Innovative Control Technology

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SPECIAL PRINT

Smart Automation in Heat Generation Plants

Thomas Hilbig
SAMSON AG

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Smart Automation in Heat Generation Plants

"Smart automation" has become a buzzword, not only among planners and engineers of industrial applications. In heat supply, implementing smart, efficient control systems to economically operate plants is equally important.

The requirements placed on automation systems used in thermal plants are growing more and more complex. Today, the focus no longer lies on controlling the instruments in the plants, i.e. valves, pumps and actuators: the market sets new challenges in terms of smart control systems for the manufacturers. For example, reading data from smart heat meters, visualizing entire plants, and making logged data readable are basic requirements to be complied with when implementing projects.

Of course, the same requirements apply to district heating applications, particularly if they are installed in large properties or entire residential areas. To distribute the heat generated in the heating plant without wasting energy and thus cost effectively across the residential areas, more and more energy suppliers install heat exchanger applications in small transfer stations spread across the heating network. The district heat provided is routed through heat exchangers and distributed to the consumers as required. If large-scale consumers, such as property management companies, use central heat transfer stations to distribute the delivered district heat to several apartment blocks, they usually implement heat exchanger sequence control.

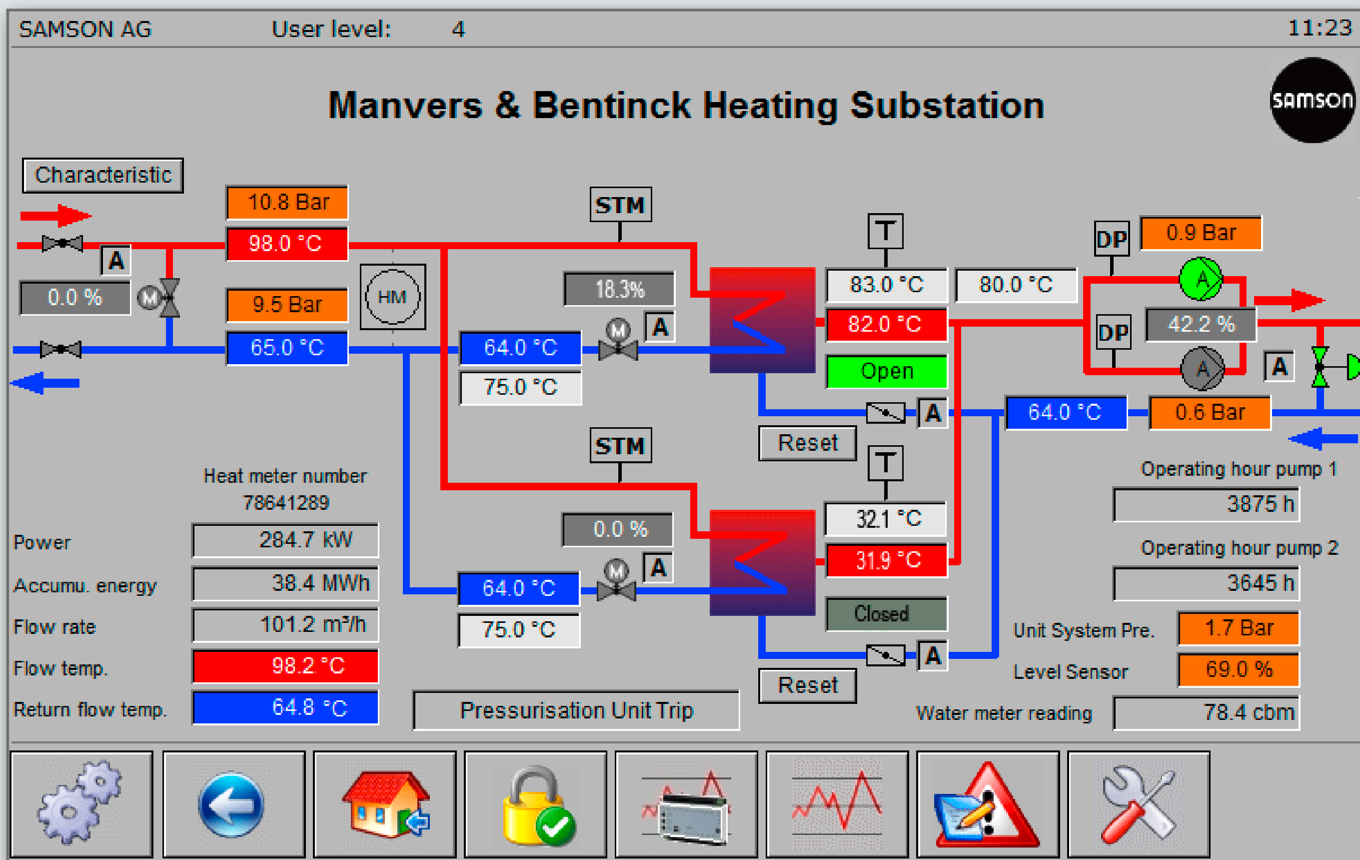

Fig. 1: Hydraulic scheme of the plant

Fig. 2: Central TROVIS 6610 CPU Module of the TROVIS 6600 Automation System

This allows the received thermal output to be reduced in times of weak loads by shutting off the heat exchanger connected in sequence. In peak load times, however, the full capacity is required. As a result, the automation system releases the sequence heat exchanger, controls the flow temperature, monitors the return flow temperature – optionally for violation of a fixed limit or a value depending on the outdoor temperature –, and controls shut-off butterfly valves and supply pumps.
These requirements make it necessary for manufacturers to no longer act as mere suppliers of devices but to provide customers with comprehensive turnkey solutions.
SAMSON has already completed a large number of projects in Germany and abroad. A current example is the residential area scheme implemented in the English city of Nottingham by Vital Energi, Enviroenergy and SAMSON Controls. Each of two residential areas is connected to the existing district heating network using a heat transfer station.
At each station, heat exchanger sequence control is implemented but sized and configured differently to cater for the different capacities consumed in the secondary circuit. The first station comes with two heat exchangers each delivering 600 kW at a connection size of DN 65. In the primary circuit, the temperature ratio is 110 °C to 70 °C, in the secondary circuit 85 °C to 65 °C. In the second station, delivery of each heat exchanger is 1 MW with a connection size of DN 80 installed in the primary circuit and DN 125 in the secondary circuit.

SAMSON Controls supplied the customer with electric control valves, flow regulators, sensors, thermostats, and the TROVIS 6600 Automation System for smart automation of the heat exchanger sequence control loops. But what tasks exactly does "smart automation" entail in heat supply?

Heat exchanger sequence

Each heat exchanger is fitted with an electric control valve in the primary circuit and a shut-off butterfly valve in the secondary circuit. The flow and return flow temperatures are measured in the supply line and in the customer circuit, and binary operating and fault messages are recorded. These messages are transmitted to the TROVIS 6600 Automation System. The system is scalable with the central TROVIS 6610 CPU Module performing the smart plant management. The CPU module is a freely programmable control unit with 20 universal inputs to optionally record binary or analog signals. In addition, twelve binary outputs and eight continuous voltage outputs are available. The system can be extended using different I/O modules, i.e. it can be adapted individually to match customer requirements.

Set points, parameters and characteristics are adjusted on the touch panel in the switching cabinet or on a mobile device. The implemented application calculates the secondary flow set point depending on the outdoor temperature, optionally based on a gradient or four-point characteristic. Of course, operators can also adjust a fixed value. To ensure that the heat exchangers work for nearly the same time, all heat exchanger demands are routed through an operating hours counter. If the operating time exceeds an adjustable threshold, the sequence of the heat exchangers is switched, causing the exchanger so far used on stand-by to take over control operation. The system detects faults occurring in a heat exchanger branch and immediately releases the second heat exchanger. Fault messages can be issued, for example, when the safety temperature limiter has been triggered or when the butterfly valve does not respond to a heat exchanger demand. The shut-off butterfly valves installed in the secondary circuit prevent the medium from flowing through a heat exchanger without demand and thus stopping the loss of heat energy. The primary return flow temperature is monitored for violation of a limit. If the measured temperature exceeds this limit, the flow set point is reduced accordingly. As a result, the system only intervenes in control operation to the degree required for the particular situation.

Double pumps

Pumps account for approximately ten percent of the worldwide energy consumption. The challenge in smart automation is to minimize the pumps' operating hours and speeds in every plant. Vital Energi opted for installing double pumps controlled by the differential pressure into the heat transfer stations. This plant section is controlled by the TROVIS 6600 Automation System as well. The differential pressure sensors are connected to the automation system using a 4 to 20 mA signal. Operators can flexibly adjust the differential pressure set point on the graphical user interface. Based on the difference between set point and actual value, a control algorithm calculates the perfect pump speed. Pump use is also switched based on the operating hours. Alternatively, pump control can be configured in split-range operation. The web interface additionally allows for manual operation of all plant components at any time, even from remote locations. To ensure that the pumps achieve their minimum speeds during low-load operation without having to transfer too much heat energy into the heating network unnecessarily, Vital Energi included a pump bypass. The pump bypass is opened based on a linear function when the calculated pump speed is lower than the pumps' minimum speed. This enables the system to operate the double pumps in an efficient and economically viable way.

Fig. 3: Electric control valve with flow regulator to control the primary bypass

To also minimize the speeds of the network pumps for the heating network operator, an additional bypass has been integrated into the primary circuit of the system. This bypass allows the heat exchanger sequence control to be shut off the network entirely. The bypass can be closed when the network temperature and heat demand are low during the summer months. This prevents the flow from being routed through unused heat exchangers without demand.

Recording meter data

In addition to actually controlling the system, analyzing consumption data is becoming more and more important. In most cases, these data are read from the smart heat meters using the meter bus or M-Bus. The bus uses electric data transmission and shows little susceptibility to faults, which makes it perfectly suited for use in thermal systems where frequency-driven pumps have meanwhile become the standard choice. In the heat transfer station in Nottingham, the heat meters are connected to the TROVIS 6600 Automation System using SAMSON's own gateway. The gateway converts the M-Bus signals into the TCP/IP protocol, which allows the meter data to be read and processed by the smart automation system. The system automatically reads the meter address and saves the measured flow and return flow temperatures, flow rate, capacity and work with their associated units into a file. Operators can use the web interface to configure the interval at which data are saved. Possible options are every 15 minutes as well as once per day, month or year. Operators can also decide on the contents and format of the log file. As the data can automatically be polled over the Internet, importing them into a billing software is possible without any problems. The recorded data can just as easily be visualized on the automation system's graphical web interface. As a result, consumption can be analyzed over the year and savings potentials can be detected and exploited.

Fig. 4: Overview of parameters on the TROVIS 6616 Web Terminal

Plant visualization

To transparently illustrate the processes that go on for the operators, TROVIS 6616 Web Terminals fitted with a touch screen are installed on site.

The web terminal has a 7″ graphical touch screen with an Android-based operating system. On screen, all plant parameters can be adjusted, manual override is possible, and alarm messages can be checked. All logged data can additionally be shown in a historical trend graph. Unauthorized access is prevented by different, password-protected user levels. This is why a function that automatically signs out users after a certain period of inactivity is already preconfigured. To minimize the wiring required, the web terminal comes with a Power over Ethernet connection. Plants are entirely visualized according to customer specifications and the visualization is saved in the TROVIS 6610 CPU Module. As the web terminal also includes a fully fledged web browser, access to the TROVIS 6610 CPU Module website is possible in addition to plant visualization. This means that no computer is required on site to adjust or change plant settings or to configure alarm notification by e-mail or mobile text message, for example.

All in all, smart automation in heat generation plants enables systems to run efficiently. This helps reduce the operators' cost and get a return on the money invested into a new plant. For manufacturers, there is the opportunity to convince customers with tailor-made solutions as well as fortify their important role in implementing new energy policies.

Thomas Hilbig, B.A.,
Product Management and Marketing,
Instrumentation and Controls, SAMSON AG,
Frankfurt am Main, Germany
E-mail: thilbig@samson.de
Phone: +49 69 4009-1744

SMART IN FLOW CONTROL.

SAMSON AG · MESS- UND REGELTECHNIK · Weismüllerstraße 3 · 60314 Frankfurt am Main, Germany
Phone: +49 69 4009-0 · Fax: +49 69 4009-1507 · E-mail: samson@samson.de · Internet: www.samson.de

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