Planners find EC fans convincing for refrigeration technology

There are plenty of reasons for this.

What do the Semper Opera House, Semper Art Gallery, the Zwinger and the Eissporthalle (ice sports hall) in Sportpark Ostragehege have in common? All these buildings are located in Dresden, the capital of the state of Saxony. They have yet another feature in common: all of them recently started working with modern EC fans for air conditioning and climate control systems. There are good reason for doing so, as the latest example from the Eissporthalle demonstrates.

When the river Elbe burst its banks in 2002, the *Semper Opera House,* the *Zwinger* and the old *Eissporthalle* in the Dresden district of Ostragehege were all badly affected. While renovation work on the cultural monuments has now been completed, construction is still in progress on the city's sports facilities. This is because the speed skating rink is located in the flood basin to the northwest of the inner city. To protect these facilities from future high water incidents, the city planning office and the Lower Elbe water authorities have been calling for them to be relocated outside the area of this flood basin before the next high water period due in August. A new modern sports hall is now being constructed to comply with this request. As a result, in the immediate vicinity of the existing speed skating rink, a large functional building is being erected with two ice rinks (30x60m) for competition, general public use and leisure sport. It will include an annexed ball sports hall and an administrative building for sporting event operations. The building owner and administrator is the 'Sportstätten- und Bäderbetrieb' (Sports Complex and Spa Administration Bureau) in Dresden. The 23-million EUR project is expected to be in full operation for the 2007 season. Roughly EUR 14 million of this investment total is sourced from the federal flood fund, which runs out at the end of 2006. The financing timeframe is based on this. The remaining money comes from sports promotion and federal funding.

The refrigeration system will be operable as early as October

The modernised refrigeration system will be ready for operation as early as October 2006, when the open-air speedskating season begins. For years, the season has lasted for five months, from October to March. For the existing double-stage NH_3 refrigeration plant, a request was placed with AIC-Ingenieurgesellschaft, Chemnitz, in early 2004 to modernise the ageing electrical substation following the progressive reduction from four to two refrigeration units. AIC had been servicing this refrigeration plant for many years. At the same time, an architectural competition was held for the construction of a new building. "We proposed to the operator that the new refrigeration plant for the main ice rink should incorporate operational requirements for the speedskating rink, rather than having two systems

operating within the immediate vicinity of one another", explained Dr. Egbert Thümmler, Manager of the Technical Equipment Competence Centre at AIC. "In the end, we were able to demonstrate convincingly that one new refrigeration plant for all three ice rinks would make more sense as an investment, and in terms of operating costs, than operating one modernised old one and one small new refrigeration plant. This meant that there were no further factual reasons why this proposal should not be adopted." Ultimately, AIC was awarded the contract. Planning work commenced at Easter of 2005. AIC was also entrusted with the planning for heating, ventilation and sanitary facilities, which also proved a sensible solution.

Special features of refrigeration technology

Since completion of the project, all three ice rinks are now operated by a common NH_3 refrigeration plant. During the on-site planning stages for the existing machine house, the planner found something he had not expected. Back in the days of the GDR, holes had been made in the shell of the building for the cold air return, which had then been sealed again with wooden shutters at a later date. This did not become apparent until the old plans were back on the table. At first glance, a return cooling solution employing evaporation condensers with air drawn in through the outside wall and extracted through the roof seemed to lend itself ideally. With the next plans from AIC, data from the German weather office relating to the site of this building (hourly values for temperatures and humidity) from three different years were used to recalculate operational requirements precisely. The specifications of the operator, *Sportbäder Dresden,* for actual usage of all three ice rinks were included in the calculations, and the result was compared to the use of dry coolers equipped with modern EC fans from the manufacturer ebm-papst, based in Mulfingen. The final outcome: the dry condensers are more economical for the project. There are two main reasons for this:

1. In construction terms, setting up 7 dry condensers poses no problems, because the machine building has already been prepared for this.
2. The speedskating rink does not have a roof and is only used during the colder half of the year, between early October and mid-March. As ambient temperatures rise, the ice surfaces requiring cooling are reduced in number until, finally, only one rink is left during high summer. The evaporation effect, therefore, would be at its greatest when it is not required for cooling. Owing to the fact that all three rinks are combined on the condenser side of the equation, it would be possible for all condensers to operate during partial load conditions. The control concept underlying EC technology enables each of the total 32 fans to be operated with infinitely variable speed control. This means that the entire condenser surface can be used at an optimum level in order to achieve specified set values with minimal use of energy from the fan motors.

"We have discovered a solution for preparing our ice rinks involving the use of dry condensation and direct evaporation of refrigerant NH_3 which also

renders the entire cost of the water end and water preparation end with evaporation cooling superfluous", explains Dr. Thümmler, a planner involved in this project. "This is a cost effective way of combining all three large ice rinks, especially in view of the fact that, in the summer, only one rink requires cooling. Of course, this calls for a control system which makes optimum use of the entire installed condenser output, in other words, the total surface area of the dry condensers. Because the fan speed is relative to the cube of the power output, this means that the sparing EC operation saves energy costs. In addition, ΔT air intake/outlet is very low. Even in summer, the condensation temperature is only slightly above 35°C, something which also helps reduce the operating costs of the refrigeration plant.

EC fans are quiet

Another important argument for the planner was the low level of noise generated during operation. "It is possible to operate these fans day and night under partial load conditions with low noise emissions. Compliance with the values specified by the German Federal Immission Control Ordinance (BImschV) is no problem with EC operation. There is none of the droning noise often associated with phase angle control. Compared to closed loop speed control using AC technology, we are also obtaining a much better efficiency rating here in Dresden.

AIC found another argument in favour of the use of EC fans which, in direct comparisons, is often noticed too late: the amount of wiring required, in comparison to that of closed loop speed-controlled AC motors, is greatly reduced, and redundancy on the seven condensers is automatically built into the system with 32 controllable EC axial fans (∅ 800 and 990 mm). With three-phase and AC asynchronous motors, several frequency converters are required and these in turn need to be taken into account in any comparison of costs. These condensers were supplied as complete units, together with their electronic control units, by the manufacturer thermofin.

Cost effective and energy conscious

EC technology also proved the most cost effective solution, including in terms of investment, as promised by the manufacturer ebm-papst. Independently of this, comparisons were provided during the invitation to tender. "Even during the proposal phase, quotation partners continued to seek lower-cost alternatives—without success. Ultimately, no other quotation was fielded". According to Dr. Thümmler, only very few applications still exist in which AC fans are the better alternative.

The fact that AIC was also responsible for heating, ventilation and sanitary facilities created the opportunity for an integrated approach to planning at a very early stage. Heat from the oil cooler in the screw compressor assembly is able to be recuperated at a temperature level of 55 to 60°C which is directed back into the building to heat the structure. The heating system operates a low temperature circuit (up to 55°C) and a high temperature

circuit up to 75°C. Heat given off from the refrigeration process is utilised in the following applications:

1. Heating of water for the preparation of ice
2. Thawing duct for ice fragments
3. Water for sanitary facilities
4. Underfloor heating of communal areas

Hot water is prepared in a two-stage process. First, initial heating occurs at a lower temperature, derived from recuperated heat. The rest is provided from a gas boiler.

The last point to mention is that the volume of refrigerant required to fill the direct-evaporation refrigeration plant amounts to 18 tons of ammonia. The plant is located in the immediate vicinity of Magdeburger Strasse, a residential district. Nevertheless, the use of this refrigerant was never raised as an issue in discussions. Also, the presence of a home for senior citizens opposite the site of this plant was a main reason for requiring mandatory compliance with the specifications defined in the German Federal Immission Control Ordinance (BImschV). The ultra-quiet EC operation of fans delivers full compliance with all these requirements effortlessly.

Fig. 1: Planning simulation of the finished building

Fig. 2: Each of the condensers is equipped with 4 ebm-papst EC fans

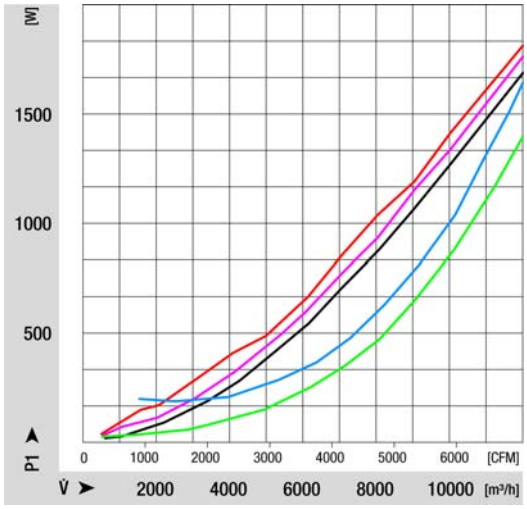

Fig. 3:

High energy savings: at every speed, the EC motor operates very efficiently. At its nominal speed, it achieves energy savings of approx. 10%. In its controlled range, the relative and absolute savings are substantially greater.

Calculation of the annual cost savings: Cs = Ps x Ec x Rt
Cs= Annual cost savings [EUR]
Ps= Power savings [kW]
Ec= Energy costs [EUR/kWh]
Rt= Run-time [h/year]

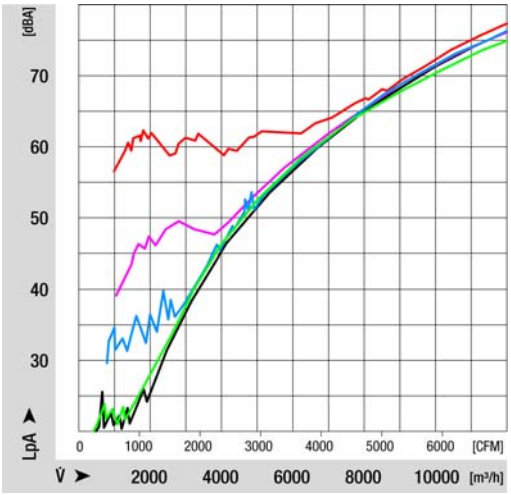

Fig. 4: Extremely quiet: no motor noise across the entire speed range. This means that peak loads can be run when there is a high requirement for cooling. When demand for cooling is low, such as at night, very low operating speeds can be selected to make operation as quiet as possible. The typical resonance levels associated with frequency inverter operation, also known as "phase noise" do not occur at all, since a different operating principle is involved.

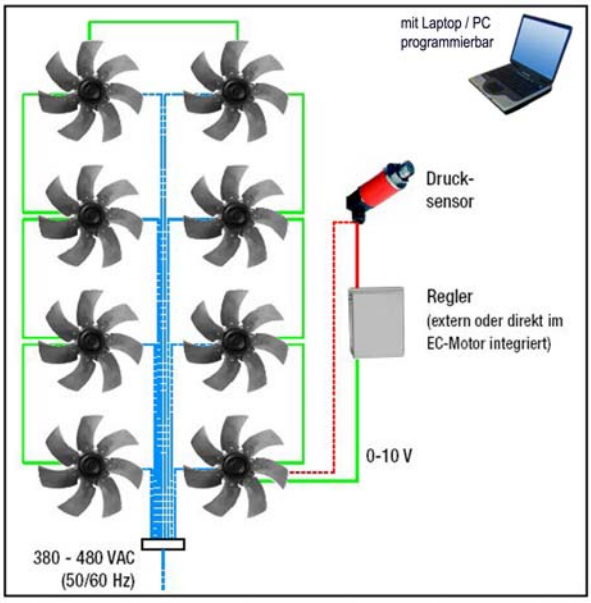

Fig. 5: New master-slave system (group control) with EC motors

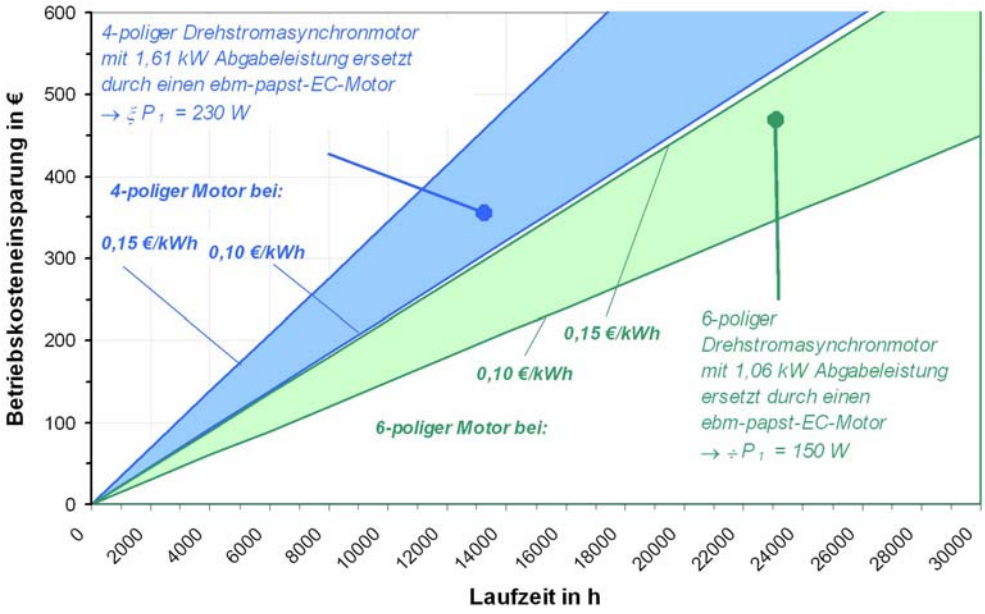

Fig. 6: Savings in operating costs when using an EC motor over its service life in various energy cost scenarios

Use free of charge: readers should contact ebm-papst in Mulfingen with any questions they may have
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Module

3 questions to Dr. Egbert Thümmler, specialist planner for the TGA and refrigeration technology for the new ice rinks in Dresden

1. ***You decided in favour of using EC technology for the condenser fans. What were your main reasons for doing so?***

Due to the highly variable load scenarios for these condensers, precise closed-loop speed control is an essential requirement while utilising the entire transmission surface area. EC technology offers optimum efficiency across the entire speed range without giving rise to any noise issues. Optimum redundancy (if one fan fails, output is reduced by less than 4%) and simple interfaces between facilities (power input 400 VAC, speed setting 0 to 10 V and 2 potential-free feedback signals – directed to just one terminal box inside the plant) are other reasons in its favour.

2. ***Did you encounter any difficulties in convincing the investor, who is also the operator of this plant, of your choice?***

The representatives of Dresden's Sports Complex and Spa Administration Bureau were very open-minded indeed about innovative solutions. Of course, when it is demonstrated that the new technology remains within the intended cost budget and that operating costs will be at an optimum level, the decision is an easy one to take.

3. ***You also planned the technical equipment for the building of the Eissporthalle (ice sports hall). In your opinion, when will the widespread use of EC technology in building systems or functional structures make commercial sense?***

The best applications for EC technology are low-power drives that are operated for long periods of time. Progress in the pump technology sector and with fans without thermal load (that is, controlled home ventilation) is rapid at the present time and, in my view, nothing is going to slow this pace in the foreseeable future.

Photo of Dr. Egbert Thümmler