



TECHNICAL DISCUSSION

K&I Instruments Technical Discussion

July 2020

4-Reasons Thermal Mass Flow Meters Optimize Pharmaceutical Manufacturing

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PHARMACEUTICAL LAB ROOM

Excessive gas consumption wastes money – and of greater importance – can affect product quality and safety. The pharmaceutical industry uses large quantities of nitrogen, oxygen, carbon dioxide gas, and air. Without good air and gas flow measurement, cost, quality, and consumer safety will suffer.

Healthcare facilities use positive and negative pressure rooms that can have similar requirements for gas flow measurement and monitoring to those in the pharma industry. This is especially true as facility managers implement airborne infection isolation rooms (AIIRs) to treat COVID-19 patients.

There are many methods of measuring gas consumption, although mass flow technologies are usually preferred. Here we will explore four reasons thermal mass flow meters are particularly applicable in the pharmaceutical industry. AIIR applications will be highlighted as appropriate.

What is a Thermal Mass Flow Meter?

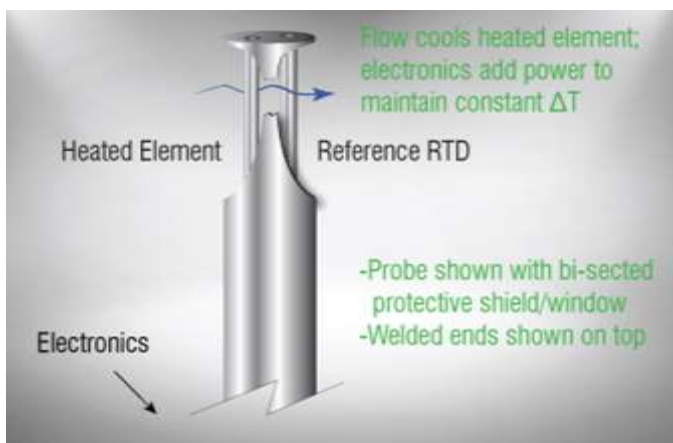
Mass is usually preferred to volume for measuring gas quantities. Volume is a function of pressure while mass is constant regardless of volume occupied. Mass flow meters apply various physical principles in using techniques like ultrasound and the Coriolis effect, but one of the most practical in an industrial setting is thermal mass flow measurement.

Thermal mass flow meters employ a phenomenon akin to wind chill. Wind chill occurs when moving air takes heat away from a surface. Air molecules contact the surface and a small quantity of thermal energy is transferred by conduction. Higher air speed means more molecules per second and thus greater heat loss.

With a thermal mass flow meter, two probe elements are positioned in the gas stream. One registers gas temperature, while the other incorporates a heating circuit to maintain a fixed differential above the first element's temperature. As the mass of the gas flowing per second rises it takes more energy away from the heated probe. The system compensates by increasing the heating current, and the change correlates with the mass flow.

Advantages of Thermal Mass Flow Measurement

As the temperature probes need only a very small cross-section, their impact on gas flow is minimal. Thus, one of the biggest advantages of the thermal mass flow meter is that it imposes negligible pressure drop. Second, when combined with high-quality signal conditioning, the technique results in a very high precision flow meter. Heat transfer does depend on gas temperature and density, and reliability is improved when the gas is clean.



The Thermal Digital Sensor Difference

The Digital Sensor Drive circuit design along with the flow meter's fast-processing electronics power helps provide a very high turndown ratio and excellent low-flow sensitivity. Plus, advanced control using free software enables switching between different gases or gas mixes with no need to return the meter to the manufacturer for recalibration.

Gas Flow Measurement Applications in the Pharmaceutical Industry

In manufacturing, three applications stand out as having potential to benefit from thermal mass flow measurement. These are:

- Tablet and pill coating
- Nitrogen blanketing
- Nitrogen purging



Tablet and Pill Coating

Uniform, consistent, and defect-free coating is essential in coating operations. Any variation in coating thickness could affect drug delivery effectiveness. In addition, appearance flaws like film cracking and logo bridging could be detrimental to consumer confidence in the product.

Coating processes rely on precise airflow control, as variation affects temperature, humidity, and coating delivery rate. Installing a high precision flow meter in the delivery system lets the control systems maintain the stability needed.

There are also benefits in measuring exhaust airflow. Variation here could indicate filtration problems and may cause a pressure differential that affects coating deposition.

Nitrogen Blanketing

Nitrogen blanketing is used in the pharmaceutical industry and elsewhere to exclude oxygen. This reduces the explosion risks associated with powder handling and prevents any oxygen reactions with ingredients. In the food industry, packaging in a nitrogen atmosphere extends product life. Flow metering ensures delivery of sufficient nitrogen without waste.



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Maximize Product Consistency

In tablet and coating processes, airflow transports the coating to the pills or tablets. Drift or fluctuations in airflow will alter coating thickness and leave it uneven. To avoid this, the flow meter must not only be accurate, but also respond quickly to minimize deviations.

Track Gas Usage

Most manufacturers that use gases like nitrogen, carbon dioxide, and oxygen will want to track consumption. Sub-metering allows monitoring down to individual room, line, or even machine level and identifies any abnormal usage trends indicative of leaks or process problems.

Reduce Waste

In the pharmaceutical industry, variation leads to waste. By identifying and then reducing variation, engineers can improve yields while curtailing excess consumption.

A high precision flow meter is a key tool in reducing variation in gas consumption. High sensitivity, coupled with short response time, provides the fine control needed for process optimization.

Minimize Measurement Costs

Installing a gas flow measurement device or system will impose certain costs:

- Equipment purchase and installation
- Meter calibration and maintenance

It is important to reflect the ROI for the implementation of a flow measurement technology. The first is to find leaks and inefficiencies in an air or gas distribution system. The second is the accurate measurement of the flow needed to achieve the maximum quality standards required by the pharmaceutical industry. For instance, one lot of powder used in the production of pills may be worth a million dollars or more. The pills associated with that lot number will be closely monitored for consistent coating and quality. There is little room for error when dealing in such costly materials.

Some flow measurement technologies will require additional measurement devices to determine or calculate the flow rate accurately. Such technologies are not able to measure the mass flow on their own, so they require auxiliary equipment to measure the temperature and pressure. Each of these devices feed their values into a multivariable transmitter to calculate the flow rate. That is four devices needed to measure flow rate: flow meter, temperature sensor, pressure sensor, and multivariable transmitter. Thermal mass flow meters do not require all these additional devices and can measure the mass flow rate in one simple device - a special advantage because there is no compounding of uncertainties from having multiple devices!

Thermal mass flow meters from Fox Thermal offer additional benefits by incorporating the Digital Sensor design and the software with gas selection menu. These versatile features coupled with the low cost and easy installation make the thermal mass flow meter from an optimal solution for air and gas flow measurement.

Thermal flowmeters offer a range of products that meet the needs of pharmaceutical manufacturers for fast-acting and accurate gas flow measurement. [Contact Us](#) for more information or to discuss your specific needs.

Nitrogen Purging

This technique is used in packaging to extend product life. Using nitrogen to push out air creates an oxygen-free environment for both drug and packaging. That reduces pharmaceutical waste while helping ensure consumer safety. As with blanketing, incorporating a high precision flow meter in the blanketing system ensures any operational issues are identified quickly.



Gas Flow Measurement/Monitoring in AIIRs

Negative pressure rooms are used in numerous healthcare environments. These are rooms where the rate of air exfiltration exceeds that of infiltration. AIIRs are a special form of negative pressure room where the CDC has specific [requirements for airborne infection isolation](#). However, both AIIRs and other negative pressure rooms need monitoring systems to maintain the required differential.

Pressure differentials in environments such as COVID-19 treatment rooms are measured with a combination of airflow and pressure sensors. A thermal mass flow meter can contribute to such a system by measuring the quantity of air moving into and out of the room. It could, for example, indicate a filtration problem.

4 Reasons Thermal Mass Flowmeters make Sense in the Pharmaceutical Industry

The pharmaceutical industry uses a lot of gas. Thermal mass flow meters are the right choice for gas flow measurement for these reasons:

1. Maximize product consistency through tablet and pill coating
2. Track gas usage by room, line, or machine
3. Reduce waste/excess gas consumption
4. Minimize measurement costs



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