

Wastewater — a suitable case for treatment

Wastewater treatment is a multi-billion-euro contributor to the global water-supply industry, where efficiency is literally vital for commercial survival — as well as for public health and well-being. A relative newcomer to the Siemens family, Siemens Turbomachinery Equipment A/S is an acknowledged expert in this niche engineering sector, helping the industry to raise efficiency in terms of both energy usage and wastewater treatment, improving effluent quality and financial health of the utilities.

In today's aggressively competitive environment, the need to apply the most cost-effective industrial engineering solutions is vital for commercial health. The water and sewerage companies, in common with other public utilities and service providers in industrialized countries worldwide, not only face tougher commercial competition, but are also being forced to meet tighter environmental and quality controls. Wastewater, industrial effluent and sewage treatment operations have had to clean up their acts to comply with the latest statutory limits, reducing environmental impact to an absolute minimum.

Danish roots in sludge

Based in the historic city of Helsingør in Denmark, Siemens Turbomachinery Equipment is a small, specialized company manufacturing and supplying state-of-the-art, single-stage turbo-compressors and associated automated control equipment, principally for waste water aeration in 'activated sludge' biological treatment systems. Formerly a part of the Kühnle, Kopp & Kausch (K,K&K) organization acquired by Siemens in November 2006, the company has fewer than 270 employees, but is an acknowledged world leader in this niche market, with over 6,000 units installed world-wide and a current annual turnover of around €85 million.

The wonderfully-named 'activated sludge' system of wastewater treatment involves forcing air through a network of specially-designed fine bubble-generating diffusers, installed typically in the base of treatment tanks, raising oxygen levels in the water in exactly the same way as a 'bubbler' in an aquarium for pet fish. The oxygenated wastewater stimulates the growth of microorganisms, which subsequently break down the dissolved biological matter, converting it to an inert sludge which, after further treatment, can be disposed of or used for agricultural purposes. The final cleaned effluent can be discharged with complete safety into watercourses or used for irrigation.

Drive for efficiency

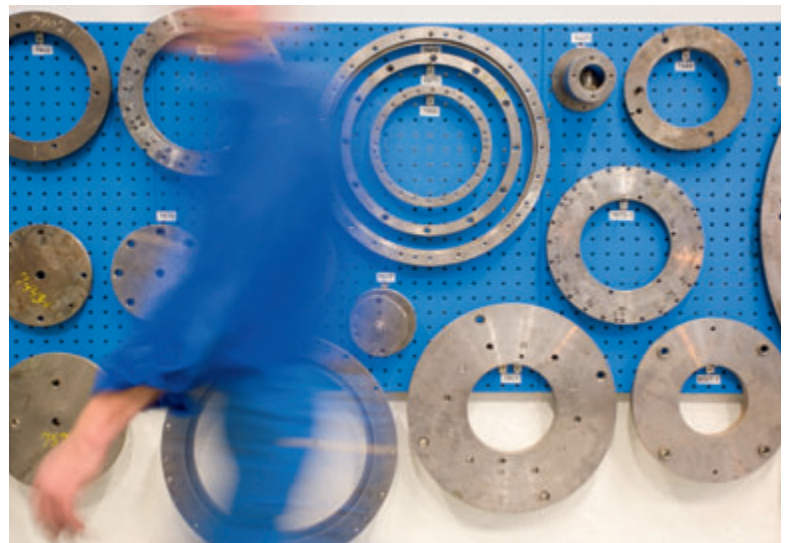
The turbo-compressors manufactured in Helsingør are motor/gearbox-driven machines designed for constant speed and constant mass-flow operation, giving the highest possible operating efficiency. This system, combined with the hydrodynamic bearings fitted to the compressor, means that scheduled maintenance intervals are increased to 100,000 operating hours. Airflow is controlled using a combination of inlet guide vanes (IGVs) and outlet diffuser comprising a series of variable discharge vanes. The electronically controlled





"Initial investments included latest 5-axis CNC machines, cutting impeller machining steps from 6 to just 2."

Franz Alig, CEO Siemens Turbomachinery Equipment





Ensuring maximum efficiency over an extremely wide operating field: adjustable inlet guide vanes and discharge vanes (diffusers) of typical Siemens compressors for aeration applications.

IGVs, combined with individually designed impellers, allow each compressor to be customized to meet precise customer requirements for inlet temperature, pressure and flow. At the same time, the discharge vanes enable the output airflow to be controlled from 100 percent to a downturn of just 45 percent. The fully automated control system not only gives the customer very precise control of output airflow, but also enables the system to compensate for seasonal changes in atmospheric conditions, including air temperature, humidity and density, at any given location around the globe. Currently there are eight turbo-compressor units in the range, providing output airflows from 1,500 up to 125,000 cubic meters per hour in power ratings from 50 kW to 3300 kW.

Non-stop running

The very high level of output turndown provided by all machines in the range means that, by using two similarly-rated compressors in tandem, the operator can vary the output airflow from 45 percent up to the full 200 percent discharge from the twinned installation. This unprecedented control facility allows overall plant-operating efficiency to be raised still further, reducing energy demand and cutting operational costs very significantly. By its very nature, the aerobic treatment of wastewater is necessarily a continuous process,

which must operate 24/7, 365 days per year. A typical installation will employ a total of three compressors operating under a cascaded control system, with two tandem units to provide optimum airflow and a third standby machine giving a high level of redundancy. The system also allows all three compressors to operate in rotational sequence to equalize the running hours, the automated system enabling each machine to be shut down and re-started in sequence, without the need to shut down the two remaining operational units or disrupting continuous plant operation.

The ABC of controlled savings

As aeration represents well over 50 percent of the total energy demand of an entire wastewater treatment plant, any possible savings through increased efficiency offer a major advantage for the operating utility. The combination of compact design, dual-vane control and constant mass-flow in Siemens' Helsingør-manufactured turbo-compressors yields world-beating mechanical efficiency of some 85 percent, reducing energy costs significantly. Nevertheless, where the aeration system is operated under simple open-loop manual or semi-automated control, energy can be wasted through excessive airflow and high dissolved-oxygen levels. Alternatively, biological action and treatment will cease completely if levels

Besos' wastewater treatment plant near Barcelona, Spain. The company owns 16 wastewater treatment plants with a total capacity of 800,000 inhabitant equivalents, serving 52 municipalities with 500,000 inhabitants alongside the Besos river.



are allowed to fall too low, leading to plant breakdown and major environmental problems.

However, Siemens' aeration units are designed to operate with twin-track automation, combining electro-mechanical systems and a specially developed Air-Biological Control, or 'ABC' system, in a fully integrated control loop. Oxygen probes measuring dissolved O₂ levels together with airflow and discharge-pressure controls are installed in conjunction with an adaptive set-point pressure control to provide optimum aerobic treatment conditions. Over a typical 20-year life-cycle where energy usage amounts to between 95 and 97 per cent of the total running costs of an aeration unit, Siemens' dedicated focus on system reliability and energy efficiency is enabling water treatment utility companies to slash their energy bills by up to a staggering 40 percent, compared with conventional systems from other suppliers.

Pay as you benefit

At a time when the availability of credit for capital equipment replacement projects is at an all-time low, it takes some creativity to promote advanced technology. In order to ease investment decisions in favor of Siemens-

based upgrades to existing obsolescent and inefficient equipment, Siemens Financial Services offers a dedicated financing scheme. Simply put, it lets customers pay for their new, energy-efficient solution with the money the solution saves them in terms of energy costs. Typical payback times on capital expenditure are less than 5 years, after which customers can fully enjoy ownership and benefits of the Siemens solution over its remaining service life of an averaged 15 years.

The wider perspective

While Siemens' aeration equipment and technological solutions have become the systems of choice throughout the wastewater treatment industry, applications are not just limited to this niche market, but include a number of fermentation processes in yeast and second-generation biofuel production, as well as onshore fish farms. With further control-system technologies already in an advanced stage of development, this newest member of the Siemens Oil and Gas business is set to meet the challenges and demands of the industry for even higher water quality, energy efficiency and plant reliability, for the foreseeable future.

SHOWCASE

Cleaning up in Spain

While design parameters, theoretical facts, figures and colorful presentations may provide a certain degree of assurance, real-life case-studies can help to convince even the most skeptical of engineers about the true performance of systems and equipment. Venture takes a close look at a recent installation where Siemens is helping a water utility save money — and the environment.

Located some 30 km north of Barcelona in Spain's Catalonia region, the city of Granollers is a major commercial and industrial manufacturing center, despite an agricultural history underlined by its name, derived from the Latin word for grain. Serving the city together with the surrounding municipalities of Canovelles, Les Franqueses del Vallès and the neighborhood of La Torreta in La Roca del Vallès, the Granollers wastewater treatment plant is owned by the locally based Besos company.

Although the plant is independently operated, Besos is responsible for quality control, maintenance and all research and development covering not only the Granollers plant, but also the fifteen other similar regional treatment plants owned by the company.



The bubbles, the Siemens solution, and a happy customer: "After a full 9 months of continuous operation, overall performance has exceeded our expectations. The new compressors operate faultlessly, and energy savings are at around 30 percent." Angel Freixó i Rey, responsible for R&D&I at Besos' Granollers plant.

Meeting expectations

The Granollers plant is capable of treating around 30,000 cubic meters of industrial and domestic wastewater per day, sufficient to meet the requirements of a population of some 200,000 people. The plant layout is designed to provide n+1 redundancy, with two Siemens aeration-compressor units in continuous operation and a further standby unit to enable each machine to be taken out of service in rotation for routine maintenance. As energy use comprises some 30 percent of total plant-operating costs, second only to the expense of sludge disposal, Besos' choice of aeration treatment system was heavily dependent on its energy-saving potential as well as both its performance and reliability.

Based on the technical specifications in Siemens' original proposal, possible energy savings were estimated to be between 20 and 25 percent, and three units were supplied together with Siemens' Air-Biological Control (ABC) to the Granollers plant. Following the subsequent installation of the Siemens compressors and controls, Besos has confirmed that, after a full 9 months of continuous operation, overall performance has exceeded expectations, the new compressors providing faultless operation coupled with energy savings

running at around 30 percent — an outstanding result made possible by the unique combination of mechanical and biological control systems.

New moves

Underlining Besos' satisfaction with the performance of the new compressor systems and the very significant reduction in running costs at its Granollers treatment facility, the company is now looking to install energy-saving Siemens aeration compressor-units as standard at all its other 15 wastewater treatment plants in the region. The move to standardize with Siemens systems will not only reduce total energy use, but will reduce through-life cost of ownership over the company's entire portfolio, through reductions in both spares and maintenance requirements.

In an ideal scenario where wastewater treatment plants throughout Spain were to be re-equipped with high efficiency Siemens aeration systems, daily energy usage would plummet by a minimum of 480 megawatts, equivalent to around half the output — and half the CO₂ — from a billion-plus-euro coal-fired electricity generating plant.



Based on a mathematical model of optimum aerobic conditions for the bacteria used in biological wastewater treatment, Siemens' Air-Biological Control (ABC) provides for a further boost in energy savings by adding a new level of accuracy to the aeration control system.