Low-pressure compressors support flue gas desulphurization

Exact oxidation air supply saves 18% of energy

RWE uses three-low pressure centrifugal compressors from Atlas Copco in the Ibbenbüren power plant to generate oxidation air for the flue gas desulphurization installation. The turbo installation has lowered their energy needs by 18%. The user also profits from the high availability of the oil-free compressors, which hardly require maintenance due to their motor with a permanent magnet.

Fig. 1: The coal power plant in Ibbenbüren.

ESSEN, GERMANY, DECEMBER 2010 – "Flue gas desulphurization is very complicated," said Manfred Hollekamp, specialist for this process at the power provider RWE Power AG in Werne and Ibbenbüren. The company burns anthracite in Ibbenbüren which is mined right next to the power plant. In order to desulphurize any resulting flue gas in the two-circuit absorbers, RWE must add an exactly defined amount of oxidation air. "Otherwise, the sulfur sticks together in the installation and cakes everywhere," Hollekamp explained. "Too little air is just as bad as too much." That could cause the reaction to take place too early or start at the wrong location in the installation.

RWE has the process under proper control using three type ZB 130 VSD low-pressure centrifugal compressors from Atlas Copco. They were installed in 2009 as part of a power plant overhaul. "This allows us to produce the exact amount of oxidation air we need at any given moment," said Uwe Jäkel, a consultant in the installation procurement and machinery department in Ibbenbüren. The machines are all speed-controlled (as indicated by the abbreviation VSD), allowing their volume flow to be adjusted precisely according to need. "This enables us to save 18.1% in energy compared to earlier."

Precision Control Keeps the Pressure Band Stable and Increases Efficiency

The precise higher-level control system for the three machines also contributes to the savings. The energy saving and compressor control system ES 130 T performs this function. This means that the compressors are always uniformly loaded. "Ideally, the machines should always operate at the most cost-effective point," stressed Jäkel. However, for speed-controlled compressors, this is "somewhere in the partial load operation range". This could mean that two or three blowers could also be activated simultaneously when one would be sufficient.

The system is designed with three ZB turbos for a volume flow of 13 680 m^3/h, but no more than 12 000 m^3/h is required. The pressure requirement for the air to be blown into the flue gas desulphurization installation (REA) is on average less than 1 bar according to RWE. "This depends greatly on the process," Hollekamp explained. "Today, the machines run with pressure increases of just 0.6 bar each." The Atlas Copco compressors keep the pressure band totally stable in the process, which is an

Fig. 2: Three type ZB 130 VSD speed-controlled low-pressure compressors by Atlas Copco produce oxidation air for flue gas desulphurization installation in the Ibbenbüren power plant. Power consumption has dropped by 18.1% compared to earlier.

Fig. 3: Distributor for three absorbers where the flue gas is desulphurized. This is where the sulfuric acid components of the gas are combined with the alkali portions of the added lime wash. The result is gypsum and clean exhaust air.

Fig. 4: The compressed air is routed over the white distributing main into the absorber.

additional reason for the efficiency of the system. The pressure required is the result of the back pressure of the ducting and the static back pressure of the liquid sump in the absorbers of the REA, where the air is sprayed using spray lances.

RWE decided on the investment in 2008, when it became known that the power plant would be upgraded in 2009 and the performance of the REA required optimizing. The compressed air distribution system to the absorbers was also rebuilt with larger cross sections and equipped with better measurement technology. The user also wanted the option of being able to generate more air than the older system. On top of this, the old compressors had been operating since 1985 when the power plant first was connected to the mains, and one compressor had damage which was no longer feasible to repair. "The high energy requirement of the machines had bothered us for a long time," Uwe Jäkel explained. "They would only run at full load or at idle, and could not be regulated at all."

2.8 Million Cubic Meters of Flue Gas per Hour

As a result, Hollekamp and Jäkel had been looking for an energy-efficient and future-oriented low pressure system to provide oxidation air for their REA. "We produce 2.8 million cubic meters of flue gas per hour," Jäkel explained. "It needs to have dust and sulfuric acid components cleaned out of it." Over 99% of the dust is removed by an electrostatic precipitator which is as large as a gymnasium. Acid components are retrieved from the gas by RWE using three absorbers, with the help of the ZB compressors. The absorbers operate using the counter-current process, so they are also called "counter-current washers". Underneath this is the "sump" made of lime wash, which is circulated as absorber and is sprayed using a sprayer from above on the flue gas containing sulfur dioxide. This is again incorporated from below in the washer. On the way up, the sulfur acids of the gas bond with the basic portions of the limestone, producing a gypsum intermediate product. This product is used in the construction industry as reusable material; it can be made into plasterboard or used in cement.

Modular Construction and Good Regulation Options

Carrying out a market comparison produced multiple reasons in favor of low-pressure compressors from Atlas Copco. "The modular construction as well as the excellent regulation options was impressive," Uwe Jäkel said. "The specific energy requirements were also lower than the other compressors we looked at." Jäkel did not get this statement from the catalog, as you might expect, but from a mathematician from his own company who carried out the calculation. "He came to the conclusion that the machines, based on their components and design, had to require less energy than the others we looked at." The result – 18% less power consumption in the REA – has since confirmed RWE expectations, plus a little extra: "The performance of the ZB turbos were actually eight to nine percent higher than what Atlas Copco promised," Uwe Jäkel said.

In the end, the significantly reduced energy requirement of the compressors increases the overall effectiveness and thus the efficiency of the installation. "This is not only economical, but good for the environment," Manfred Hollekamp said. "At the end of the day, the power plant uses less coal per kilowatt hour produced." The controllability of the compressors is a typical component of numerous RWE investments in existing installation technology; controllability means flexibility and everything flexibility increases, improving the profitability of a power plant on the current energy market.

Hard Coal that is Difficult to Burn Requires a Lot of Auxiliary Air

The type of coal that is needed and burned in Ibbenbüren also played a role in the decision, Uwe Jäkel stressed. Anthracite has a different composition than a lot of imported coal. "If we were using a different type of coal here, we might not need to add any oxidation air, or perhaps the amount would not need to be controlled so precisely," he explained. A simpler blower might have been enough in that case. The local coal is difficult to burn, requiring precise doses of auxiliary air. To be

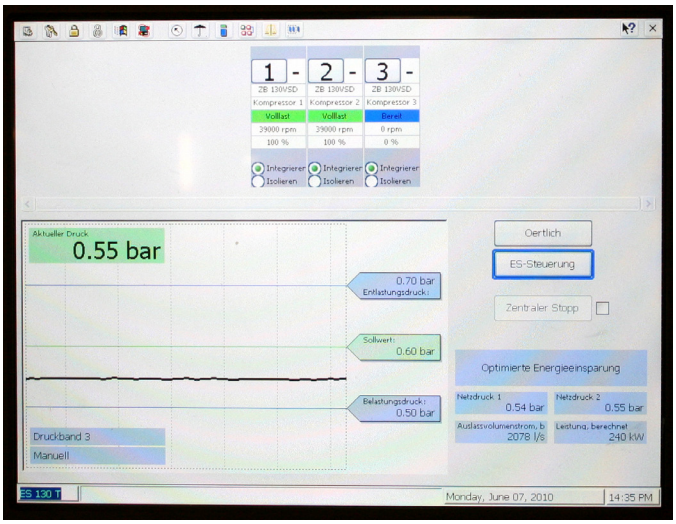

Fig. 5: ZB compressors produce compressed air with low operating overpressure of about 0.5 to 1 bar for RWE, depending on the variable flue gas desulphurization process. Regardless of the ideal value at any point in time, higher-level control unit ES 130 T keeps the pressure band very stable and lowers energy needs.

Fig. 6: Manfred Hollekamp and Uwe Jäkel are pleased with the serviceability of Atlas-Copco compressors.

able to optimally adjust the process, the electrical conductivity is constantly measured which monitors the oxidation in the washers.

The tendency of the sulfur-lime mixture to cake in the REA requires the process to be optimized and the inspection interval to be extended as much as possible, Manfred Hollekamp said. “Earlier, installations were often stopped for many weeks at short intervals,” he said. “That is absurd from the process perspective and is also not economical.” Today, an inspection is only carried out every three to four years. In the meantime it is understood that legal conditions regarding emission limits will be complied with at all times. “Today, all values are monitored by authorities around the clock online,” Hollekamp emphasized. Additionally, relevant environmental data must be kept for ten years. That alone shows how useful it is to be able to precisely control the air supply.

Non-contact Motor Running and Oil-free Operation

“Given these long inspection cycles, of course we would like all machines to run smoothly in the meantime,” Hollekamp said, referring to the low maintenance susceptibility of Atlas Copco compressors. He pointed out the permanent magnet bearing of the drive with its non-contact running, as well as the oil-free operation. “Even if the oil content could otherwise be retrieved from circulation, I would much prefer that I can do without any oil circulation and have fewer components needing maintenance or regular replacement.” The machine also runs for approximately 8000 working hours a year, i.e. almost around the clock. “With loads like this, any machine will need servicing,” Hollekamp said, “and every drive or component with a mechanical bearing assembly will need repairs for purely technical reasons.” He not only liked the design of the ZB turbos but also the unusually long warranty that Atlas Copco allows the company. “What we imagined was met 100 percent,” Uwe Jäkel emphasized, before correcting himself quickly: “Well, actually 108 percent, but don’t tell our mathematician.”

Hard Coal Power Plant, Ibbenbüren

The hard coal power plant in Ibbenbüren has a maximum electrical output of 838 MW. It was built between 1980 and 1985, was connected to the mains in 1985 and is operated by RWE Power AG. It burns very hard anthracite from the mine right next door in Ibbenbüren. The compressed air required for general control and other purposes is 104 m^3/min at 6.6 bar. Twice as much is needed for the oxidation processes in the flue gas desulphurization installation, but at a lower pressure of only 0.5 to 1 bar.

For more information, please contact
Ben Van Reybroeck
Product Manager Low Pressure of the
Atlas Copco Oil-free air division :
ben.van.reybroeck@be.atlascopco.com
or +32 3 870 47 56