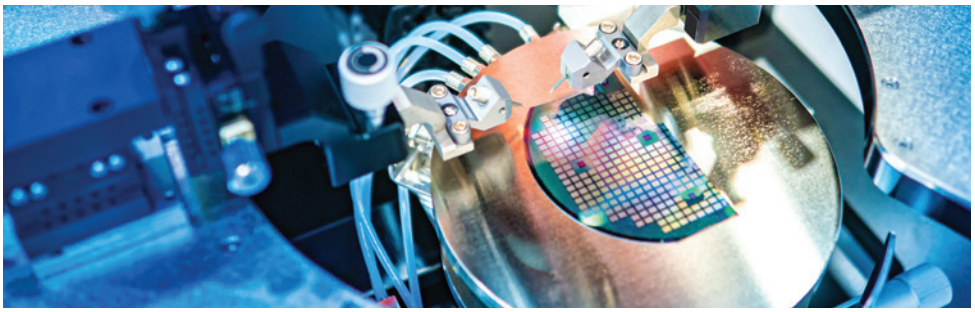
CASE STUDY

eROI℠ by Ecolab

Semiconductor Fab Saves Water, Cost and Environmental Impact via Improved Visibility into Process Cooling Water (PCW) Operation



BACKGROUND

Process cooling water (PCW) systems are essential to semiconductor production, providing reliable heat removal from the tools used in the manufacturing processes. Efficiently operating PCW systems protect expensive production assets and help ensure uptime.

Operationally, PCW systems are very dynamic as semiconductor production itself is an everchanging landscape. As an example, fabs often swap tools in and out of service on PCW loops to optimize productivity. Each change-out can introduce contaminants into the loop. Other commonly encountered issues include dissimilar metals (resulting in galvanic corrosion) and low flow velocities (increasing risk of stagnant water and biofilms that can impair heat transfer).

A large U.S.-based fab was experiencing a variety of operational challenges in their PCW loops, which negatively impacted the site in several ways:

CHALLENGE	RESULT	IMPACT
Undetected water leaks	▪ Difficult to maintain correct treatment chemical levels ▪ High make-up water use	▪ Potential corrosion damage to tools on the PCW loop ▪ Potential risk of biofilm formation on heat-exchange surfaces ▪ Exceeding treatment budget ▪ Excessive water use, high water costs
Insufficient visibility to PCW conditions	▪ Difficult to assemble sufficient info to make a case for action ▪ Limited ability to link PCW issues to other fab-critical matters	▪ Potential for unaddressed problems to hurt fab uptime reliability
Uncontrolled water discharge	▪ Excessive azole discharge	▪ Concern from local publicly owned treatment works (POTW) regarding impact on their operations

ANNUAL SAVINGS

WATER

Water savings of
10.9 million gallons
per year

COSTS

$674,000
per year

ENVIRONMENTAL RESPONSIBILITY

Reduced azole discharge by
64%
per year

VALUE DELIVERED

$674,000 ANNUALLY

The fab's utility managers suspected several of these issues but lacked the compelling data to diagnose and quantify the impact of the problems. This made it difficult for the fab to prioritize troubleshooting and corrective action.

NALCO Water
An Ecolab Company

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SOLUTION

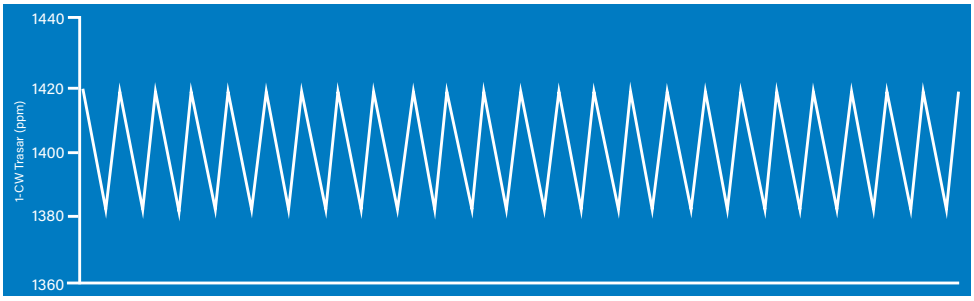
The fab implemented the Nalco Water treatment program to help manage its PCW system. This included a 3D TRASAR™ program to manage water quality within the PCW loops. This technology includes the following capabilities:

- Inert tracer to monitor water losses, which are common in PCW systems
- Real-time corrosion measurement to give the fab visibility to corrosion control performance
- Real-time pH and conductivity measurement to detect process in-leakage

Soon after start-up, data from the 3D TRASAR controller revealed, for the first time, water leaks occurring in the PCW loops. This is shown in Figure 1.

Based on the decay rate of the inert tracer over a specific period of time and the known volume of the loops, a precise calculation of water loss was possible. Prior to this discovery, the only indication of water loss was the position on the make-up water valve to the loops.

Figure 1: Data showing the periodic water losses occurring in one of the fab's PCW loops

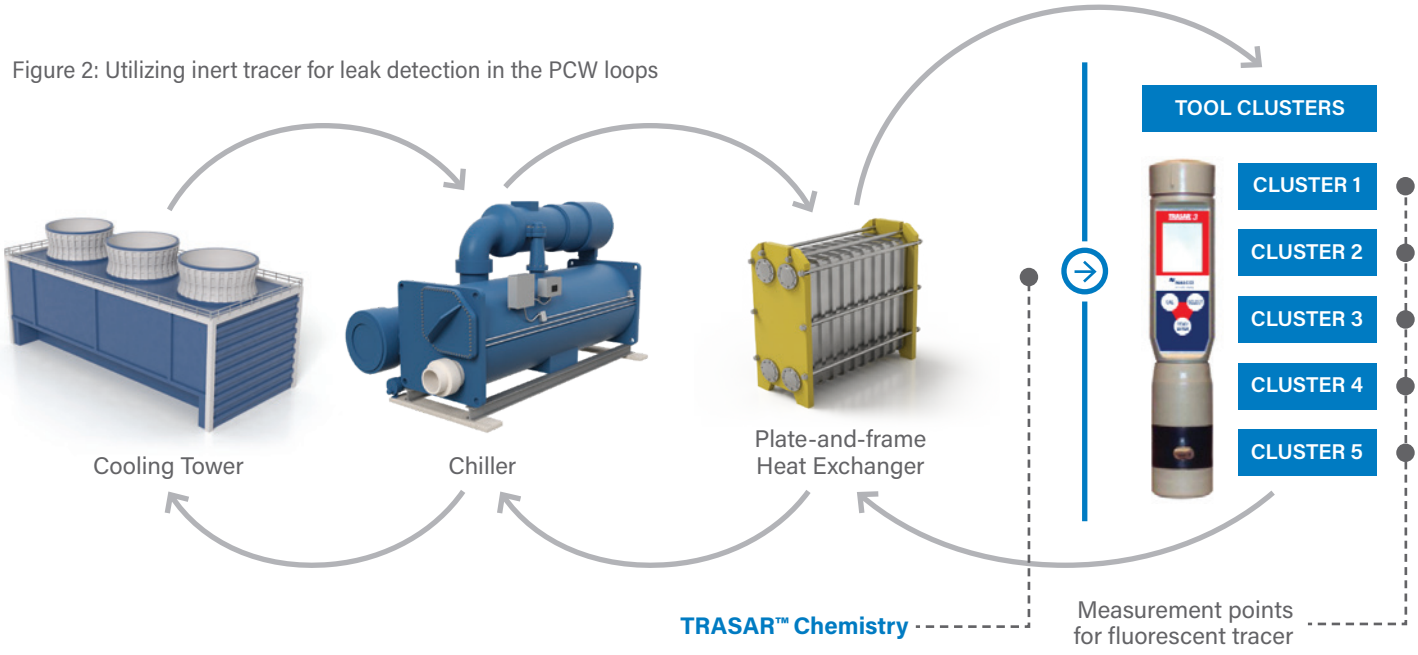


This was the first step in building a case for additional joint action by Nalco Water and the fab. These findings enabled the team to quantify the financial impact to the fab, and to enlist the help of the tool owners in tracking down and eliminating the leaks.

Nalco Water often uses an integrated mechanical/operational/chemical approach in its solution-development process. The next step was to equip the fab's utility management team and tool owners with resources to specifically identify where these leaks were occurring so the tool owners could take the appropriate remedial action. The following approach was taken:

1. Additional specialized fluorescent tracer was added to PCW loops, measured at a different wavelength to distinguish from treatment chemistry.
2. Tool owners were provided with fluorometric pens to check each floor drain. This test was designed to be fast, simple and reliable, enabling quick detection without requiring in-depth knowledge by the operator.
3. If tracer was detected, the facilities team and tool owner were notified of leak detection. In most cases, leaks were promptly resolved. Detection of the tracer at the drain of a tool cluster enabled specific clusters to be the focus of additional investigation (Figure 2). Heat exchangers associated with that tool cluster were checked, including pressure testing and exchanger replacement when needed.

Figure 2: Utilizing inert tracer for leak detection in the PCW loops



The inert tracer used in this application was chosen for several specific characteristics:

FEATURE OF TRACER	BENEFIT FOR LEAK DETECTION APPLICATION
Functions at a different spectrum versus the spectrum of the tracer present in the PCW loop's treatment chemistry	Distinct measurement without interfering with the PCW loop treatment program
Response is independent of pH and temperature	Does not require specialized conditions for measurement – broad applicability
Response is in a very low background region of the spectrum	Provides visibility in a region of the spectrum where other potential interferents would be rare
Response strong at low concentration	"A little goes a long way" – makes detection a simple "Yes / No" condition
Rapid, accurate and easy use	Tracer pen does not require advanced operator skill: 1. Pour in water sample 2. Push button 3. Take reading

RESULTS

This work yielded several significant improvements for the fab:

Reducing water leaks from the PCW loops saved an estimated 10.9 million gallons of water per year — enough water to meet the annual demand of 348 families.

Azole levels in the fab's effluent were reduced by 64% — a decrease of 7,260 lbs. This eased the local publicly owned treatment works' (POTW) concern regarding incoming azole concentrations.

The program stabilized chemistry within the fab's PCW system, which reduced their corrosion risk and reduced demand for hands-on operational attention. As a result, staff and vendor labor resources could be reallocated to higher value tasks.

The combination of reduced chemical spend and UPW operational cost generated net savings of more than $674,000 per year. This team effort also provided the fab with an internal framework to maintain the gains going forward.

CONCLUSION

Through collaboration between the fab's utility staff, tool owners and Nalco Water, this semiconductor fab gained a quantitative understanding of the operational issues within their PCW systems. The customer also gained tools and strategies to effectively resolve the challenges and prevent future occurrences.

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