

Innovative Solutions to Conservation New Approach to High Purity Water Treatment

Analog Devices ([NASDAQ:ADI](https://www.nasdaq.com/symbol/adi)) is a world leader in the design, manufacture, and marketing of a broad portfolio of high performance analog, mixed-signal, and digital signal processing (DSP) integrated circuits (ICs) used in virtually all types of electronic equipment. Since our inception in 1965, we have focused on solving the engineering challenges associated with signal processing in electronic equipment. Used by over 100,000 customers worldwide, our signal processing products play a fundamental role in converting, conditioning, and processing real-world phenomena such as temperature, pressure, sound, light, speed, and motion into electrical signals to be used in a wide array of electronic devices. We focus on key strategic markets where our signal processing technology is often a critical differentiator in our customers' products, namely the industrial, automotive, communications, and consumer markets.

We currently produce a wide range of innovative products—including data converters, amplifiers and linear products, radio frequency (RF) ICs, power management products, sensors based on microelectromechanical systems (MEMS) technology and other sensors, and processing products, including DSP and other processors—that are designed to meet the needs of our broad base of customers.

ADI currently employs 9,600 employees worldwide with corporate headquarters located in Norwood, Mass, and manufacturing sites located in Ireland, Philippines and Wilmington, Mass. The ADI Wilmington Manufacturing site employs over 3,000 people (employees and contractors) and is made of up 7 buildings (~600,000 square feet) on 65 acres.

Introduction

Water quality and capacity are critical to the production of high technology integrated circuit (IC) chips in the semiconductor industry. At Analog Devices in Wilmington, Massachusetts, ultrapure water is a crucial resource for manufacturing ICs used in high technology applications around the world. Complex systems are in place to treat the incoming public water supply to meet strict industry standards for water purity. Both efficient water use as well as the ability to reclaim and recycle high quality water in sufficient capacity is of vital importance to this industry. This case study shares some recent related water and chemical conservation successes at Analog Devices.



Background

Analog and others in its industry are continually challenged with identifying and implementing opportunities to reduce and reuse water, while still maintaining high water quality for manufacturing. At Analog, a complex series of reverse osmosis (RO) and ultrafiltration (UF) membrane devices in conjunction with ion exchange (IX) resin technology is used to treat the incoming public water supply to remove ions that interfere with the ability to create semiconductors. The water used in manufacturing process is then treated via a similarly complex system to allow reclamation and recycling of a portion of the water for re-use in manufacturing and related facilities operations.

The IX resins used to treat both the incoming water supply and the water to be recycled need to be periodically regenerated. Over time, mineral ions removed from the incoming water build up on the resins, as measured by the conductivity of the recycling system effluent water. The resin regeneration process involves the use of hydrochloric acid (HCl) and Sodium Hydroxide (NaOH) to remove minerals from the resin beds and restore them to their original state for continued use in the treatment and recycling systems.

By more efficiently using water, Analog is also able to reduce the frequency of IX regenerations required, which in turn reduces chemical use. Over the past few years, Analog has successfully implemented a number of water use reduction initiatives throughout its Wilmington facility, which allowed it to nearly double manufacturing capacity without significantly increasing water use. Nonetheless, Analog continually seeks opportunities to improve.



Project & Results

More recently, an Analog team consisting of both internal and external experts focused on additional ways to reduce chemical regenerations of the IX resins in one of its water reclaim systems. Prior to implementing improvements, this system required approximately 12 regenerations per year. Each regeneration used approximately 15,000 gallons of water and 110 gallons each of HCl and NaOH. In the quest for continual improvement, the Analog team recognized potential opportunities to reduce water use, chemistry, manpower and costs by identifying innovative solutions to reduce resin regeneration frequencies.

A detailed study was conducted that reviewed opportunities in four categories: manpower, materials, methods and mechanics. Important considerations were physical space constraints and the need to install and test system changes during a shutdown period. A key finding of this study was that the system would greatly benefit by pretreating RO influent water to improve the quality of the RO product water that fed the IX resins. The incoming water to the RO membranes was originally in the pH range of 3 to 6. Under these conditions, the weak acids are poorly rejected by RO membranes, which increases the downstream load on the IX resins and drives the need for more frequent resin regenerations.



By adjusting the incoming pH to a more neutral range of 7 to 8, the number of regenerations required was reduced from 12 times per year to only 1 to 2 times per year. Also, the total quantity of acids and bases required for neutralization of incoming water supply and regeneration of resins was significantly reduced.

Implementing these changes resulted in annual savings of approximately 1,100 gallons each of HCl and NaOH, approximately 150,000 gallons of water, and about 100 man-hours. Another important benefit is the improvement to safety by significantly reducing the amount of chemical handling. From an economic standpoint, the project resulted in an annual savings of \$35,000 in chemistry, water, and membrane maintenance costs.

Next Steps

To build on the successes of this project and consistent with its philosophy of relentless improvement, the Analog Wilmington site intends to mirror these enhancements at the system in their central utility plant, which is three times the scale of the system in this initial project. It is anticipated that the translation of these learnings to the larger system will result in even more significant savings in chemistry, water, man-hours, and costs.