



Overcoming Flow Measurement Challenges In Wet Gas And Open Stack, Rain-Down Installations

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Wet gas is a challenge to measure in a number of industries, including those with combustible gases that represent a safety hazard. In the laboratory, today's air/gas flow sensors and measurement technologies operate at their highest accuracy and greatest reliability in air or gas free of moisture, droplets, particulates, etc. The real industrial world, however, is a much different environment where moisture can be entrapped in one form or another in air or gas flow streams with variable gas compositions and flow rates.

There is no single definition of what constitutes wet gas. It is instead a variable condition that ranges from mild humidity in the pipe to gas that presents itself as a multi-phase flow with for example a 90 percent volume of gas and 10 percent volume of other fluid in various forms. At the other end of the spectrum, pollution monitoring systems that measure air/gas flow in large vertical stacks must at times contend with the natural phenomenon of frequent rain in the pipe.

No matter the industry, the application or the pipe size, process engineers need to be able to measure wet gas flow accurately and consistently independent of the fluid composition in the pipe or the weather conditions. Failing to achieve accurate air/gas flow measurement creates inefficiencies in processes, reduces product volume throughput, causes maintenance issues, etc. The result of inaccurate measurement is higher costs and competitive weakness.

Wet Gas Solutions

For entrained moisture, eliminating the moisture from the gas stream is always the preferred, best practice. Common methods for this include the installation of a gas dryer or the installation of a knockout drum or knockout pot upstream from the flow meter's point of installation. Another option is to insulate or heat wrap the pipe to prevent condensation.

While these wet gas mitigation options are often effective and completely solve the problem, there are instances where either the gas composition or the variables in process, installed equipment or piping layout can frustrate the best efforts. If none of these moisture elimination practices are feasible or adequate to solve the problem, then there are several more solutions to consider at the instrument level.

Option 1. Install a standard thermal flow meter using constant power (CP) technology and optimize the installation itself to minimize or prevent condensation from contacting the sensor.



Angled at 45° from Horizontal

Figure 1: Angle-mounted standard thermal flow meter



Side Mounted

Figure 2: Side-mounted standard thermal flow meter

During the flow meter's installation, be sure the meter is angle-mounted in the pipe (*Figure 1*) so that gravity moves the moisture away from the sensor. If a knockout pot is already employed, the installation of the flow meter as shown (*Figure 1*) is also the recommended best practice.

Another alternative choice is to install a ΔT (CT) method meter that is extremely heated, to 300°C (572 °F) to "flash off" any moisture. There is an issue however with inserting such a high heat source into the flow stream. This could create an unsafe condition, consumes much more energy to operate and can result in a shortened operating life-cycle, accelerated aging and susceptibility to drift and/or premature failure of the sensors.

Option 2. Install a special purpose "wet gas" thermal flow meter, such as FCI's new "wet gas" sensor head. Its innovative design shunts the condensate away and never allows it to reach the sensors. As a mechanical design solution, all safety approvals remain in place, there is no increase in energy consumption to power the instrument and there is no impact on the sensors' service life. Furthermore, there is no de-rating of the instrument's T-rating and the sensor is safe to touch. The recommended installation is side-mounted in either the 90° or 270° position (*Figure 2*).

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The Wet Gas Sensor

The most effective of these approaches is the previously mentioned Wet Gas MASter™ sensor for the ST80 Series Flow Meter. This innovative mechanical design shunts moisture, condensation and water droplets away from the thermal sensor, thus maintaining an accurate gas flow measurement while minimizing errors that occur from a cooling effect on the sensor that could cause a spike or false high reading.

The Wet Gas MASter can be used in applications that have either moisture entrained in the gas (annular mist) or for protection against rain in larger, vertical stacks. Why is it needed? This new wet gas sensor is designed specifically for use in applications that have a high level of moisture or condensation present in the gas flow stream that cannot otherwise be removed using traditional solutions.

The measuring principle of thermal mass flow meters involves heat transfer caused by gas flow. Any moisture or condensate in the gas stream that contacts the heated sensor can cause a sudden, momentary change in the heat transfer that can result in a spiked or fluctuating output reading, creating inaccurate or unstable flow measurement. Thermal flow meters using the constant ΔT (CT) method are particularly reactive to moisture droplets, while constant power (CP) method meters, because their slightly heated sensor elevates the dew point, are less so (Figure 3).

Common moist gas applications with condensation droplets are found in biogas recovery systems (wastewater treatment digesters, landfill gas biogas production systems and reactors). Rain droplets are found in open vertical stacks and flues are common in power plants, oil and gas operations, chemical plants and refineries.

The Wet Gas MASter sensor option for the ST80 meter (Figure 4) is suitable for pipe diameters from 1 inch to 99 inches [25 mm to 2500 mm] and air/gas temperatures up to 850 °F [454 °C]. These meters are accurate to $\pm 1\%$ of reading, $\pm 0.5\%$ of full scale, with repeatability of $\pm 0.5\%$ of reading for flow rates up to 1000 SFPS [305 NMPS] and 100:1 turndown.

These meters are available with an extensive choice of outputs and user interfaces to ensure interfacing with virtually any control system and/or set-up or configuration devices. Standard outputs include dual 4-20 mA, NAMUR NE43 compliant analog outputs, HART (version 7), Modbus 485 and a USB port. FOUNDATION Fieldbus or PROFIBUS PA can be optionally added.

An intuitive, easy-to-read backlit LCD display provides digital and bar graph readouts of the meter's flow rate and temperature,

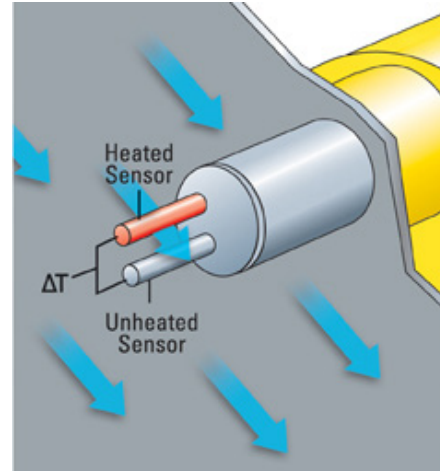


Figure 3: Thermal dispersion principle of operation



Figure 4: ST80 flow meter; Wet Gas MASter flow sensor

totalized flow, alarms, diagnostics feedback and a user defined label field is also available. Technicians can easily spot check flow data in person for reliability.

The meter's transmitter enclosure is NEMA 4X/IP67 rated, selectable for NPT or metric conduit port threading and is available in both aluminum and stainless steel and maybe remotely located up to 1000 feet (305 m) apart from the flow element. In addition to SIL rating, the instrument with the wet gas sensor also carries full global instrument Div.1/Zone 1 Ex hazardous location approvals of FM, FMc, ATEX, and IECEx.

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Conclusions

While wet gas is unavoidable in many industries and processes, solving wet gas measurement challenges can be easier than you think. There are multiple options to eliminate the moisture or to mitigate any interference with flow measurement sensors.

Where possible, choosing the point of measurement and installation of the flow meter downstream from dryers, knock-out pots or knock-out drums is the traditional and best possible solution. If that doesn't work, then angle-mounting the meter in the pipe helps isolate the flow sensor from the fluid in the pipe.

The newest option is the wet gas sensor designed for the ST80 thermal meter, which mechanically shunts moisture away from the sensor head to ensure accurate, repeatable measurement. Its unique construction eliminates affects from both moisture in the pipe and is suitable for use in large open stacks where rain fall is an issue. ■