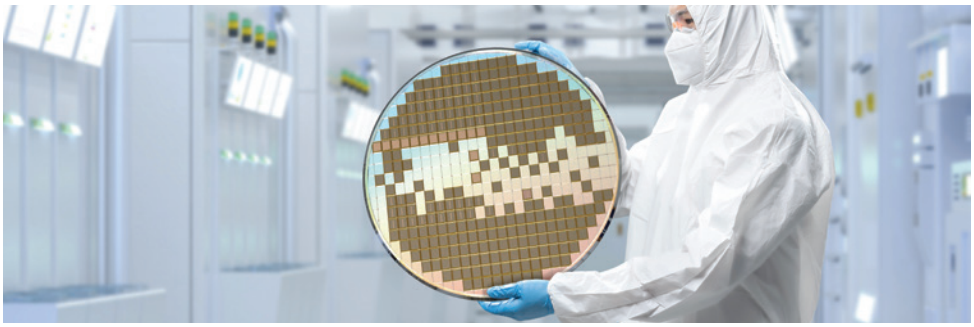
CASE STUDY

eROI℠ by Ecolab

Semiconductor Fab Cuts Unplanned Maintenance by 95%+, Saves $85,700 Annually with Process Vacuum (PVAC) Treatment Program



BACKGROUND

In the Microelectronics industry, process vacuum (PVAC) systems ensure specific tool conditions to support reliable wafer processing. Heat rejection from PVAC systems requires efficient heat transfer. Improper water management in this area has the potential to compromise operational performance and long-term asset life. In severe cases, costly unplanned downtime can result.

In liquid-ring process vacuum systems, water is critically important. A rotary vane mechanism spinning inside a cylindrical chamber with individual vanes are part of an impeller that is located off center of the pump casing. A liquid is introduced into the chamber and, as the rotary vane spins, centrifugal force creates a sealing ring of liquid around the inside perimeter of the vacuum pump chamber; this seals the rotating vanes. This liquid ring does not directly contact the pump chamber walls, letting the pump pass a considerable number of contaminants and debris through the pump's mechanical parts without harm.

One U.S.-based semiconductor fab had long faced challenges in the operation and maintenance of their PVAC system, primarily in the form of microbial fouling. Specifically, the fab's biofilm contained high levels of iron, a corrosion byproduct.

This fouling was impacting heat transfer and system performance, and required frequent, unplanned maintenance of the heat exchangers for cleaning. For some units, the maintenance frequency was twice a year. For others, it was quarterly or monthly. The customer brought the issue to the attention of their Nalco Water team.

Root-Cause Analysis

Nalco Water worked with the customer on-site to conduct a root-cause analysis. The team found substantial levels of slime-forming bacteria in the heat exchangers, caused by mineral oil within the units, which was added at the point of manufacture for in-transit corrosion protection.

Due to fab production demands, there was no time to remove the oil and clean the internal surfaces of new PVAC units before start-up. Once an oil-contaminated unit was up and running, the compression step of each operating stage moved the oil throughout the unit. This step embeds the oil into the surfaces of the cast iron housing. The oil would settle throughout the unit and cause bacteria to grow, as a water/oil interface is an excellent starting point for bacterial growth. In most industrial cooling water situations, microbio growth is the leading challenge (see Figure 1).

ANNUAL SAVINGS

PROFITABILITY

Cleaning labor reduced by
$42,850
per year

COSTS

Chemical cleaning costs reduced by
$42,850
per year

ASSETS

Reduced iron levels in system water by
97%

TOTAL VALUE DELIVERED

$85,700 ANNUALLY

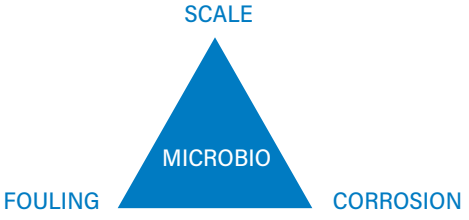


Fig. 1. The four common, interrelated cooling water challenges are corrosion, microbio, scale and fouling. Microbio is often the biggest problem and the most difficult to control.

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Another contributing factor was the lack of rotation once any PVAC unit came online. Facilities often have more than one PVAC unit and may only require one unit to run at any given time. This period of downtime can accelerate bacterial build-up in the exchanger due to the absence of flow; microbio growth is favored in stagnant water environments.

Lastly, the team ensured they had a comprehensive understanding of the metallurgy of the systems. Although the biofilm contained high amounts of iron, if a chemical corrosion program were to be implemented, it would be important to ensure all wetted metals were protected against corrosion. Iron levels in the system were sometimes as high as 30 ppm, with water in the system periodically turning red as a result.

SOLUTION

Nalco Water often uses an integrated mechanical/operational/chemical approach in its solution-development process. Here are the specific steps implemented to resolve these problems and prevent future occurrences.

Mechanical / Operational

- Cleaning of new PVAC units prior to being put online, to remove all traces of mineral oil
- Customer staff received a four-hour training on proper maintenance of the PVAC units
- Maximum PVAC unit run time was set to one week, to support proper equipment rotation
- Operating performance of all PVAC units was monitored via Service Intelligence, powered by ECOLAB3D™. System data helped fab personnel identify when units were performing out of spec, requiring additional corrective action.

Chemical: Microbio Control

Given the high incidence of and high potential for microbial fouling, the team focused on resolving this first. Nalco Water's Selecticide™ test enabled the team to choose a biocide with the highest potential effectiveness and minimal operational risk. The test takes the guesswork out of choosing microbio control products by indicating the appropriate biocide and optimum dosage range for a particular system.

When biocide is added to a recirculating cooling water system, a reduction in total microorganism count occurs. The reduction in total count demonstrates the ability of the biocide to kill off microbial growth in the cooling system. The Selecticide test works by comparing the performance of various biocides across samples of system water in a particular application and assessing the microorganism count reduction in each sample.

Chemical: Corrosion Control

A corrosion-control chemistry was added to the program for the purpose of minimizing iron corrosion.

RESULTS

Exchangers were examined after each change in the program. Over a two-year period, heat exchangers were pulled eight times, each time continuously showing less biofilm.

The value for the customer was considerable. Previous cleaning frequency ranged from monthly to quarterly to semi-annually. Today, the fab has maintained a record of 21 years and counting with no unplanned shutdowns to clean heat exchangers. This reduction in cleaning frequency has yielded $42,850 in annual labor savings plus an additional $42,850 in annual chemical cleaning savings.

In addition, iron levels in the system water were reduced by 97%, from the previous high of as much as 30 ppm (indicating active corrosion) to 0.02-0.8 ppm. Enhanced corrosion protection supports the customer's ability to maximize uptime and meet the manufacturer's projected asset life for each PVAC unit.

CONCLUSION

Candid and open communication between the customer and Nalco Water enabled the team to diagnose a lingering and costly performance issue. Then, leveraging Nalco Water resources to identify the root cause, our team developed a solution the customer and Nalco Water could deploy and maintain together.

While this story details the annual cost savings, it's important to note the enhanced value achieved by maintaining these gains: Through continued support and no unplanned cleanings in 21 years, the customer's cost savings have been compounded to reach $1.8 million in total.

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