

Yuhuan Power Plant

Application: Ultrafiltration of seawater for Reverse Osmosis pretreatment

Capacity: 20 MGD (76,800 m³/d)

Location: Zhejiang Province, China

Commissioned: July 2006



The Problem

Recent industrial and urban growth in China has led to an explosive increase in energy demand. While this is good news for the country's power producers, a continual decline in freshwater supply has put undue pressure on the industry. With the existing freshwater supply being depleted at a rapid pace, the government is placing restrictions on its use and charging increasingly higher fees. Clearly, future industrial growth will depend upon the country's ability to find alternative sources of water.

One solution is to use desalinated seawater for industrial applications, thereby reducing the demand on groundwater and surface water supplies. Huaneng Power International, one of China's largest independent power producers, is doing just that.

Located in Zhejiang Province, the Huaneng Yuhuan Power Plant will draw seawater from the East China Sea. After desalination, the treated water will be separated into two streams for use at the plant as boiler feedwater and potable water. Any surplus potable water will be sold to the community.

Given the high levels of impurities in seawater, and the detrimental effects of fouling on reverse osmosis (RO) membranes, effective pre-treatment is vital. The company is turning to immersed membrane technology for cost-effective, high quality pre-treatment of seawater for its RO desalination system.

The Solution

ZENON Membrane Solutions, part of GE Water & Process Technologies, ZeeWeed* immersed ultrafiltration (UF) membranes were selected for the Yuhuan Power Plant. The Yuhuan plant is a significant project, for a number of reasons. The ZeeWeed system is one of the largest UF pretreatment installations of its kind, producing just over 20 million gallons per day (76,800 m³/d) of feedwater for the power plant. This plant will be the first in China to generate 1,000 megawatts per generator, and is also the country's first ultra-super critical, coal-fired plant.

While RO is a common and effective method of desalination, it requires aggressive pre-treatment to ensure stable operation. At a minimum, RO membranes require a feedwater turbidity of less than 1.0 NTU, and a silt density index (SDI) of less than 4.0. If the feedwater quality does not meet these requirements, the RO membranes will foul rapidly causing reduced efficiency and higher operating costs through more frequent cleanings, and increased membrane replacement costs. Therefore, proper pre-treatment is considered paramount to protect expensive RO systems and to ensure efficient operation.



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Conventional pre-treatment methods typically incorporate a complex system of coagulation, flocculation, media filtration, and cartridge filtration, combined with chemical addition. Such methods, however, must be continuously optimized to deal with fluctuating influent characteristics.

With a nominal pore size of 0.02 microns, ZeeWeed UF membranes provide a physical barrier to particulate matter, producing high quality water regardless of the seawater turbidity. Membrane technology represents a superior method of RO pre-treatment, providing stable and consistent feedwater quality and substantial resistance to system upsets.

ZeeWeed UF membranes also offer high performance in a smaller footprint than granular filter media or pressurized microfiltration systems. ZENON membranes are configured in modular cassettes that are ideal for retrofitting or expanding plants that are currently using conventional pre-treatment systems.

The high surface area offered by ZeeWeed UF membranes can ease space constraints during expansions or retrofits, and provide savings in land acquisition and capital costs. These benefits, combined with ease of cleaning, higher RO membrane operating flux, and reduced downtime, maintenance, and operating costs, make ZeeWeed immersed UF membrane technology a compelling choice for RO pretreatment.

Process Overview

The pre-treatment system at Yuhuan Power Plant will consist of enhanced coagulation clarifiers and six trains of ZENON ZeeWeed 1000 hollow fiber membranes. The pre-treated RO feedwater quality will be exceptional, with SDI less than 2.5 90 percent of the time, turbidity less than 0.1 NTU, and Total Suspended Solids (TSS) less than 0.5 mg/L.

Seawater will first be pumped into four clarifiers where enhanced coagulation will help to remove settleable organic and floatable solids. The clarified water, after screening, will flow to six individual membrane trains, each providing an average day flow of 533 m³ per hour (2,350 gpm). The UF system piping is designed for a future capacity of 640 m³ per hour per train (2,800 gpm), to allow for possible expansion.

The ZeeWeed UF membrane cassettes will be immersed directly in the process tanks. A low-pressure vacuum applied to the membranes will draw the water through the microscopic pores and into the hollow fibers. The membranes form a physical barrier against suspended particles and colloidal materials. Rejected particles remain in the process tank and are periodically removed by backwashing.