

One of China's largest petrochemical plant achieves a key by-product: clean water

Case study

Safeguarding the environment from refining's potential impacts

Jiujiang, a city of 5 million people, borders the edge of the Yangtze River as well as Poyang Lake, each China's largest. To the east of the city's residential districts, midway on a peninsula separating the two bodies of water, sits the giant petrochemical complex of the Sinopec Jiujiang Company, a subsidiary of the Sinopec Corporation, the nation's largest refiner. Nearly 3,000 people work there.

Built in 1975 with a major modernization to double capacity in recent years, the plant covers 4 square kilometers and processes about 57 million barrels of oil annually, on its way to an eventual goal of 72 million barrels per year. Outputs include jet fuel, gasoline, kerosene, and diesel products. With that production, comes massive amounts of oily, water-borne effluents that are extremely difficult to treat.

One example is the plant's various spent caustic streams resulting from its different refining processes. For petrochemical plants in general, the Chemical Oxygen Demand (COD) loads in these streams are usually extremely high — up to 100,000 mg/l versus < 50 mg/l limits in treated water. Plus, spent caustic contaminants typically include sodium carbonate, sodium sulfides, mercaptans, phenols and emulsified hydrocarbons.

Despite these water-treatment challenges, the facility has won numerous awards over the past 40 years for operating excellence, including environmental stewardship. The latter has helped to safeguard the quality of

the two important freshwater sources within walking distance of its perimeter. To keep its sterling environmental record intact, the plant needed to expand and upgrade its already considerable wastewater treatment capabilities as part of the much larger effort to enlarge its production capacity.

Nonetheless, many community stakeholders outside the plant were watching its expansion closely. For example, the petrochemical complex is considered an important element of the Poyang Lake Ecological Economic Zone. This cooperative effort among the region's civic and business interests focuses on environmental and economic sustainability, putting the plant well within the group's sights.

In addition, the Chinese government announced that environmental protection and restoration of the Yangtze River had become a top priority in its development plan for the world's third longest waterway. It would start imposing the strictest environmental protection and water resources management measures on industries operating within the river's watershed, home to some 600 million people.

Choosing Siemens for its wastewater treatment technologies and experience

Both plant management and the engineering team carefully considered the many available options to upgrade the wastewater treatment facilities, including

various technologies and suppliers. Not only would the project's initial capital construction and commissioning need to be thought through, but also its lifecycle management. After all, the plant and surrounding region would depend on the quality, reliability and serviceability of the project for decades to come.

After months of deliberation, they chose Siemens for its advanced wastewater treatment technologies and specific integrated solutions using those technologies. Other factors in their decision included Siemens having more than 40 years of experience in designing, engineering, installing and supporting nearly 1,000 complex water treatment facilities over the world; its water solutions lifecycle management model and local service and support of it; and the company's financial strength, ensuring its viability to support its water solutions far into the future.

"Siemens has rich experience in the oil and petrochemical wastewater treatment, as well as lots of cooperation with Sinopec," says Zhu Yuzhong, deputy director of the Sinopec Jiujiang Company's water management operations. "Siemens technology can help conserve energy and protect the environment. In the long run, it can also help us save on other operating costs to lower our total cost of ownership."

Meeting project requirements and challenges

From the start, the wastewater treatment project team composed of the refinery's engineers and Siemens experts faced three core challenges: Due to limits on available land, the new system had to be built at the existing plant site, yet also ensure the continuing operation of the plant's legacy wastewater treatment facility — all while demolition and other construction was going on around them.

To gain a thorough understanding of the project's scope, the project team conducted a comprehensive site assessment, which included mapping the plant's refining processes and various effluent flows.

The project required that the new wastewater treatment systems separately process two large streams: 500 tonnes per hour of oily wastewater and 500 tonnes per hour of salty wastewater. The team also had to be clear on where the expanded and upgraded water treatment facility would fit in context of the plant's much larger expansion project.

Based on the assessment and specific project requirements, Siemens recommended that these streams be managed by Siemens' proprietary treatment technologies, including:

1. **Zimpro Wet Air Oxidation**, providing oxidizing pre-treatment of toxic spent caustic streams;
2. **PACT Wastewater Treatment**, combining powder activated carbon with activated sludge technologies for a synergistic, more highly effective cleaning of wastewater, both:
 - Oily Wastewater Streams
 - Salty Wastewater Streams
3. **Zimpro Wet Air Regeneration**, recovering up to 95 percent of the activated carbon and destroying all the excess biomass.

1. **Wet Air Oxidation (WAO)**. Spent caustic is a typical — and extremely toxic — by-product of oil refineries and the Sinopec Jiujiang plant is no exception.



Zimpro® WAO unit at Jiujiang plant

Wet air oxidation via the Siemens Zimpro WAO solution is an effective technology for managing this noxious waste. It provides complete oxidation of highly odorous, reduced sulfur species such as sulfides and mercaptides. By increasing temperature and pressure, organic contaminants such as phenols can also be broken down to either carbon dioxide and water, or biodegradable short-chain organics.

After treatment by WAO, odors associated with the sulfides and mercaptides are eliminated and the treated spent caustic is suitable for discharge to a conventional biological treatment process. This step significantly reduces the concentration of pollutants, which lightens the operational load for the next stage in the water treatment process.

2. **PACT Wastewater Treatment**. That next stage in cleaning the Jiujiang refinery's wastewater is handled by a patented Siemens PACT/WAR (powered activated carbon treatment/wet air regeneration) system, one of Siemens leading technologies for wastewater treatment of effluents from refining and petrochemical activities. PACT combines powder activated carbon and activated sludge synergistically to maximize the cleaning efficiency of each, while also simplifying the number of process stages compared to conventional approaches.

PACT/WAR treatment provides multiple, simultaneous processes, including powdered activated carbon adsorption, and activated sludge biological degradation, plus regeneration of activated carbon return and re-adsorption. The activated carbon in the system can effectively absorb the refractory pollutants, volatile organic compounds and odor.

3. **Wet Air Regeneration (WAR)**. While each of the refinery's two wastewater streams are treated by their own Siemens PACT systems, they both share a Siemens Zimpro WAR system. This is a key technology associated with the Siemens PACT system, because it can regenerate up to 95 percent of the PACT system's activated carbon.

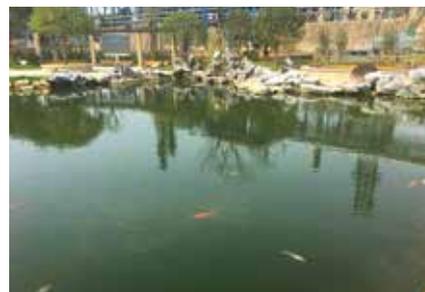
The Zimpro WAR system does this by oxidizing the refractory toxic pollutants and biological sludge attached to the activated carbon, using oxygen from air to regenerate the activated carbon. In turn, this regenerative process avoids the substantial operating expense of replenishing this core material from external sources. Over decades of operation, this cost avoidance can significantly lower the water treatment facility's total cost of ownership, which can help offset the project's initial capital costs, accelerate its breakeven point and boost the return on the company's investment.

Exceeding the project's water treatment quality standards

The project team successfully completed the design, engineering, installation and commissioning of the three-stage water treatment process just described on time and budget. In fact, the water output from the combination of Siemens water treatment solutions has exceeded the effluent quality standards set forth by the plant. COD in the treated water, for example, is less than 50 mg/l limit set forth by the plant and mandated by the Chinese government.

In order to test the water quality — aside from precise laboratory testing — the Jiujiang refinery's engineering personnel built a pond near the wastewater treatment facility, filled with post-treatment water and added Koi fish. The fish have since thrived in the water and show no signs of ill-health. This has helped the plant prove its treated water has achieved its quality standards, if not exceeding many of them, while its discharge would not harm the environment.

Sinopec's successful upgrade and expansion of the wastewater treatment facility at its Jiujiang petrochemical complex has helped to ensure both long-term cost savings and continued environmental stewardship by the plant. What's more, the latter has helped reassure the plant's nearly 3,000 employees that the work they do each day contributes to the economic vitality of the region without degrading the health of the environment.



Koi pond uses treated wastewater.

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