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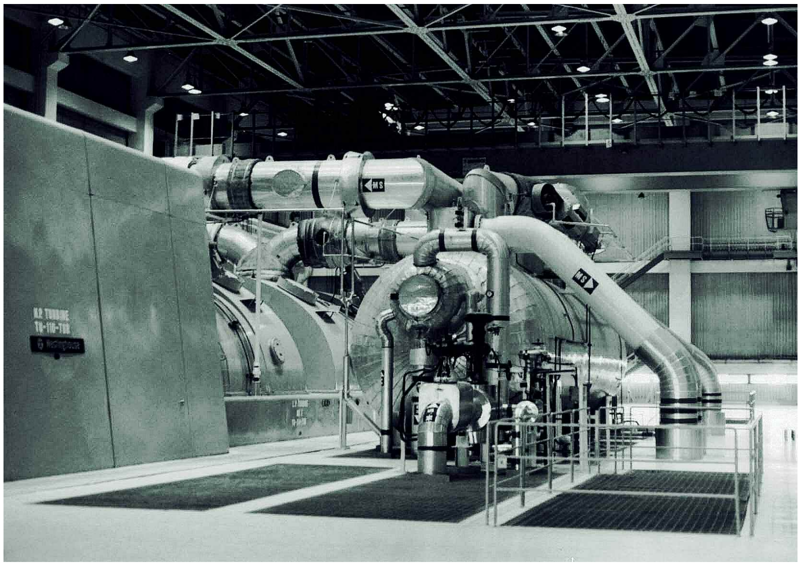

Optimize HVAC and Process System Efficiency by Matching Your Plant and Processes to the Right Flow Measurement Technology

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Tech Article

Optimize HVAC and Process System Efficiency By Matching Your Plant and Processes To The Right Flow Measurement Technology

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Plant engineers have many flow measurement technology options when selecting flow sensors or flow meters to optimize heating-ventilation-air-conditioning (HVAC) and process control systems. It is therefore helpful to understand in some detail, the multiple types of flow meters and flow sensor technologies available today, such as differential pressure, positive displacement, mass, turbine, positive displacement, vortex shedding and ultra sonic.

Both plant HVAC systems and process control equipment that provide air flow, heating, curing, cooling or chilling consume large amounts of energy. The cost of plant climate control alone for a 100,000 square-foot building is a major electric energy use, which can be one of a company's highest expenses. In addition, many plants require additional energy to operate process equipment responsible for heating, blowing, curing, cooling, chilling and other functions vital to the manufacture or processing of their products

Reducing Energy Costs

Energy utilities and the suppliers of HVAC and process equipment have invested heavily and worked diligently for many years to improve the energy efficiency of their systems. There are also utility and local and state government programs designed to help manufacturers audit, improve and reduce their energy costs. However, even after installing the most efficient, up-to-date HVAC systems and equipment, sooner or later most plants reach a point where the next meaningful level of improvement requires monitoring the flow of plant air and/or natural gas throughout the facility.

In addition to plant climate control, the careful location of flow sensors and flow meters in the HVAC system or process control loops will provide additional energy cost savings as well as improve the efficiency of processes. The end result is often better quality at lower unit costs and sometimes proprietary processes with competitive advantages. There can be a significant and rapid return-on-investment.

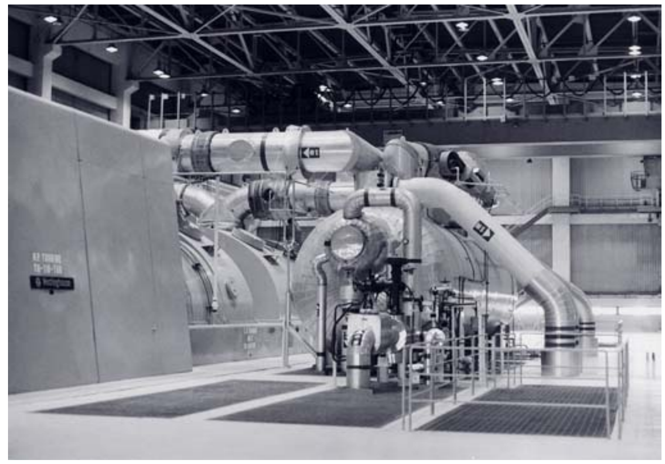

Fig 1. Turbine Air Cooling System

Flow Measurement Technologies

The first consideration in selecting air/gas flow sensors and flow meters to optimize plant HVAC systems and process equipment required for heating, chilling, air drying, curing, etc., is selecting the appropriate flow technology. While there are numerous technologies available, the better choices will be narrowed with proper consideration for your plant's layout, processes, installation environment and conditions, maintenance schedules, energy costs and ROI. Some flow technologies, for example, are ideal for air and gas applications and not useful in liquids, while still others may represent the only effective solution for steam. Before trying to increase the efficiency of HVAC systems or process equipment, it is important to understand the various flow measurement technologies:

Differential Pressure (DP). Overall DP is a widely used flow measurement technology and encompasses several sub-technologies including orifice plates, averaging pitot tubes, venturi's, sonic nozzles and v-cones. DP flow meters are used to measure volumetric flow rate and, depending on the sub-technology, can be applied in most liquids, gases and vapors, including steam. They are well understood and easy to use. They also, however, can cause pressure loss in the line and require a pressure gage, additional energy costs to boost pressure and the use of sensors for temperature and pressure when mass flow measurement is required

Positive Displacement (PD). PD measures the volumetric flow rate of a liquid or gas by separating the flow stream into known volumes and counting them over time. This group also includes many sub-technologies--all with their own unique application advantages and disadvantages. These devices, which are mechanical in nature, include vanes, gears, pistons or diaphragms that are used to separate the fluid. They are one of the few choices for reliably measuring viscous liquids, but they cause pressure loss in the line and their moving parts are subject to wear.

Turbine. Turbine flow measurement devices rely on a spinning rotor. The rotational speed of the rotor is proportional to the velocity of the fluid. Multiplying the velocity times the cross-sectional area of the turbine provides the volumetric flow rate. They are suitable for use in clean liquids and gases, but they cause pressure loss in the line and their moving parts are subject to wear.

Electromagnetic. The velocity of a conductive liquid can be determined by passing it through a magnetic field and measuring the developed voltage with a "Mag Meter". Velocity times area yields the volumetric flow rate. These devices have no moving parts and do not obstruct the flow stream. They are accurate in conductive liquids or slurries flowing into a full pipe, but their liners are subject to wear.

Ultrasonic. Transit-time sound velocity or Doppler frequency shift methods are used to measure the mean velocity of a fluid. There are two basic types, a line-of-sight which requires two or more sensors inserted into the pipe and clamp-on in which the transducers are mounted to the outside of the pipe wall. Like other velocity measuring meters, volumetric flow rate is determined by multiplying mean velocity times area. They offer good to excellent accuracy in a liquids. They are obstruction-less, and the clamp-on type is non-intrusive.

Vortex Shedding. In vortex shedding devices, the frequencies of vortices shed from a bluff body placed in the flow stream is proportional to the velocity of the fluid. Again, velocity times area gives the volumetric flow rate. Vortex flow devices are particularly effective and one of the few technologies applicable for steam applications. They have no moving parts and are fouling tolerant, but require flow rates high enough to generate vortices.

Thermal (Mass). Mass flow rate with thermal sensors is determined by measuring the temperature rise of a fluid (heat gain) or the temperature drop of a heated sensor (heat loss). Thermal flow devices provide direct mass flow measurement. They are also inherently dual-function providing both flow rate and fluid temperature measuring from the same device. They have no moving parts, no orifices to plug and are temperature compensated. They are most effectively applied in air and gas applications and, because they install in a single-tap point, they are often the most effective and economical solution for large pipes or duct applications or stacks.

Coriolis (Mass). In Coriolis devices, fluid flowing through a vibrating flow tube causes a deflection of the flow tube proportional to the mass flow rate. Coriolis devices also provide density measurement. They are highly accurate in liquids, slurries, or gases. Because Coriolis Mass flow meters provide extreme accuracy, 0.1% of reading typical, they have become very popular for use in monitoring fuel flow in custody transfer or fiscal metering applications. Additionally, the inherent mass flow reading compensates for any effect due to temperature or density differences in the fluid.

Key Questions To Ask

When optimizing plant HVAC systems or process equipment that provides heating, cooling, air flow or curing, there are a number of important questions to consider before deciding on a flow sensor or flow meter. The first consideration is always matching the flow measurement technology to the media, such as air for HVAC systems or specialty process gases, such as nitrogen, in chilling systems.

Accuracy and Repeatability. It is important to understand the accuracy, repeatability and flow range of the flow sensor or flow meter that you plan to use. Most manufacturers state specifications for these parameters in water, air or a specific gas. For example a typical air flow meter, such as FCI's insertion-style, thermal mass ST50 Series, operates in air over a flow range from 1.5 to 150 SFPS (0.46 to 46 NMPS) with an accuracy of ±2% of reading, ±0.5% of full scale, with a repeatability of ±0.5% of reading.

Be sure to check that the accuracy, repeatability and flow range in the manufacturer's specification matches

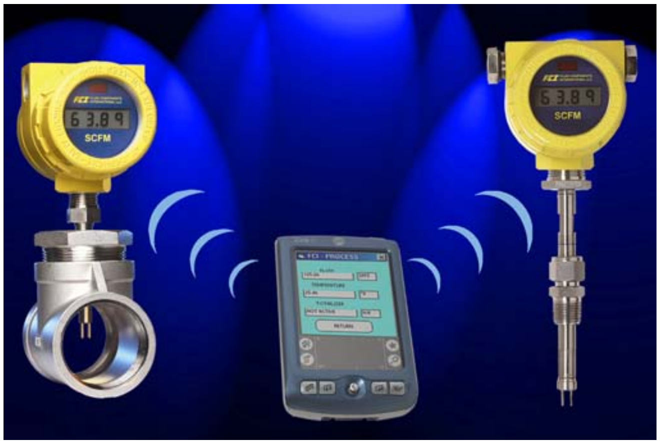

Fig 2. Wireless Flow Meters

your process media. The accuracy and range may differ in water, air or gas. It is also critically important to look at a flow meter's repeatability specification, which tells the user how reliably the device will maintain its specified accuracy level.

Operating Environment. In large plant HVAC systems with long runs of ducting, or in large stacks or in air drying applications, or nitrogen blanketing for chilling, it is essential to match the plant's physical layout, the installation area temperature and humidity conditions with the flow measurement technology. The same is true for individual process control loops providing air flow handling, heating or cooling.

Depending on your plant's operating conditions, factors such as the number of shifts (hours of operation), climate (hot/cold extremes), specific process requirements for humidity levels, etc., you will find that some flow measurement technologies are better able over time to measure extremely low flows accurately, deal with wide swings in flow volume (turn-downs) and pressure drop. Further, packaging and electronics housings vary widely. Where a plastic housing may be fine for protected and climate controlled indoor applications, a rugged, metal and appropriately rated NEMA/IP enclosure will ensure longest service life in non-climate controlled or outdoor applications.

Ease of Installation. When it comes to installation, some flow meters are more straightforward than others. Be sure to ask if the flow device can be inserted directly into the process pipe or if it requires an inline configuration that will require you to cut and splice your pipes in multiple places. The more penetrations required into the pipeline or duct-work the greater the risk of pressure drop as well as the complexity and overall cost of the installation Some flow measurement devices feature minimally invasive or non-intrusive sensing technology, which make them much easier to install and require the least amount of installation time and labor cost. In optimizing plant HVAC systems and many process control operations requiring air or gas flow, pressure drop causes expensive inefficiencies in the system.

Flow measurement devices require a specified length of unobstructed pipe straight-run upstream and downstream from the device to obtain a well developed flow profile for the sensor to achieve their specified accuracy. The amount of straight run differs from technology to technology; some require little and some may require several lengths. Be sure you evaluate the straight run requirement. This is especially true in retrofit projects, where additional plant real estate may not be available or the cost to reconfigure equipment will extend the project pay-back time.

Maintenance and Life. Be sure to consider the maintenance requirements for your flow sensor or meter. Some flow measurement devices need more frequent recalibration, and/or, particularly with mechanical oriented technologies can require cleaning which can be time-consuming or, worse, require you to remove the meter from service. For plant HVAC systems, the ideal flow measurement device will have no moving parts to wear out and no routine cleaning requirements to minimize maintenance cost and provide many years of service.

When calculating cost, be sure to look beyond the purchase price to determine the initial cost, the total installed cost and the life-cycle cost. Some flow devices are initially inexpensive, but they require frequent maintenance or have a short service life. Other devices, whose initial purchase price may be higher are actually easier and much less costly to install or require less maintenance and/or have a longer service life that will actually provide a much better ROI and payback.

Flow Monitoring Energy Savings Check List

To increase the efficiency of your plant HVAC system and process equipment providing air/gas flow, heating, curing, cooling or chilling, the selection of accurate air/gas flow measurement sensors or meters is critical. Before you start, be sure you understand all the flow measurement technology choices available. They have advantages and limitations that will differ depending on your plant's unique operations.

Create a check list to evaluate: flow sensor or flow meter accuracy/repeatability, operating environment, installation time and maintenance/life. To determine the potential energy savings, look at what a small percentage improvement in the efficiency your plant HVAC system or process equipment is worth on a daily basis and then add it up over time.