

GUIDANCE NOTE 21

INDIRECT DETERMINATION OF HEAT OUTPUTS

HOT WATER AND THERMAL FLUID SYSTEMS

GN21.1

The CHP heat output may be via hot water or heat transfer oil circulating systems that are used to transport heat for process or space heating, or for Community Heating CHP Schemes. In such cases, in addition to the circulation rate, the flow (hot) and return (cool) temperatures of the circulating fluid at the CHP plant boundary are required. The mean specific heat of the circulating fluid over the working temperature range is required to determine the heat output. Heat metering stations are commercially available (GN16.13), control and monitoring systems such as DCS or BMS may be used (GN16.14), and less rigorous alternatives are permitted for Schemes <2 MWe (GN16.15 – GN16.16).

DIRECT USE OF EXHAUST GASES

GN21.2

Some CHP Schemes use part or all of the exhaust gases from a gas turbine or engine for direct heating or drying applications. The useful energy extracted from the exhaust gases involves, as a minimum, measuring the gas temperature leaving the gas turbine or engine and the gas temperature in the flue leaving the process plant.

GN21.3

It is possible to determine the energy utilisation by measurement of exhaust gas velocity, composition (moisture and oxygen as a minimum) and temperatures. A wide range of instruments is available for measuring flue gas oxygen concentrations and information on the procedure can be found in:

- BS EN 14789:2017 Stationary source emissions. Determination of volume concentration of oxygen (O₂). Reference method. Paramagnetism.

Moisture is normally determined gravimetrically, by manual extractive absorption or condensation methods as described in:

- BS EN 14790:2017 Stationary source emissions. Determination of the water vapour in ducts

Flue gas velocity can be determined using a variety of methods such as velocity head methods, e.g. pitot static tubes or averaging pitots. In addition, there are a number of continuous methods that can be used, e.g. ultrasonic - time of flight. Manual and continuous methods are described in the following standards:

- BS EN ISO 16911-1. Stationary source emissions. Determination of velocity and volume flow rate in ducts. Part 1. Manual reference method; and
- BS EN ISO 16911-2. Stationary source emissions. Determination of velocity and volume flow rate in ducts. Part 2. Automated measuring systems

In addition, other standards provide methodologies and guidance on the measurement

of flows and the factors affecting the quality of flow measurement such as:

- BS EN 15259:2007 Air quality. Measurement of stationary source emissions. Requirements for measurement sections and sites and for the measurement objective, plan and report

However, unless the conditions for velocity measurement are exceptionally good (i.e. there should be provision of long, straight lengths of duct before and after the measuring location) these measurements are likely to have uncertainties of $\pm 10\%$ or more. Useful information on the number of straight unobstructed duct diameters required can be found in BS EN 13284-1:2017.

The relevant parts of ISO 10780:1994 can be followed for the measurement procedure, and instructions for calibrating pitot tubes can be found in ISO 3966:2025.

Uncertainty of flow measurement can also increase if gas velocities are too low due to the sensitivity of devices such as inclined gauges used for the measurement of differential pressure, e.g. if a boiler is operating at high turndown conditions. To reduce these impacts there are highly sensitive pressure cells available. Other options may be more reliable. For example, US EPA Method 19 contains a procedure for calculating flue gas flow rates from an analysis of the fuel, and measurements of fuel feed rates and flue gas oxygen content. The use of manufacturers' data on exhaust gas flow versus load may provide an alternative strategy.

GN21.4

Where all of the exhaust is used for direct heating, an energy balance around the prime mover may be possible providing that all of the other energy inputs and outputs can be reliably determined. Such a model is easily formulated and is suitable for continuous monitoring. Providing the fuel energy input is known, this information, together with the exhaust gas temperatures before and after the process heat load is sufficient to derive the heat output. This, too, can be set up as a model for continuous monitoring. If supplementary or auxiliary firing (with additional combustion air) into the engine exhaust is used, its energy input and the mixed gas temperature after the supplementary/auxiliary burner will be required.

GN21.5

Where only a proportion of the exhaust gas is used for direct heating, it is likely that the remaining exhaust will be used for some other duty such as steam generation or water heating. In this case, an energy balance that includes the boiler duty can be used to derive the direct heating duty.

MULTI-PRESSURE STEAM SYSTEMS

GN21.6

Steam systems may provide heat at several pressure levels and the heat output is the sum of these steam energy outputs from the Utilities Area to the Process Area. Pressure, temperature and steam mass flow measurements are required for outputs at each pressure level.