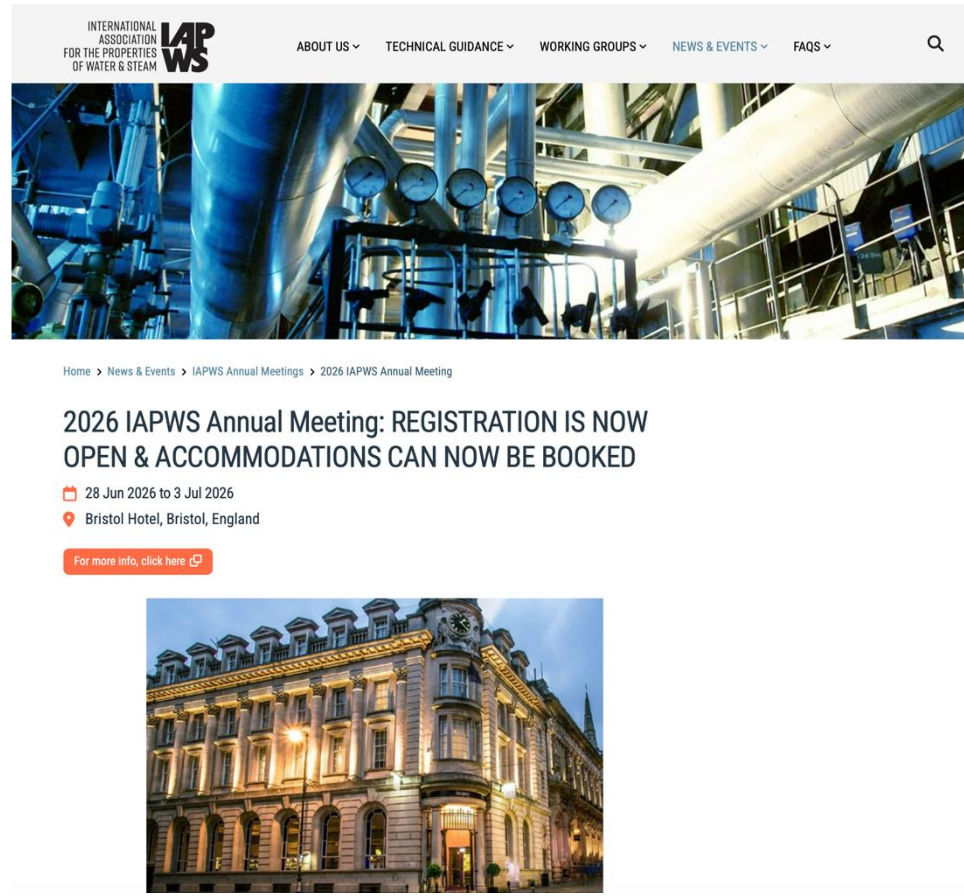
IAPWS Annual Meeting – June 2026

- IAPWS Power Cycle Chemistry Group open to anyone
- Contact IAPWS PCC Chair – David Addison david.addison@thermalchemistry.com for any questions
- Upcoming IAPWS PCC webinar on steam purity – 31st March – Barry Dooley and Bobby Svoboda
- https://iapws.org/news-and-events/webinars/steam-turbine-ptz-damage-failure-and-steam-purity-requirements-webinar
- Next PCC webinar likely to be on Stator Coolant chemistry with Bobby Svoboda – Date TBC – following the IAPWS PCC LinkedIn Page



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Thermodynamics of Copper Oxidation

- **Passivation Goal:** Formation of a stable copper oxide layer on internal water-contacted surfaces.
- **Dual-Stable States:**
  - **Low Dissolved Oxygen (DO) (< 20ppb):** Cuprous oxide (Cu_2O) is the dominant stable phase.
  - **High DO (> 2000 ppb):** Cupric oxide (CuO) is the dominant stable phase.
- **Operational Zones:** Manufacturers specify one of four regimes (Low/High Oxygen cross-referenced with Neutral/Alkaline pH).

The "Dangerous Middle": Oxide Destabilization

- **Phase Transition Risks:** Moving between oxygen regimes forces oxides to change state.
- **Mechanism of Failure:**
  - Unwanted release of surface copper oxides.
  - Transport and redeposition within narrow conductor flow paths.
- **Critical Range:** The 'in-between' zone of **100 to 2000 ppb** oxygen prevents a stable protective layer from forming.

Case Study: 250 MW Coal-Fired Unit Analysis

- **Profile:** 1980s commissioned unit; copper-containing stator.
- **Design Basis:** Low-oxygen, neutral pH regime.
- **Incident Trigger:** Repeated drain/refill cycles during return to service after major outage and small air leak from pump seal
- **Observed Data:** Frequent blockage of specialized stator coolant filters due to Copper Oxide transport. Concerns with condition of the stator

Limitations of Amperometric (Clark Cell) Sensors

- **Interference Mechanism:** Entrained hydrogen gas in the coolant diffuses through the sensor membrane.
- **Electrochemical Failure:** H_2 interferes with the electrochemical reaction, causing significant drift or total signal loss.
- **Maintenance Burden:** High frequency of membrane and electrolyte replacement in hydrogen-rich environments.

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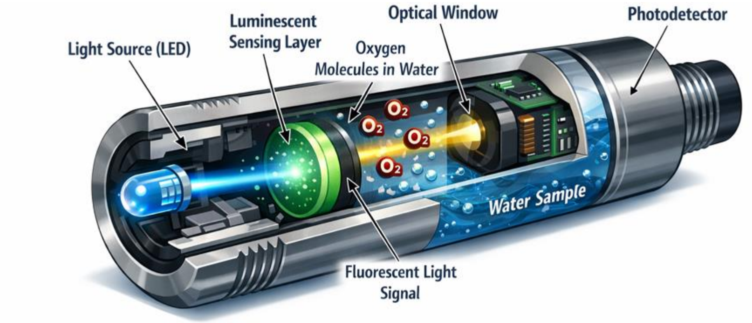
Methodology: Luminescent DO (LDO) Technology

- **Principle:** Dynamic Luminescence Quenching.
- **Process:**
  - A blue LED excites a luminophore (dye) on the sensor.
  - The dye emits red light (fluorescence).
  - O_2 molecules collide with the dye and "quench" the fluorescence.
- **Measurement:** The phase-shift / decay time is inversely proportional to the oxygen concentration.



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Technical Advantages of Optical Sensing

- **H_2 Immunity:** Optical measurement is completely unaffected by dissolved hydrogen.
- **Flow Independence:** Unlike amperometric probes, LDO does not consume oxygen and is not impacted by sample flow rates.
- **Durability:** Sensor spots typically last up to four years.
- **Stability:** Zero drift ensures measurements remain accurate in the low ppb range.

Implementation and Real-Time Diagnosis

- **Deployment:** Waltron 9165 LDO Analyzer installed for rapid troubleshooting.
- **Confirmed Chemistry:** Measured DO was discovered at **100–2000 ppb**—the unstable transition zone.
- **Trend Analysis:** On-screen reporting allowed operators to correlate filter changes with further oxygen ingress.

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Corrective Action: Nitrogen Sparging

- **Procedure:** Offline nitrogen sparging initiated to strip excess O_2.
- **Feedback Loop:** LDO Analyzer provided instant feedback on sparge efficiency.
- **Results:**
  - Re-established low-oxygen, neutral pH design basis within hours.
  - Chemistry stabilized, halting the formation of transportable CuO.

Conclusion & Maintenance Roadmap

- **Vigilant Monitoring:** Luminescent technology provides a proactive mitigation strategy where galvanic sensors fail.
- **Trustworthy Data:** Eliminates the "blind spot" in hydrogen-rich stator cooling loops.
  - **Next Steps:** Evaluate the need for chemical cleaning to remove legacy oxide deposits and assess current conductor bar risk. Trouble shooting underway to find source of low level air ingress – LDO analyser critical for this

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