APPLICATION REPORT

Power Generation

Equipping a biomass plant with process instrumentation for billing steam quantities

- Compliance with all metrological requirements for subsidies and feed-in tariffs in accordance with the Combined Heat and Power Act
- Traceably calibrated meter runs for precise calculation of thermal energy
- Full scope of delivery from one source – from instrumentation to documentation to calibration and commissioning

STORK

1. Background

The Industrial Park Kleefse Waard (IPKW) in Arnhem, the Netherlands, was once an important production site for cellulose and nitrocellulose. Today, the industrial complex is home to manufacturing companies from various sectors and has become a pioneer in the sustainable production and use of energy. The operating company has set itself the goal of making the IPKW the most environmentally friendly industrial site in the Netherlands. To this end, the operator is investing in the expansion of renewable energy generation at the site.

Historic boiler house with new biomass boiler in the Industrial Park Kleefse Waard (IPKW)

Stork Thermeq, a leading global solution provider for steam generation and heat recovery in industrial plants, was commissioned to build a new biomass cogeneration plant. The cogeneration plant will supply sustainably produced heat and electricity to the companies in the industrial park and will also supply households in the city of Arnhem via the district heating network.

Cogeneration – the combined production of heat and power (short: CHP) – is considered particularly sustainable. The plant is therefore in principle eligible for promotion under the national Combined Heat and Power Act (CHP Act). The heat and electricity generated by cogeneration is also subsidised by feed-in tariffs.

KROHNE

2. Measurement requirements

Stork Thermeq turned the existing boiler plant into a state-of-the-art biomass-fired CHP plant. Due to the high demand for steam for the district heating network, the CHP has been equipped with a back-pressure turbine. The high-pressure steam flow produced by the boiler is split into two streams. One stream of high-pressure steam is supplied to the industrial enterprises within the industrial park, and the other stream is used for electricity production via a back-pressure turbine. The remaining heat in the low-pressure steam from the turbine is then further utilized in the district heating network.

In terms of measurement, the plant must be designed in a way that the operator can bill the process steam consumed by the industrial estate's customers. In addition, the sustainably produced energy (electricity and steam) is subject to verification as soon as the state subsidies and feed-in tariffs are claimed. It must be accounted for that only heat and electricity from CHP plants can be invoiced. Biomass CHP must therefore also be strictly separated metrologically from other plant components (e.g. auxiliary boilers and other heat sources) that are not part of sustainable energy production.

The measurement of the energy flows is carried out in accordance with the Measuring Instruments Directive (MID) and the applicable calibration law. This applies, for example, to the billing of hot water (MI-004/ OIML R-117). However, not all media are defined in the MID. For the billing of heat energy (steam) no valid calibration law applies. For the metrological design of measuring points, the best available technology is to be considered here. Appropriate measuring procedures are to be used to ensure the highest possible accuracy. Among others, this requires the measuring instruments to be traceably calibrated.

Stork Thermeq required instrumentation for process control and for billing and verification purposes for several measuring points. Particular attention was paid to steam measurements. The measurement technology had to be accurate in accordance with the ISO 5167 standard and generate only low residual pressure loss.

Medium	Steam
Flow velocity	14 m/s
Density	17.8 kg/m³
Pressure	56 bar / 812 psi
Temperature	+450°C / 842°F

3. KROHNE solution

As a main instrumentation vendor (MIV) with many years of industrial experience in the power plant sector as well as in custody transfer and billing applications, KROHNE was able to qualify as a partner in this project. KROHNE supplied a complete solution made up of flow, pressure, and temperature measurement instrumentation as well as a flow computer. This package also included design and sizing, as well as documentation and calibration in accordance with the Dutch Power and Heat Act. The complete package focused on the following four measuring points:

Feedwater measurement with the OPTISONIC 3400 ultrasonic flowmeter

3.1 Feedwater measurement

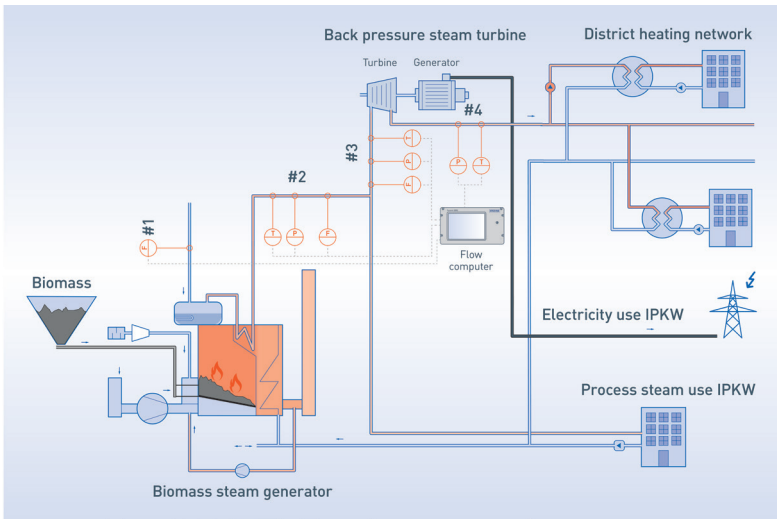
For feedwater measurement, KROHNE supplied the OPTISONIC 3400 ultrasonic flowmeter with remote field-mounted signal converter (F). The flowmeter monitors the amount of feedwater used for the biomass-fired steam boiler. Additionally, the OPTIBAR PM 3050 pressure transmitter and the OPTITEMP TRA-S34 temperature assembly have been installed. This enables the energy content (enthalpy) of the feedwater to be determined in addition to the volume flow rate. The readings are then transmitted to the SUMMIT 8800 flow computer. These measured values serve as important parameters for adjusting the performance of the plant as required. In addition, they prove the amount of feedwater used for cogeneration and enable a clear and consistent separation from the process of the conventionally fired auxiliary boiler.

3.2. Flow measurement of process steam

In order for the operator to bill process steam quantities used, KROHNE supplied a meter run calibrated according to ISO 5167. This consists of a Venturi nozzle with annular chamber as primary element, including a forged 5-way manifold and process valves. The flow rate is measured by the OPTIBAR DP 7060 differential pressure transmitter, which in this application has a differential pressure measuring range of up to 500 mbar with an overload protection up to 160 bar.

OPTIBAR DP 7060 (centre) as well as gauge pressure measurement with the OPTIBAR PM 3050 (left)

KROHNE carried out the calibration on a traceable calibration facility using the same Reynolds numbers prevalent in the real process. The OPTIBAR DP 7060 was 3D linearised at the factory over the entire range of static pressure and ambient temperature. Typically, high line pressures and increased ambient temperatures have virtually no influence on the measurement uncertainty. In addition, the measuring point was equipped with the OPTIBAR PM 3050 pressure transmitter for gauge pressure measurement as well as the OPTITEMP TRA-S34 temperature assembly. This enables the operator to carry out a pressure and temperature-compensated mass measurement and additionally determine the thermal energy (enthalpy). All measured values are transmitted to the SUMMIT 8800 flow computer approved for custody transfer measurements.



#1 Feedwater measurement
#2 Flow measurement of process steam
#3 Flow measurement in the steam line to the back-pressure turbine
#4 Feed-in measurement of steam for district heating

Calibrated meter run with Venturi nozzle, OPTIBAR DP 7060, OPTIBAR PM 3050 and OPTITEMP TRA-S34

3.3 Flow measurement in the steam line to the back-pressure turbine

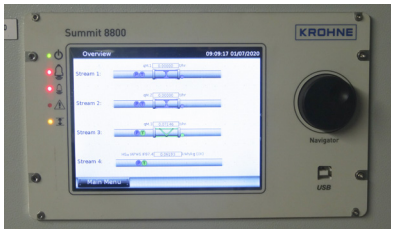
Another traceably calibrated meter run with the same instrumentation was installed in the steam line supplying the back-pressure turbine. The measured values are again processed by the SUMMIT 8800. The energy quantity of this measuring point is offset against the energy quantity of the previous measuring point, so that the individual steam flows can be recorded exactly separated from each other.

3.4 Feed-in measurement for district heating

In order to bill the energy fed into the district heating network, the existing flow measurement into the turbine is combined with the enthalpy of the condensate measured at this point. The measuring point is equipped with the OPTIBAR DP 3050 pressure transmitter and the OPTITEMP TRA-S34 temperature assembly. The SUMMIT 8800 calculates the energy with the flow measurement readings of the turbine feed and precisely determines the energy flow provided to the district heating network.

Venturi nozzle installation

Temperature measurement with the OPTITEMP TRA-S34



SUMMIT 8800 flow computer displaying the measurements of steam and feedwater

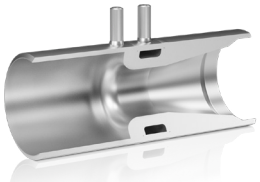
4. Customer benefits

The traceably calibrated meter runs reduce the installation effects on the measurement to a minimum, so that the energy flows are measured accurately and in accordance with the legal requirements. In this way, the operator complies with all requirements, both for the billing of steam quantities and for state subsidies and feed-in tariffs.

In addition to the hardware and the corresponding instrumentation, KROHNE supplied the full scope of services required – from engineering, documentation and material certification to calibration and commissioning on site. Stork Thermeq and the operating company equally benefited from a comprehensive tailored solution, which KROHNE was able to deliver from a single source, thanks to its process knowledge and years of experience in custody transfer and calibration.

KROHNE can provide the appropriate flowmeter technology for all Power and Heat Act related applications like steam, feedwater, condensate, fuel gas, etc. e.g. measurements in district heating networks according to MID MI-004 (accuracy class 1).

5. Products used



Venturi nozzle
- Engineered primary element according to standard (ISO 5167)
- For high accuracy flow measurement at low residual pressure loss

OPTIBAR DP 7060
- High performance DP transmitter with integrated line pressure measurement
- For advanced flow measurement in combination with primary elements

OPTIBAR PM 3050
- Compact pressure transmitter for pressure and level applications

OPTISONIC 3400
- Ultrasonic flowmeter for feedwater and other liquids

OPTITEMP TRA-S34
- Threaded RTD temperature assembly for use in existing thermowells

SUMMIT 8800
- Flow computer for custody transfer (CT) measurement

Contact

Would you like further information about these or other applications?
Do you require technical advice for your application?
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Please visit our website for a current list of all KROHNE contacts and addresses.

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