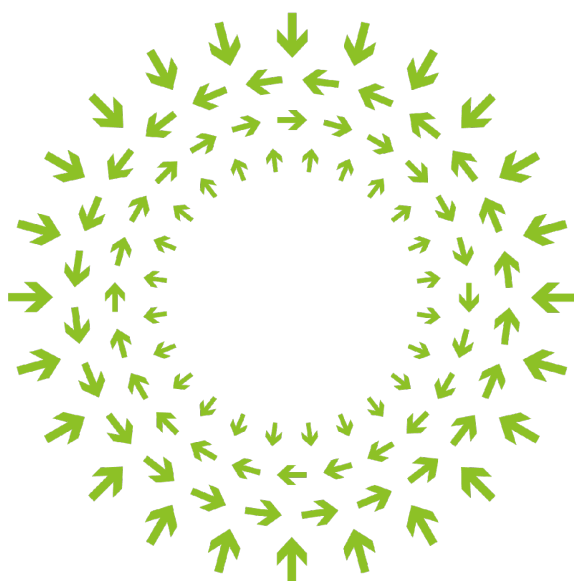




OPEN

Compute Project

<Cooling Environment – Cold Plate Workstream>

Base Specification for Single Phase Water-Based Cold Plate Coolants

Version 1.3

Base Specification

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Version History

Note, refer to the OCP Contribution Versions, Revisions and Errata best practices documentation. Generally speaking, versions and revisions are made to this document and logged here. Errata is a separate document such that the contribution specification document it refers to was not revised. Ex: Version 1, Errata E1

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1. License

1.1. Open Web Foundation (OWF) CLA

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1.2. Acknowledgements

The Contributors of this Specification would like to acknowledge the following companies for their feedback:

Matt Hatley (Fluid2Chip), Richard Tribble (ChemTreat), Michael Coffin (Individual), Senne Degroote (Arteco Coolant), Sean Sivapalan (NVIDIA), Gerald Singer (PFX Group), Dolly Batra (Ecolab), and Florian Rüping (Castrol).

2. Compliance with OCP Tenets

This Specification is intended to be openly shared with the OCP community, following the open-source ethos of the project. It is designed to be compatible with existing OCP hardware and interfaces, ensuring interoperability and encouraging broad adoption. By providing open guidelines, the document enables manufacturers, integrators, and operators to implement and adapt the solution to their specific needs, in line with OCP's principle of openness.

2.1. Openness

This fluid specification was developed in collaboration with industry experts both within and externally to OCP. The cold plate Coolant Liquids community will continue to build and evolve this specification as needed. Since this specification does not specify all the fluid parameters, but the Figure of Merits (FOMs), it leaves room for the fluid suppliers to innovate to develop more efficient and sustainable coolant fluids.

2.2. Efficiency

Water-based coolant is an efficient cooling solution for the overall Liquid-Cooled Racked systems. It provides better heat transfer than air-cooled technology. This results in significant improvement of efficiency and a lower power usage effectiveness (PUE) value compared to air.

2.3. Impact

This is the first water-based coolant specification generated for cooling of both current and future IT equipment. This document will provide a base for future discussion, and FOMs may be added and defined as needed to help guide fluid selection appropriate for cold plate cooling.

2.4. Scale

Design your contribution for easy implementation and deployment at any scale, with minimal intervention. Aim to create additive solutions where minimal usage or instances can be deployed and incrementally scaled as needed to effectively address the entire problem. Provide all necessary tools and supporting documentation, such as installation guides, initialization processes, configuration information, and details on obtaining service support. Include features like simple manual and automated maintenance, remote management, upgradability, and error reporting. Management tools should be open-sourced and/or made available to adopters.

2.5. Sustainability

The fluid specification allows water-based coolant technology adoption and streamlines the supply chain. There are many water-based coolant choices in the industry today. This document creates a general guideline on treated water supply chain, which allows easy adoption of water-based liquid cooling solutions.

3. Scope

This specification defines the technical details on the use of water-based coolants for single-phase cold plate cooling systems within the OCP ecosystem. Any supplier seeks OCP recognition for a hardware product based on this specification must be 100% compliant with any features or requirements described in this document.

4. Overview

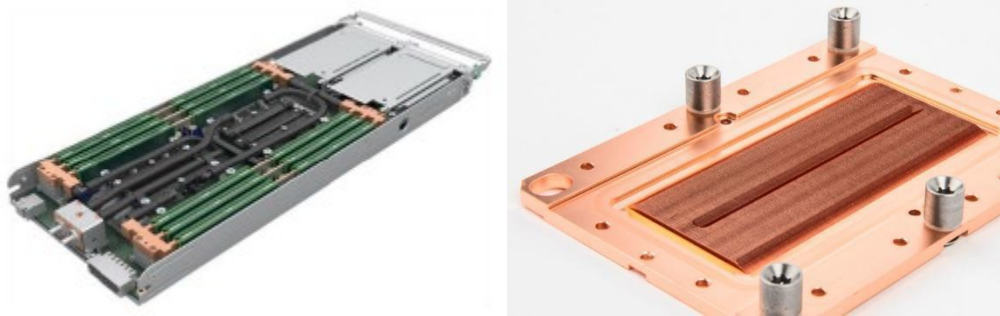
Single-phase cold plate-based cooling with water-based coolants

There are multiple options for liquid cooling of IT racks, including options for heat transfer fluid. For example, there are water-based and glycol-based heat transfer fluids. The owner and design team will need to assess the specific needs of the project to determine the suitable coolant for liquid cooling. The water-based coolant provides a slight advantage on overall heat rejection in liquid-cooled computer racks.

Standardizing water-based coolant

This specification is to list a basic composition for the operation of liquid-cooled computer racks using a water-based heat transfer fluid.

Figure 1. Example of a single-phase cold plate that can be cooled with either water-based or propylene glycol-based coolant liquid.



5. Base Specifications

5.1. Description

There are some key metrics that have to be specified for the liquid that meet the requirement for:

- Thermal performance
- Material compatibility & reliability, maintenance, and serviceability
- Corrosion protection for the cold plate metallurgy
- Environmental Impact

5.2. Goals and Vision

The goals of this specification are:

- To standardize the use of water-based coolant in cold plate-based thermal management solutions across the OCP ecosystem.
- To ensure cross-vendor interoperability and component compatibility for easy system integration.
- To enable safe, low-maintenance cooling solutions for high-performance compute servers and data centers.
- To reduce total cost of ownership (TCO) by extending component life and asset protection with improved energy efficiency.

5.3. Functional Requirements

This specification lists the key functions of water-based heat transfer liquids shall provide cooling between the secondary or closed loop between the Coolant Distribution Unit (CDU) and the cold plates within the racks/servers. This loop is designated as the Technology Cooling System (TCS) by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

The coolant must contain:

- Water-based solution that is compatible with all the wetted materials used in datacenter TCS loop
- Corrosion inhibitor for copper corrosion protection
- If there is aluminum used in the wetted materials, additional corrosion inhibitors are needed to protect aluminum and eliminate galvanic corrosion between copper and aluminum.
- Possible pH buffering to maintain the coolant pH at the range of 8.0 to 10.5
- Purified water with low conductivity, low total dissolved solids (TDS) low hardness, and low turbidity to reduce fouling potential

- Preservative to ensure no detectable bacteria (< 1 CFU/ml) to eliminate biofouling risk

5.3.1. Environmental Regulatory Compliance and Requirements

All chemicals formulated in the water-based coolant need to be in full compliance with local municipal water discharge regulations in case the coolant needs to be disposed into the sewer.

5.4. Features

The water-based coolant is a clear liquid solution with no visible floc or discoloration.

5.4.1. Total Suspended Solids (TSS) < 5 ppm

Normally the coolant should not have any TSS or visible solids.

5.4.2. Total Dissolved Solids (TDS) < 2,000 ppm

The TDS is mainly contributed by water treatment chemistry (e.g., azoles) or buffering chemicals.

5.4.3. Conductivity < 2,000 μ S/cm

Related to TDS. This is the baseline in the shipment container prior to its filling to CDU. This is not a critical parameter, but it is very easy to measure to provide information on possible contamination. It is a temperature-dependent measurement.

5.4.4. pH 8.0 ~ 10.5

Normal range for most treated water products.

5.4.5. Total Hardness (total Ca/Mg as CaCO_3) < 30 ppm

A deionized or reverse osmosis (RO) is recommended as the makeup water source to blend in corrosion inhibitors. Any hardness in the solution will be a risk for scale particles precipitate inside the microchannel of the cold plate or within the quick disconnects (QDs).

5.4.6. Turbidity < 5 Nephelometric Turbidity Unit (NTU)

Turbidity is the measure of particles in a fluid that affect the clarity of water. The fresh unused coolant should be clean with no visible discoloration or opacity. The coolant should not have any TSS or visible solids.

5.4.7. Total Viable Count (TVC) in bacteria < 1 CFU/ml

ASTM Type IV grade of reagent water with no detectable bacteria present. Use test methods for detection down to 1 CFU/ml or better. The TVC is usually determined with Petri dish with R2A agar or Petrifilm® to determine the bacteria growth potential.

5.4.8. Corrosion byproducts/ions; Cu < 0.2 ppm, Fe < 0.1 ppm and Al < 0.1 ppm

Baseline of residual metal ion levels using Inductively Coupled Plasma (ICP) Lab test for soluble ions (iron, copper and aluminum) should be run. Increases above these baseline levels indicate active corrosion in the system. Typical baseline levels are less than 0.1 ppm but may be higher due to biocide/preservative addition to the fluid.

5.5. Performance Requirements

The fluid must contain suitable additives to provide corrosion protection to metallurgy used in the TCS loop. Fluid should meet with exceed the following corrosion rates determined by following ASTM D8040 (fluid as-is with corrosion salts added, 88 ± 2 °C and aeration rate of 100 ± 10 mL/min for two weeks):

- Copper < 0.1 mpy
- Brass < 0.1 mpy
- Stainless steel < 0.1 mpy
- Aluminum < 0.1 mpy (if applicable. However, the combination of aluminum and copper are known to cause galvanic corrosion issues)

A common formula for calculating corrosion rate in mpy is: $\text{mpy} = (\text{weight loss in grams} * 22,300) / (\text{area in sq. in.} * \text{density in g/cm}^3 * \text{time in days})$.

The fluid should be free of any microbial contamination (< 1 CFU/ml in total viable aerobic bacteria count) to cause any biofouling concern in the TCS Loop. The total viable count in CFU/ml can be determined with a petri dish of R2A agar medium or 3M Petrifilm®.

The fluid should be compatible with approved wetted materials and metal alloys as OCP listed on Table 2 of Guidelines for Using Water-Based Transfer Fluids in Single-Phase Cold Plate-Based Liquid-Cooled Rack published in 2022 [1].

5.6. Constraints

All fluids should have individual SDS that lists components in compliance with local laws and regulations.

Disposal of the fluid in accordance with local, regional and federal laws.

Be aware of azole residual while discharged to the sewer with dilution considered.

5.7. Test and Validation Requirements

A Certificate of Analysis (COA) must accompany every shipment of water-based coolant and to be made readily accessible to the customer upon delivery. The COA serves as a critical quality assurance document, verifying that the product meets the required specifications for performance and consistency.

Additional data may be included to support transparency and traceability, such as batch number, production date, and results of other QC-related testing. The COA ensures that end users can confidently validate product quality and compatibility with their systems, in alignment with OCP Inspired standards.

5.8. Prescribed Materials

Please refer to the Wetted Materials list on Table 3 of OCP Guideline published in 2022 for prescribed materials. <https://www.opencompute.org/documents/guidelines-for-using-water-based-transfer-fluids-in-single-phase-cold-plate-based-liquid-cooled-racks-final-pdf>

5.9. References

[1] “Guidelines for Using Water-Based Transfer Fluids in Single-Phase Cold Plate-Based Liquid-Cooled Racks”, 2022, OCP whitepaper.

<https://www.opencompute.org/documents/guidelines-for-using-water-based-transfer-fluids-in-single-phase-cold-plate-based-liquid-cooled-racks-final-pdf>

[2] ASTM D1125-23, Standard Test Methods for Electrical Conductivity and Resistivity of Water, ASTM International, West Conshohocken, PA, 2023.

<https://www.astm.org/d1125-23.html>

[3] ASTM D5465-25, Standard Practices for Determining Microbial Colony Counts from Waters Analyzed by Plating Methods, ASTM International, West Conshohocken, PA, 2025. <https://www.astm.org/d5465-25.html>

[4] ASTM D8040-18, Standard Test Method for Corrosion Test for Heat Transfer Fluids in Glassware ASTM International, West Conshohocken, PA, 2023.
<https://www.astm.org/d8040-18.html>