APPLICATION REPORT

Heating, Ventilation & Air Conditioning (HVAC)

Enhanced energy measurement for a facility heating and cooling system

- Carbon-friendly air conditioning concept for office and manufacturing buildings
- Energy savings through continuous monitoring and optimisation of energy and heat flows
- Dedicated energy measurement setup consisting of flowmeters with paired temperature sensors and energy calculators

1. Background

Rising energy costs and growing regulatory requirements are encouraging many building owners and management companies to optimise their energy consumption. A major cost driver is the production and use of thermal energy for heating or cooling of manufacturing, commercial or industrial buildings.

When the KROHNE Group, one of the world's leading suppliers of process instrumentation, had a new multi-storey office building built at its headquarters in Duisburg, Germany, a few years ago, the company made the deliberate decision to use sustainable geothermal heating and air conditioning technology to meet or exceed the latest government specifications (Energy Saving Ordinance or EnEV). Like most facilities in northern climates, the heating and cooling air conditioning system operates in different modes in winter and summer. The main energy sources for this system are:

- Wells that store or extract geothermal heat energy from a depth of 155 m / 508.5 ft
- A hybrid recooling plant
- A network connection to the municipal district heating system and
- A gas-powered humidifier.

A heat pump is used in the central air-conditioning system. The building features radiant ceiling cooling with concrete core activation and water-air heat exchangers for air heating.

2. Measurement requirements

In the summer months, the cooling carrier medium passes through a hybrid cooler, which dissipates the heat and thus cools it down. The cooling medium then passes through piping that is installed within the concrete elements and corridor floors of the seven-storey building. The concrete core and underfloor cooling is

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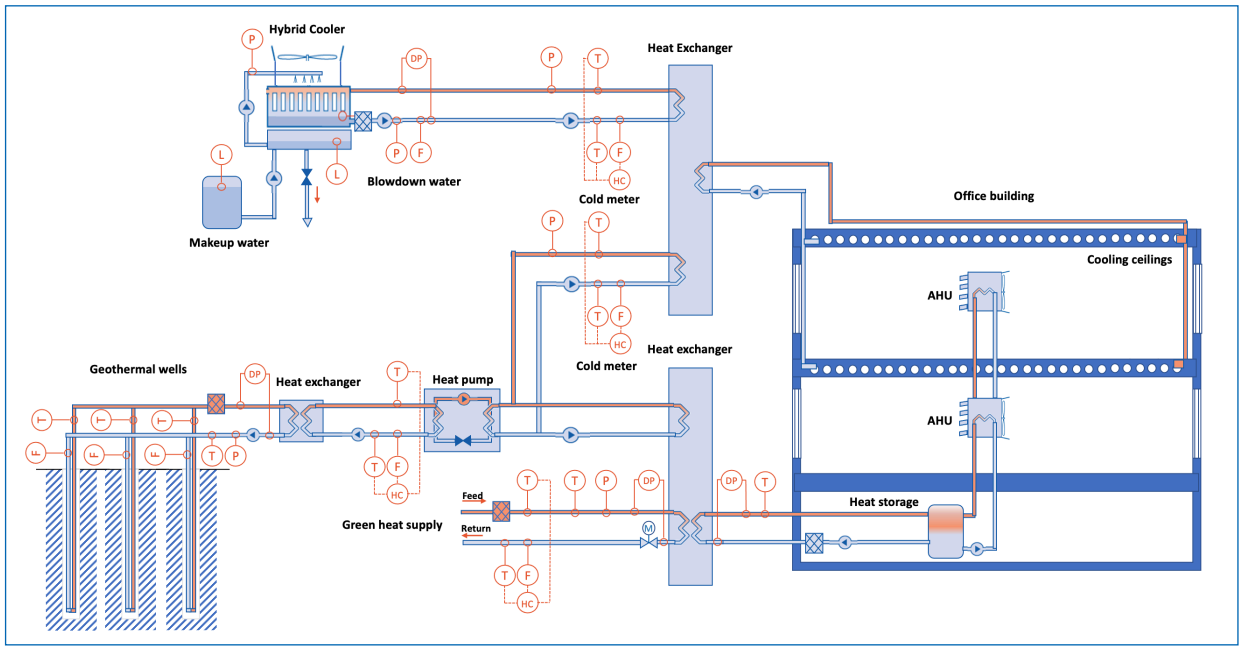
extremely effective and energy efficient. It reliably cools the offices to a comfortable working environment even at very high outdoor temperatures. If required, adiabatic, or evaporative, cooling can be activated in addition to dry cooling. In the winter months, the system uses geothermal heat or heat recovery to heat the concrete core, as well as supplying underfloor heating. Additional municipal district heating energy is only occasionally fed into the system when and if required.

Operating the system in the most cost-saving and sustainable way made it necessary to introduce comprehensive energy management. Clearly understanding the actual and long-term energy consumption, spontaneously occurring load peaks and average energy losses through better measurements helped to determine the system's optimal characteristics so that steps could be taken to gradually bring the system performance closer to the ideal.

Measurement and control technology had a crucial role in this. Therefore, KROHNE identified measuring points within the internal heating and cooling system to determine the current as well as the total consumption of thermal energy. The focus was particularly on the energy measurements in the cold and hot water circuits between the geothermal probes, the heat pumps and the heating systems, as well as between the heat exchangers and the concrete core piping in the building as shown in the process diagram below.



Process flow chart of the cooling and heating system

3. KROHNE solution

Due to the existing conditions, including many measuring points with limited installation space and only short straight inlet/outlet runs, KROHNE predominantly used WATERFLUX 3300 electromagnetic flowmeters (EMF). These meters monitor the heating and cooling water circuits and determine the transferred thermal energy. A range of DN50...125 flowmeters measure hot and cold-water flow rates for concrete core heating or cooling as well as the water quantities returned to the geothermal probes. These EMFs are designed for flow measurement of the conditioned, but still sufficiently conductive heat transfer medium. Due to their high accuracy and long-term stability, they are also certified as cold and heat meters in DIN EN 1434 / MI-004 applications. The measuring devices are used as compact version (C) or, depending on the installation, with remote transmitter as field version (F). The sensors are mainly insulated in the pipes to avoid medium heat loss.

WATERFLUX 3300 measures the return flow to the geothermal probes

To record the thermal energy consumed in the heating system, the heating system is additionally equipped with paired OPTITEMP TRA-12 temperature sensors. Based on the flow rates and temperatures, a heat calculator determines the incoming thermal energy and what is consumed and transfers that information to an energy data monitoring system that graphically displays the measured data for visualisation.

Since this innovative office building heating of the was installed, natural gas consumption at the site has already been significantly reduced. The volume of natural gas consumed by KROHNE's nearby production facility is monitored by an OPTISONIC 7300 ultrasonic flowmeter.

Energy calculator

Measurement of cold and heat with the WATERFLUX 3300


Electromagnetic flow measurement of hot water

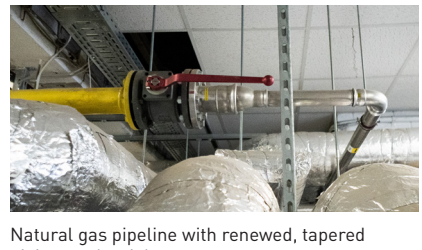

EMF with paired temperature sensor


Concrete core temperature control

Flow measurement of natural gas for the humidifier

4. Customer benefits

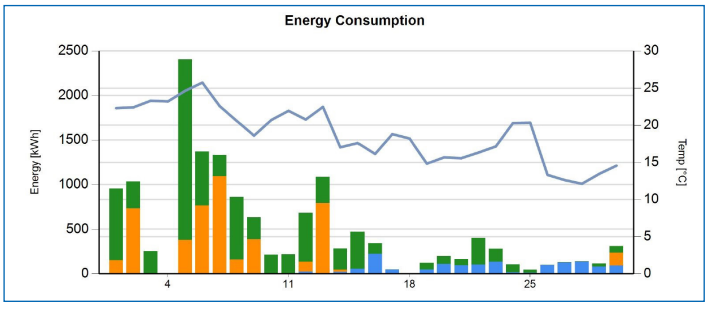
The switch from gas and district heating to geothermal energy as the main energy source has already been able to significantly reduce the costs for externally purchased energy. This is also visible in the nominal diameters of the gas pipes which have been substantially reduced because of lower natural gas consumption by using geothermal energy, heat pump technology and a modern building with optimised energy management. In this way, KROHNE has contributed to decarbonising its own heating and air conditioning system.

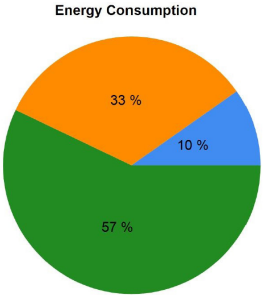

Natural gas pipeline with renewed, tapered piping on the right

The measurements enable KROHNE to further explore and realize even more potential optimisation of the heating and air conditioning system. In an ongoing process, based on the enhanced energy measurements, the company is now striving to bring the consumption and efficiency of the system ever closer to the ideal characteristic curve. Comprehensive energy data monitoring based on the measurement and calculation of flow rates and energy flows are key to monitoring and consistently reducing energy costs.

At KROHNE, all the values and measuring points can be viewed at any time via a monitoring system. Weekly evaluations provide a full overview of flow rates and energy consumption over time. In addition to regular reporting, critical operating states such as load peaks and conspicuous consumption profiles can be made visible at any time via real-time monitoring.

The monitoring system can also be used as an alarm system. Since it is also a building management system (BMS), the operating service is automatically informed in the event of malfunctions and conspicuous measurement deviations.





Data monitoring: evaluation of energy consumption (green = geothermal probe field / orange = heat pump / blue = recooling plant)

Saving resources in the long term is only possible if energy consumption is precisely measured and evaluated to make processes transparent. Companies that want sustainable energy management need to design their energy networks accordingly. KROHNE is a single source supplier of process instrumentation for certified flow technologies including ultrasonic, electromagnetic and others plus temperature sensors, level transmitters, pressure and differential pressure transmitters as well as energy calculators and flow computers.

The scope of supply goes far beyond standard applications for internal energy monitoring. We can also offer metrological consulting and project support, e.g. for the introduction of EMAS systems, and includes applications with measurements subject to billing and verification in transfer stations where the Measuring Instruments Directive applies.

Measurement of hot and cold with KROHNE electromagnetic flowmeters

5. Products used

WATERFLUX 3300

- Electromagnetic flowmeter for advanced water applications without straight inlet and outlet runs
- High accuracy (±0.2%) for water consumption measurement and distribution networks; approval according to MID MI-004 for heat/cold networks

OPTITEMP TRA-S12

- Resistance (RTD) temperature assembly for heat quantity measurements; available in paired version

OPTISONIC 7300

- Ultrasonic flowmeter for applications with natural gas, process gas and utility gas applications

Contact
Would you like further information about these or other applications?
Do you require technical advice for your application?
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