Direct-to-Chip Liquid Cooling Treatment Helps DOE National Laboratory Improve System Performance

1. Introduction

National laboratories managed by the Department of Energy (DOE) often have extensive direct-to-chip liquid cooling and high-performance computing (HPC) systems that need to operate at peak efficiency to meet critical research goals. These facilities require a variety of customized water treatment solutions to maintain operating efficiency and preserve their assets.

One national laboratory was struggling with performance issues in its open recirculating, closed loop, and HPC cooling systems. As a preferred water treatment consultant to the DOE, ChemTreat employed state-of-the-art technologies and provided technical and analytical support to address the lab's needs.

2. Improving Cooling System Performance

2.1 Addressing Inefficiencies in Open Recirculating Cooling Towers

2.1.1 Project Description

The laboratory operates several large open recirculating water systems responsible for cooling critical research equipment and data center HPCs. These systems were fouled with mineral deposits that significantly impacted heat transfer and cooling efficiencies and contributed to increased metal corrosion and microbiological activity.

2.1.2 Solution

To address these issues, ChemTreat's Research & Development team developed a treatment solution using Quadrasperse® polymeric dispersant and corrosion inhibition technologies, specifically designed to meet the unique needs of this facility.

2.1.3 Results

After applying our custom-designed treatment program, mineral deposits were removed from the cooling tower fill and heat exchanger surfaces, significantly improving heat transfer efficiency and reducing the risk of underdeposit corrosion and microbiological activity.

For more than 10 years, the systems have remained free of mineral deposits and have exhibited excellent corrosion and microbiological activity control.

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2.2 Enhancing HPC Cooling Performance

2.2.1 Project Description

The facility has many computer applications with direct-to-chip liquid cooling, including a large, recently built HPC that was unable to pass speed testing because of poor cooling performance.

The HPC's cooling loops had become heavily fouled with biological growth, mineral scale, and other additives, preventing the unit from reaching the maximum expected calculations per second that it was designed to achieve.

Traditional cooling treatment methods add film inhibitors, such as silicates, to control corrosion, and biocides to mitigate microbiological issues. However, direct-to-chip liquid cooling systems have slightly different needs.

2.2.2 Solution

ChemTreat developed CL2001, a product specifically designed for CPU applications, to treat the laboratory's HPC cooling loops. This treatment methodology takes a more holistic approach, avoiding inhibitors that can cause fouling while implementing a proprietary protocol to control corrosion and microbiological activity.

2.2.3 Results

The CPU cooling at the site has been optimized with CL2001 treatment, and the HPC has passed the speed test. Stress testing is ongoing, and the laboratory is expected to accept ownership of the HPC from the manufacturer in the coming months.

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2.3 Addressing Fouling and Corrosion in Aluminum Closed Loop Cooling Systems

2.3.1 Project Description

The closed loop system was experiencing fouling events that led to underdeposit corrosion in aluminum equipment, reducing heat transfer efficiency.

2.3.2 Solution

The facility began using ChemTreat's patented FlexPro® multi-metal corrosion inhibitor specifically designed for aluminum applications. The new inhibitor has a neutral pH, allowing the cooling systems to operate within an acceptable pH range.

2.3.3 Results

Thanks to the application of the patented FlexPro corrosion inhibitor, the chilled water loop is now free from suspended solids caused by corrosion byproducts. The water clarity is excellent, and heat transfer and cooling efficiency have improved greatly. Aluminum corrosion has been reduced from >10 mpy to <0.1 mpy.

2.4 Value-Added Water Conservation Project

In addition to treating the issues experienced by the laboratory's closed loop cooling systems, ChemTreat implemented a program to help the facility meet environmental goals.

34 million gallons of water per year was saved while protecting critical research equipment.

Utilizing a proprietary, state-of-the-art aluminum corrosion inhibitor, ChemTreat

assisted the laboratory with a once-through to closed loop cooling water conservation project, saving 34 million gallons of water per year while protecting critical research equipment.

3. Conclusion

ChemTreat's water treatment expertise and custom solutions helped a national laboratory improve the efficiency of its direct-to-chip liquid cooling and other cooling systems.

The results of this partnership have yielded the following benefits for the facility:

- Cooling tower systems have remained free of mineral deposits and have exhibited excellent corrosion and microbiological control for more than a decade.
- Improvements to CPU cooling treatment helped the facility's HPC pass the speed test.
- Aluminum corrosion reduction in the closed loop improved water quality and heat transfer efficiency.
- A water conservation project in the closed loop cooling system helped the laboratory save 34 million gallons of water annually.

About ChemTreat, Preferred Supplier to DOE

Headquartered in Richmond, Virginia, ChemTreat is one of the largest and fastest-growing industrial water treatment companies in the world. We create lasting partnerships and sustainable value by aligning our entire organization around the common goal of making our customers more successful.

ChemTreat is honored to be a preferred supplier with a Basic Ordering Agreement for the DOE and its Integrated Contractor Purchasing Team. We deliver best-in-class water treatment solutions to DOE sites across the U.S.