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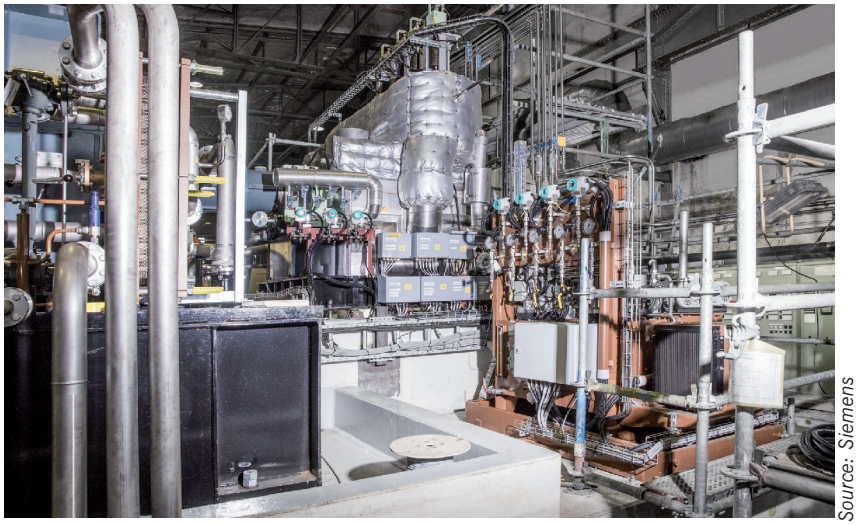
Historical facade houses state-of-the-art technology: How a chemical plant is optimizing its in-house energy production

Chemical park producing its energy 15 percent more efficiently



The new 12 megawatt Model SST-600 steam turbine and its generator were both fabricated at Siemens' manufacturing location in the Czech city of Brno.

Source: Siemens

POWER SUPPLY | The former Ruhrchemie Plant, today a chemical production complex of the company Oxea GmbH, operates around the clock, 365 days a year. Operations there require continuous, uninterrupted supply of electricity and heat. The company is now in the process of installing a modern, high-efficiency turbine-generator unit to replace an historical 63 year old radial steam turbine from Siemens that has clocked 400,000 operating hours serving the site's cogeneration plant. The move will enhance cost-effectiveness and thus profitability, while increasing energy-cycle efficiency by 15 percent.

The power plant building on the grounds of the Oxea chemical production site in Oberhausen-Holten, Germany, formerly the Ruhrchemie Plant, reveals the long history of this industrial complex. Behind its historical facade, several dozen engineers, industrial mechanics, piping planners and chemical plant technicians are hard at work. They ensure that the chemical company's energy-intensive processes are continuously supplied with electric power and steam around the clock.

Oxea GmbH uses the oxo synthesis process developed by the German chemist Otto Roelen – otherwise known as hydroformylation – to transform unsaturated hydrocarbons such as propylene and ethylene into aldehydes by adding syngas. Oxea either sells the aldehyde or uses it to produce what are termed oxo intermediates – alcohols and esters, for example – as well as oxo derivatives such as carboxylic acids, polyols, amines and special esters.

Although not highly visible products, these substances go into making many everyday products such as sunscreen lotions, detergents, plastics, paints and varnishes. The company, which was acquired by Oman Oil Company (OOC) in 2013, has a yearly production capacity exceeding 1.3 million tons and annual sales totaling some € 1.5 billion, producing more than 70 different oxo chemicals destined for a multitude of end-applications. Company information shows that just one average car alone contains 7.5 kilograms of products that originate from Oxea.

Byproducts are used to generate steam and electricity

While almost every chemical reaction produces multiple end-products, industrial applications generally seek to generate only one of those substances as its specific final product. Oxea's on-site combined heat and power plant thermally recycles all liquid and gaseous byproducts of its own chemical production processes and those of the other six companies operating at the chemical industrial park. „All of these byproducts can be thermally recycled", explains Martin Riering, Head of Operational Infrastructure, Power Supply and Energy Assessment at Oxea. Two high-pressure boilers and two exhaust gas-fired boilers enable this energy conversion. Approximately two thirds of the fuel mix is comprised of process exhaust gas, and one third of liquid byproducts. Purchased natural gas makes up only a very small percentage of the mix. The steam generated by firing this gas mix drives two Siemens industrial steam turbine-generator units which, all told, produce some 130 gigawatt hours of electricity – enough to meet the complete power demand of Oxea GmbH. As part of plant modernization efforts aimed, too, at increasing efficiency, Oxea is this year installing a new, state-of-the-art steam turbine-generator unit to replace a back-pressure steam turbine built in 1954 and its paired generator.

Chemical plants require safe, reliable and competitively priced energy supply

Oxea manages industrial park grounds measuring some 1.2 square kilometers in size and, as local operator of the site's energy distribution grids, supplies its location partners with the necessary energy in the form, for example, of electricity and steam. The site's power plant also produces compressed air, demineralized water, hot water and heat for the regional district heating system. The steam generated in the high-pressure boilers is discharged at a temperature of 500 °C and a pressure of about 110 bar to the steam turbines, which regulate the steam flow and route it via various process steam networks in the 3, 18, 30 and 60 bar pressure ranges to the various energy-intensive raw-material chemical processes in operation around the industrial park. „We need extremely reliable base-load input of electric power and heat to be able to ensure continuous, uninterrupted supply to our customers", notes Riering. Plant operations run around the clock, every day of the year. Outages are scheduled solely for

Source: Oxea

The Oxea plant grounds in the Holten District of Oberhausen, Germany, cover some 1.2 square kilometers.

Source: Oxea

Siemens' new 12 megawatt Model SST-600 steam turbine arrives at the chemical plant.

Source: Siemens

A fitter operates the crane suspended from the roof of the Oxea power plant building to hoist the old turbine-generator unit.

maintenance and inspection purposes.

Ready availability of energy at an economical price – especially electricity – is vital to ensuring the competitiveness of resultant chemical products on the international market. The overall chemical industrial park consumes about 730 gigawatt hours of electric power every year.

Stethoscope used to examine historical turbine

This is why the company is investing not only to expand production, but also to enhance the efficiency of its energy generating facilities. There, the historical 15.2 megawatt Siemens steam turbine has been reliably running for 400,000 operating hours since 1954. According to the Munich-based manufacturer, it's the last Siemens radial turbine still in operation in Germany. „The old turbine is fully intact and functions flawlessly", Riering emphasizes. „Still, we've opted to purchase a new unit for reasons of cost-effectiveness and energy efficiency." Another consideration is that the crew familiar with the historical unit's technology – know-how particularly important for maintenance and inspection outages – is slowly shrinking as older staff members retire. In former times, personnel would simply place their hand on the turbine, for example, to check its temperature. One older colleague even checked the turbine bearings using a sort of turbine stethoscope to determine if it was running smoothly and free of friction. Nowadays, in contrast, bearings in modern turbines are under continuous surveillance by a vibration monitoring system, and precisely checked for displacement down to a tenth of a millimeter.

Replacing both the generator and turbine was the most economical solution

The unit's generator had likewise been showing its years, exhibiting the aging-induced signs of wear in its winding and insulation and increased partial discharge typical for its long period of service. With the risk of equipment failure rising, Oxea considered three options: First, it would have been possible to install a new generator winding, a measure which, however, would have entailed long outage periods. Secondly, the company could have opted to replace the generator only. The third variant was to place both the generator and turbine with new units. „Ultimately, this proved to be the most economical solution for us", explains Riering. In December 2016, Siemens was contracted to supply the new equipment.

Replacement executed to chemical plant's tight time schedule

Oxea set a firm, tight time schedule for the replacement project: The new turbine-generator unit needed to be commissioned and operating within only about 11 months after the order was placed. As Riering recounts, „Siemens was the only manufacturer to offer an attractive total solution that met our demanding time schedule and what we envisaged in terms of pricing, and was simultaneously able to flexibly adapt to our technical environment". The new 12 megawatt Model SST-600 steam turbine and its generator were both fabricated at Siemens' manufacturing location in the Czech city of Brno. The machines have meanwhile been delivered to the Oxea Chemical Plant together with the associated auxiliary systems, including the lube oil system, the high-pressure control oil system and the instrumentation and control (I&C) system. Siemens' experts delivered the turbine-generator unit in three packages that would fit through the transfer opening in the floor slab of the turbine building. The main steam lines were inspected in early November 2017, and further tests and examinations performed. Commissioning is already underway and handover to Oxea (PAC), planned to take place before Christmas, is right on schedule.

The new turbine is 15 percent more efficient

Oxea and Siemens jointly analyzed the capacity utilization of the old turbine-generator unit in recent years when planning and designing the new SST-600 turbine. The old back-pressure steam turbine had been run at 70 percent capacity on average. The unit's load adjustment must be able to change spontaneously on demand. „This rapid load changing poses a challenge for turbines", explains Christoph Küpper, the responsible Service engineer at Siemens. Hence, the newly planned steam turbine was designed for Oxea so that it achieves its highest efficiency rating at 70 % capacity utilization. Three conventional valves and one overload valve ensure that the turbine, when necessary, can also process the maximum main steam flow volume. As a result, the new turbine is significantly smaller than the old one, and consumes only 114 tons of main steam per hour instead of 130 tons to produce the same performance output. The I&C system installed in the turbine ensures steady, consistent capacity utilization and is integrated into the chemical plant's overall digital control system. Leakage steam volumes have been reduced from around one ton previously to about 100 kilograms now.

Oxea is convinced that the new solution is the right one: „We're very pleased that, together with Siemens, we've succeeded in meeting the set time schedule, and anticipate a more than 15 percent increase in efficiency over the previous energy supply system", exclaims Riering. What's more, the efficiency of the electrical generator has significantly improved. The real show-stopper is that the old turbine-generator set will continue producing power right up to the final day before startup of the SST-600, and operational changeover to the new unit will take place without need for any outage.

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