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Singapore's Changi WRP Project–An Update

Singapore's Deep Tunnel Sewerage System will be the cynosure of all eyes when completed. It includes the Changi Water Reclamation Plant, a state-of-the-art, covered and compact treatment facility.

William H. Selle, Bruce Ratzlow, Rick Parker and Kevin MacEachern

Singapore has a comprehensive system for the conveyance, treatment and disposal of wastewater serving its whole population. To cater to 21st century needs, Public Utilities Board of Singapore has embarked on the Deep Tunnel Sewerage System (DTSS). The DTSS will use cross-island deep tunnels to intercept all wastewater and convey it by gravity to two new centralised water reclamation plants located on the southeastern and southwestern coasts. The treated effluent will be discharged through deep sea outfalls into the Straits of Singapore.

The first phase of the DTSS will be completed in 2008, and includes the construction of an 800,000m^3/d capacity Changi Water Reclamation Plant (CWRP), which is located on reclaimed land on the eastern edge of the island. Under this phase, CWRP will have an influent pumping station (IPS), two liquid treatment modules, solids treatment facilities and effluent outfalls.

Three USFilter companies, RJ Environmental Products, Envirex Products and Asdor Products, are providing equipment for odour control, primary and secondary wastewater treatment and solids conveyance and handling systems for the Changi plant. CH2M Hill is the design consultant for the project.

The LO/PRO® system handles air flow rates up to 65,000 ft^3/min, treats multiple contaminants, has low operating costs and requires little maintenance.

Stopping odour where it starts

USFilter RJ Environmental Products will provide three sets of odour control equipment for the IPS at the CWRP. Two odour control trains, consisting of a LO/PRO® multi-stage chemical scrubber, followed by a dual-bed, horizontal-flow V-bank-style carbon adsorber, will each treat 10,000 ft^3/min of air flow. The third system, consisting of one "Unitary Multi-stage" chemical scrubber system, followed by a large V-bank carbon adsorber, will treat 65,000 ft^3/min of air flow.

The IPS has three shafts, each of which is approximately 35m in diameter and 72m deep. The low profile, small footprint odor control systems will be located near the top of one of the shafts, approximately 14m underground and at an elevation of 10m below sea level.

The IPS will be the initial section to be completed at the CWRP. It will come on-line later next year while the rest of the plant is still being constructed. To cover operation of the system through completion of the plant, USFilter is providing an extended four-year warranty.

The LO/PRO® system is a "once-through," three-stage absorption system consisting of a gas conditioning/pre-treatment removal stage followed by two vertical counter-current gas absorption sections. The systems remove ammonia (NH_3) and hydrogen sulfide (H_2S) from the NH_3- and H_2S-producing plant process areas and exhaust the deodorised air into the atmosphere, using sulfuric acid (H_2SO_4), sodium hydroxide (NaOH) and sodium hypochlorite (NaOCl). This multi-stage, high-efficiency scrubbing guarantees a minimum overall removal efficiency of over 99.9%, also minimising chemical discharge to the environment. The LO/PRO® system handles air flow rates up to 65,000 ft^3/min, treats multiple contaminants, has low operating costs and requires little maintenance.

Fine- and Coarse-bubble Aeration

USFilter Envirex Products will also provide the Changi facility with nearly 40,000 DualAir® fine-bubble and WideBand™ coarse-bubble diffuser systems to aerate wastewater for secondary treatment.

The DualAir membrane fine-bubble diffuser systems' design – two diffuser bases connected by a curved saddle that fits over conventional CPVC air distribution piping – allows twice as many saddles to be mounted to a given length of pipe, compared to conventional single-pod diffuser designs.

Specifically, 960 DualAir membrane fine-bubble diffusers will be installed in four oil and grease skimmer basins and 36,000 DualAir ceramic fine-bubble diffusers will be installed in two bioreactor basins (aerobic zones). The systems' design–two diffuser bases connected by a curved saddle that fits over conventional CPVC air distribution piping–allows twice as many saddles to be mounted to a given length of pipe, compared to conventional single-pod diffuser designs.

Another key benefit to using the diffusers includes reducing the header pipe and associated supports by 50%. This subsequently reduces installation costs and frees up more area in the tanks, which allows operators easier access to the diffusers during maintenance.

Likewise, 4,224 WideBand coarse-bubble diffusers will be installed in two bioreactor basins (anoxic zones). These diffusers are made of 316 stainless steel. Introducing air sequentially in the anoxic zones raises the water level in a given zone and moves scum downstream.

Space-saving Primary and Secondary Treatment

USFilter Envirex Products will supply the CWRP with 464 chain and scraper clarifier mechanisms. The mechanisms will include:

- eight grease removal tanks, each with two skimmer mechanisms (sixteen mechanisms);
- sixteen primary clarifiers, each with four mechanisms (64 mechanisms);
- 32 secondary clarifiers, each with eight mechanisms (256 mechanisms) and four skimmers per tank (128 two-shaft skimmers);
- 96 scum pipes; and
- 464 flight monitoring system with control panels.

Envirex Products will engineer the unique, space-saving system at its facility in Waukesha, Wis., USA. The chain and scraper stacked clarifier system is the largest such installation in the world.

The project consultant recalls evaluating several stacked clarifier installations, namely those in Singapore and Boston, USA, before recommending USFilter's equipment.

The chain and scraper mechanisms will form the heart of 48 stacked clarifiers, constructed one upon the other to reduce the footprint while providing a high volume of quality effluent. The sludge collectors are composed of stainless steel chains and Envirex specially designed "Diamond" fiberglass flights. Fabricated with high-strength fibreglass strands entirely encapsulated in a water-resistant resin, the flights are designed for longer service life than conventional channel flights. The components will operate in covered tanks, limiting visual inspection.

Asdor-supplied Diamond Seal™ discharge slide gates in the cake storage silos will feed five dryer trains each 11 tonnes/hr Ev. rate.

Much of Singapore's Changi Water Reclamation Plant will be underground.

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"This is one of the main reasons stainless steel chains are preferred for use in stacked clarifiers, as opposed to non-metallic chains," says Govar Katta, P.E., director of international sales and marketing for USFilter Envirex Products.

"We recommended installing the mechanisms because of the system's reduced footprint, as well as USFilter's prior experience at similar facilities," continues the project consultant. "And despite the distance from Wisconsin to Singapore, we were always able to obtain local support through their local representative."

Solids conveyance and handling system

USFilter Asdor Products will be supplying over 500m of screw conveyors and 50 discharge slide gates for the pre- and post-dewatered sludge drying system process.

Asdor Products' supply scope will collect dewatered sludge from centrifuges, delivering it to cake storage silos through a system of screw conveyors. In addition, Asdor-supplied Diamond Seal™ discharge slide gates in the cake storage silos will feed five dryer trains each 11 tonnes/hr Ev. rate.

Upstream at the headworks area, Asdor Products will provide the storage and handling facility for the washed and dewatered screenings and grit.

Other partners on the DTSS Project

The other partners along with USFilter in the Changi DTSS project are:

- Public Utilities Board of Singapore (PUB)
- Project Engineering Consultant CH2M Hill
- General contractor Lum Chang Building Contractors Pte. Ltd., Singapore (C2B);
- General contractor Koh Brothers Building and Civil Engineering Contractor Pte. Ltd., Singapore (C3A);
- General contractor Sembcorp Engineers and Constructors Pte Ltd., Singapore (C3B), (EP3);
- General contractor Keppel Engineering Pte., Ltd., Singapore (C3D);
- General contractor United Engineers Ltd. / Voltas, Singapore (C3C);
- Local representatives: **Bill Reilly Jr.** of William H. Reilly, Portland, Ore., USA and **Wayne Ho** of Water & Waste Pollution Engineering Pte. Ltd., Singapore.

Once completed in 2008, Singapore's Changi WRP will help reclaim 800,000 m^3/d of wastewater. The project is currently under construction and on schedule. ***AW***

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