

Monitoring Antifreeze Concentration in Data Center

Monitoring Antifreeze Concentration in Data Center Cooling Systems

Data centers are fundamental to the uninterrupted operation of digital infrastructure. As AI, high-performance computing (HPC), and dense server configurations increase rack power and heat density, cooling has become a critical part of infrastructure reliability, performance, and operating efficiency.

Liquid Cooling for High-Density Computing

Traditional air cooling is increasingly challenged by high and sustained heat loads. Direct liquid cooling (DLC), including direct-to-chip cold-plate systems, transfers heat from processors to a circulating coolant. Coolant flows through small channels close to the heat-generating components, where fluid quality and stable thermal-hydraulic properties are essential.

Data Center Cooling Zones

Inside a data center, infrastructure can be viewed in three functional zones:

White space: where the compute lives: servers, storage, networking, AI accelerators, rack-level power distribution, in-row cooling and CDUs.

Grey space: where support systems run: chillers, pumps, heat exchangers, UPS systems, switchgear and building-management infrastructure.

Black/outdoor space: where the grid meets the campus: utility interconnection, transformers, generators, fuel systems and outdoor heat-rejection equipment.

The white space is the most thermally critical zone. Heat generated is transferred through CDUs to the facility cooling system in the grey space and ultimately rejected to the outdoor environment. Each loop has different requirements, but concentration control is relevant wherever a glycol/water mixture is used.

Why Propylene Glycol?

A water/propylene glycol (PG) blend combines useful heat-transfer capability with freeze protection and, when correctly inhibited, corrosion protection for mixed-metal systems. PG also contributes to suppressing microbial growth and maintaining the biological stability of the cooling loop.

Cold plates contain extremely narrow microchannels. Microbial growth and resulting biofilm formation can restrict coolant flow, impair heat transfer, and, in severe cases, obstruct individual cooling passages. Compared with ethylene glycol, propylene glycol offers a lower-toxicity profile, which is an important consideration in occupied technical areas and near sensitive IT equipment.

PG in Data Center Cooling Loops

A typical PG heat-transfer fluid contains approximately 25% propylene glycol blended with high-purity water and a suitable inhibitor package. Water performs most of the thermal work, while glycol lowers the freezing point and supports biological control. Increasing glycol concentration can provide a larger freeze margin, but it also increases viscosity and reduces specific heat. Over-concentration therefore raises hydraulic resistance and pumping energy and can reduce heat-exchanger effectiveness. Too little glycol, on the other hand, can reduce freeze and biological protection. The correct concentration is therefore a performance parameter, not simply a fluid specification.

Refractive Index as Process Analytical Tool (PAT)

The refractive index (RI) of a propylene glycol/water mixture changes systematically with composition. After establishing an application-specific concentration curve, refractive-index measurement can be used for continuous determination of PG concentration. Because refractive index is temperature-dependent, the measured RI and fluid temperature are evaluated together to calculate concentration. An inline process refractometer measures directly in the circulating coolant and continuously converts the optical signal and the measured temperature into a concentration value. This provides fast detection of dilution, concentration drift, incorrect top-up, or other deviations without relying solely on manual sampling. Continuous concentration monitoring is especially valuable in CDU circuits. Cold plates and manifolds contain narrow passages and microchannels; stable coolant composition helps maintain predictable flow, heat transfer, corrosion protection, and biological stability. If evaporation or water loss changes the mixture, the concentration value provides a direct basis for corrective make-up.

Solution from SCHMIDT + HAENSCH

For continuous monitoring of glycol-based cooling fluids in data centers, SCHMIDT + HAENSCH offers the iCS² PG inline concentration sensor for propylene glycol. Installed directly in the cooling circuit, the compact inline refractometer continuously measures the propylene glycol concentration, providing operators and control systems with real-time information without the need for manual sampling. In the white space, the instrument can monitor individual CDU circuits serving high-density racks and direct-to-chip cold plates. In grey-space facility loops, it can verify that glycol concentration remains within the specified operating range for freeze, corrosion and biological protection. Outdoor or heat-rejection loops can likewise be monitored where glycol is required for low-temperature protection. Its robust optical measurement technology ensures reliable measurements under demanding process conditions. Maintenance-free operation further reduces operational effort. Via its Modbus RTU interface, the sensor can be quickly integrated into existing process control systems. Deviations from the specified target concentration can be detected immediately, allowing the glycol-water mixture to be adjusted accordingly.



iCS²
Inline Concentration Sensor

Product type	Product
Process Refractometer	iCS ² PG Inline Concentration Sensor with propylene glycol scale
Process Refractometer	iCS ² EG Inline Concentration Sensor with ethylene glycol scale
Accessories	T-Piece Housing with ½" NPT connection
Accessories	VARIVENT Adapter for VARINLINE® housings
Accessories	VARINLINE® housings (several ends and diameters)

Advantages

- Continuous, real-time PG concentration monitoring
- Fast detection of dilution and concentration drift
- Temperature-compensated RI measurement
- Reduced manual sampling and laboratory analysis
- Supports optimized pumping and heat-transfer efficiency
- Supports freeze, corrosion and biological protection strategy
- Direct integration into plant and data-center control systems
- No moving measuring components
- Robust optical measurement principle
- Improved coolant consistency and system reliability

Typical industries

- AI and HPC data centers
- Direct-to-chip liquid cooling
- Coolant Distribution Units (CDUs)
- Heat-rejection and free-cooling systems