Zero liquid discharge and water reuse at a coal power plant

Changxing County, China

water scarcity impact

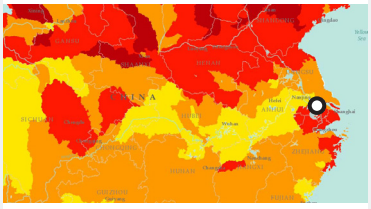
Reduced withdrawal	●
Reduced consumption	
Improved water quality	●
Increased productivity	
Net basin benefit	●

volumetric impact
231 000 m^3/yr

capital cost
$20 million

Estimated unit cost of water
>500 ¢/m^3

Water Stress
Changxing County, China



Arid & low water use
Low (<10%)
Low to med (10-20%)
Med to high (20-40%)
High (40-80%)
Extremely high (>80%)
No data available

Water Stress Map:
F. Gassert, P. Reig, T. Shiao, M. Luck and M. Landis, 2015. "Aqueduct Global Maps 2.1."

Confidence level
Low Medium High

Water Scarcity Impact Key
Main Minor

Credits
We would like to acknowledge John Tracy of Oasys Water for his input in the preparation of this case study.

Project Overview

Located on the lake Taihu (or Tai) in the Zhejiang Province west of Shanghai, Huaneng Power International`s Changxing Power Plant is a new 1.3GW high efficiency ultra-supercritical coal-fired power plant.

Water pollution and water scarcity are the two main environmental concerns of the region. With annual precipitation of 1 000–1 500mm, Lake Taihu gets fair amount of rain but not enough to meet the growing demands of industries located on the lake (chemical, metal, printing, dying industries) and the rapidly growing population. Since the last major algae bloom in April 2007, licence to operate has only been given to industrial plants that control their effluent discharges and air emissions tightly and reduce their water intake from the lake.

This environment, together with a national policy on sustainable water resource management under the China 12th five-year plan of 2011-2015 has led to the implementation of the most rigorous zero liquid discharge treatment.

Operational since May 2015, the wastewater treatment process produces annually 231 000 m^3 of treated effluent collected from the Flue Gas Desulphurisation (FGD) process and cooling tower blow-down and reused in the boiler feedwater purification system. The softening pretreatment sludge is disposed of in a landfill and salts from the process are dried to >95.5% solids and sold to the local chemical industry, cutting the wastewater discharge to zero.

Key Elements

- Action driven by:
  a) national policy implementing the strictest water resource management system, and;
  b) Zhejiang province industrial water withdrawal target in terms of water used per unit of GDP generated by 2020, which should be reduced by 27% of 2013 levels.

- State-of-the-art technology for zero liquid discharge including Pretreatment, Ion-exchange, Reverse Osmosis, Forward-Osmosis and a Crystalliser.

Key Outcomes

- Water withdrawals from Lake Taihu were reduced by up to 231 000 m^3/year, which equals approximately 10% of the overall power plant water usage.
- Effluent discharges reduced to zero in April 2015.
- Production of up to 10 000 tonnes of dried salt product per year that is sold to the chemical industry.

Changxing County, China

Intervention Features

- Wastewater reuse in power generation
- Reuse of cooling blowdown water
- Zero liquid discharge
- National and regional policies

Project Levers

(1) National and provincial policy

The 12th five-year plan (2011- 2016) has been instrumental in promoting sustainable water management in China. Particularly the policy document titled "Opinion on implementing the strictest water resource management system" (State Council Doc. No. 2012.3) created a guideline framework for managing water efficiency, total water withdrawal and total pollution discharge. The policy does not set technology requirements, but instead sets national water withdrawal quotas for each province to be met by 2015, 2020 and 2030. The Provincial Government then has the authority to set industry specific targets in order to meet its overall target. The Zhejiang Province, where the Changing Power Plant is located, is required to reduce its overall water withdrawals by 27% between 2013 and 2020.

(2) Wastewater reuse

The key technological aspect of this project is the collection and treatment of wastewater generated through the FGD wastewater and cooling tower blow-down. This generates 26.4 m^3/hr of treated effluent which is used as boiler make-up water. As FGD wastewater is highly polluted, the water reuse system includes a series of tertiary treatment steps to generate an effluent of desired potable quality. This includes pre-treatment steps such as a softener, media filter and Ion Exchange, followed by a two-step Reverse Osmosis (RO) and Forward Osmosis (FO).

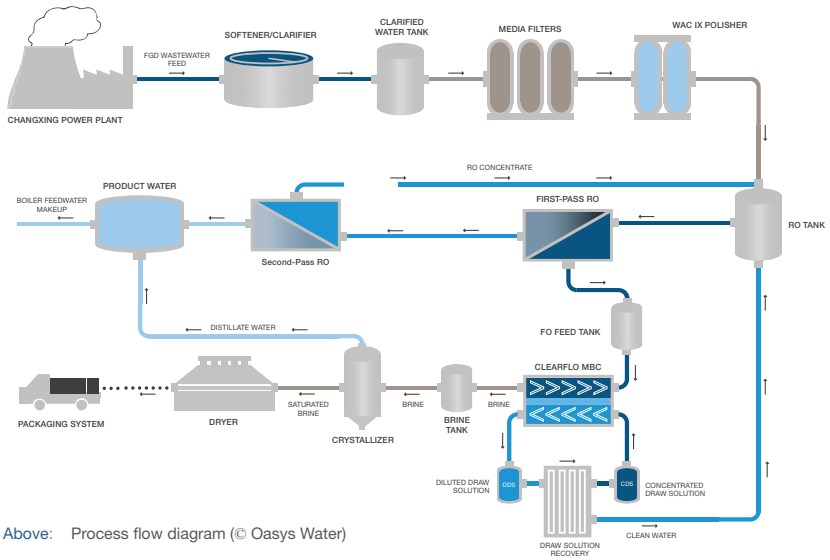
The FO reject is then processed through a crystalliser where an additional small proportion of the treated effluent is recovered (2.2m^3/hr) and combined with the RO effluent (24.2m^3/hr) prior to being fed directly to the boiler.

Outcomes and Challenges

Fully financed by Huaneng Power International, the project was delivered internally with no major partner involved other than local regulatory agencies. The greatest challenge was to complete the wastewater treatment on time prior to May 2015 when the ZLD operational requirement started. This led to the fabrication of the equipment and construction happening at the same time and completion of the project within six months.

Another challenge from the long-term perspective is to keep ZLD economically feasible. Evaporating wastewater to 95.5% of solids is an energy intensive and expensive process with an average operating cost for treating water of $3-$3.5/m^3. This requires the company to take a longterm view on the project and focus on maintaining the license to operate, particularly when located in such a water scarce and pollution sensitive region.

The Changxing Power Plant now serves as a prototype of the next generation of high-efficiency ultra-supercritical coal-fired power plants in China. Huaneng Power International, which is state-owned and among the top five power plant operators in China, now has the knowledge and capability to replicate the solution in other locations where similar operating concerns are present.



Above: Process flow diagram (© Oasys Water)