

Case note

ACS 1000 variable speed drives improve efficiency of CHP power plant

The boiler feed-water pumps at Helsinki Energy's CHP plant were controlled by wound-rotor motors with slip recovery control system.

In order to reduce maintenance costs and further improve the plant's efficiency, the pump drive systems were upgraded with four ACS 1000 variable speed drive systems from ABB (each rated at 4500 kW).



A feedwater pump drive train: the gearbox in front, main pump to the right, booster pump behind the 2-shaft induction motor.

Helsinki Energy

Helsinki Energy is one of the leading experts in the world in the field of Combined Heat and Power (CHP) technology and one of the biggest energy companies producing and distributing electricity and district heat in Finland. The energy is mainly generated in the company's own CHP power plants where a remarkable share of the fuel's energy is used for district heating, instead of condensing it by sea water.

In 1990 Helsinki Energy was granted the UN International Environmental Award for its pioneering and determined work in developing CHP technology and the consequent improvement of the city's air quality.

Combined Heat & Power

The basic indicator for efficiency and environmental impact of power generation is the total efficiency achieved. The more effectively the plant is able to convert the fuel's thermal energy - either to electricity or to heat - the higher is the efficiency of the plant. Combined heat and power provides low cost energy and produces much less carbon dioxide than other power plants.

Highlights

Improved power plant efficiency
Reduced maintenance costs

Challenge

As the loading of a power plant can vary from minimum load at night time to peak load during daylight working hours, the plant's processes have to be adjusted accordingly.

The processes, in the form of liquid or gas flow, are typically driven by large electric motors with the power demand following affinity laws. There are three main principles to control the flow: either throttling it (1), or adjusting the pump speed by mechanical or electrical slip (2) or directly with a frequency converter (3).

Driving the pumps with fixed speed motors and controlling them at partial loads either by throttling or mechanically by fluid coupling decreases the power plant's efficiency tremendously.

Originally, the Hanasaari power plant's equipment was selected among the best available technologies at the time of construction to fulfill the requirements of high availability and efficiency. However, since the time of construction, variable speed drive technology had taken a big leap forward.

Even though the old ASEA and Strömberg wound-rotor motors with slip recovery control systems operated very well, Helsinki Energy decided to upgrade them in order to reduce maintenance work and to further improve the plant's efficiency.

Additionally suppliers were challenged by the limitations of the existing building.

Solution

Given the efficiency problem of boiler feed-water pumps driven by fixed speed motors at partial loads, the most economic control is achieved with a variable speed drive system.

In the spring of 1999, Helsinki Energy ordered from ABB four water-cooled ACS 1000 drive systems with AMB 560 motors and oil-immersed 3-winding supply transformers.

The Hanasaari B power plant's automation upgrade project was executed together with Helsinki Energy's HelenEngineering that specializes in the design of energy production and distribution equipment as well as in the related project management. The aim of these design and construction services is to support the profitability of business operations throughout the life cycle of the equipment.

As it was not possible to haul the complete frequency converter cabinet with a total length of only 4.7m into the building without major destruction, ABB designed and delivered the ACS 1000 drives with splittable cabinets that fit into the elevator.

Benefits

Power plant efficiency

Boiler feed-water pumps are one of the biggest energy consumers in a power plant. Operating feed-water pumps with variable speed drives can significantly increase the efficiency of a power plant.

Outside the boiler feed-water pump's nominal range, the capacity needs to be sufficient to handle rare but possible abnormal situations in a boiler that operates under very high pressure. Depending on the local authorities' requirements, the pump - and the supplying drive - have to be capable of delivering 10-25 % over pressure or overflow. As a consequence, the drive operates practically all the time under partial load, a situation where a variable speed drive offers the best available efficiency.

Reduced maintenance

Using ACS 1000 variable speed drives as level control device of feed-water drums can reduce maintenance of the feed-water throttling valves. These haven't necessarily been designed for the full pressure differential resulting from throttling the flow with fixed speed motors.

Further savings

Further savings can be achieved by designing a new generating unit's electricity distribution network for feed-water pumps operated by frequency converters.

As main loads, their across-the-line starting behavior typically impacts on - depending on impedance of the plant transformer - capital cost, either through a more expensive transformer, through higher fault currents, or a more expensive switchboard. Variable speed drives as such act as soft starters and cause no starting current peaks.

The ACS 1000 can be connected via the most common field-buses to become an integral part of the plant's control system.



ACS 1000 key data	
Inverter type	Three-level Voltage Source Inverter (VSI)
Power range	Air cooling: 315 kW - 2 MW
	Water cooling: 1.8 MW - 5 MW
Output voltage	2.3 kV, 3.3 kV, 4.0 kV, 4.16 kV (optional: 6.0 kV - 6.6 kV with step-up transformer)
Maximum output frequency	66 Hz (optional: 82.5 Hz)
Converter efficiency	Typically > 98%
Type of motor	Induction motor

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