



Flow Conditioning Improves Flow Measurement Accuracy and Reduces Process Plant Costs

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Tech Article

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If you're planning to expand, upgrade or retrofit your plant in the near future, chances are that you'll be facing a real estate crisis when it comes to finding a place for all your new or upgraded equipment. The loss of space either inside plant buildings or even in outdoor installations can lead to problems with providing the upstream/downstream pipe straight runs required by pumps, compressors, valves, flow meters, blowers, burners and other devices that must have a stable material process flow in order to operate effectively.

Flow Disturbance Problems

The necessary addition of elbows, expansions or reductions, and/or spiral piping in close proximity to instrumentation and other devices often further exacerbates the problem of inadequate pipe straight runs. Too much equipment, too little space and poor piping layouts all work together to alter the process media's tangential, radial and axial velocity vectors. Flow disturbances then result, including swirl, jetting and velocity profile distortions.

The impact of flow disturbances on flow meters, pumps and other equipment can be significant. In the case of flow meters, irregular material flows adversely affect the accuracy and repeatability of many of the most popular flow sensing technologies: differential pressure, turbine, magnetic, thermal, ultrasonic and vortex shedding. Depending on the flow sensing technology, the straight pipe run requirements for flow meters varies—from 10 to 20 or more diameters.

In pumps, control valves and other critical process components, flow disturbances create cavitation that results in noise, excessive wear and damage, and ultimately premature failure. Less obvious is these same conditions can reduce process media delivery capacity and cause end-product quality problems. Irregular liquid flow to pumps, in particular, can result in dry running conditions that lead to seal or

bearing damage and result in highly expensive repairs or even replacements.

In the ideal process plant, there would of course be space for everything and everything would be in its proper place installed exactly according to the manufacturer's specifications. The real world of process plants, however, is a very different place when it comes to squeezing out every last bit of process capacity and quality delivered at the lowest possible cost per unit of production.

The Solution

One of the most practical ways to work around a lack of adequate straight pipe run that results in flow disturbances is the installation of flow conditioners. There are several types of flow conditioners, including: honeycomb vanes, perforated plates, tabs, tube bundles and vanes. They all have their advantages/disadvantages, depending on the viscosity of your particular process media, the equipment problem, pipe layout, cost requirements, etc.

Some general guidelines for the best applications of these flow technologies include:

- **Honeycomb** vane-type conditioners are frequently found in HVAC or compressed air handling system applications where they provide modest flow profile corrections. They are available in many designs and materials. Depending on the material and environment they may need routine replacement and maintenance.
- **Perforated Plates** are a good choice in natural gas pipelines or other clean gases and liquid applications. They are simple to install and require no spool piece, but they can be problematic in dirty gas or solid-laden media where they are prone to clogging. They generally have a higher head loss coefficient and therefore may cause

- more pressure drop than tube bundles and the tab type.
- **Tab-Type** flow conditioners are a good choice in clean or dirty gases and liquids because of the tapered design of their tabs. They provide excellent cross-mixing to remove swirl and correct velocity profiles with virtually no pressure-drop. They are the only technology that can be retrofitted into elbows, but the tab design makes them unsuitable for most sanitary applications
 - **Tube Bundles and Vanes** have been used for decades. Tube Bundles reduce swirl in clean gases and liquids, but are not effective at correcting velocity profile and are not suitable for custody transfer applications. Vanes are also effective at removing swirl, but are not able to isolate flow irregularities and remove them from the flow stream.

Reviewing your process will likely shorten the list of potential candidates. Be sure to consider the viscosity of the process media when selecting a flow conditioner. Some technologies are prone to clogging in slurries, for example, and/or contaminant build-up in dirty gas processes. Remember too that in general the more effective flow conditioners are at correcting flow profile distortions, the more pressure drop they can produce.

One flow conditioning technology that has proven itself effective in highly rugged conditions is the tab-type flow conditioner (Fig 1).

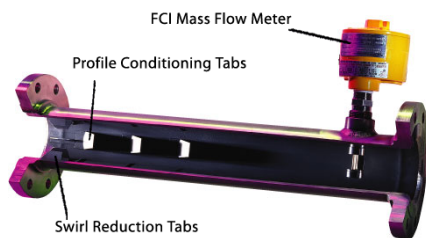


Fig. 1. Vortab Flow Conditioner and Flow Meter

The standard straight tube Vortab® Flow Conditioner consists of pipe fitted with a short section of swirl reduction tabs combined with three arrays of profile conditioning tabs. The combination of anti-swirl and profile conditioning tabs creates a repeatable, flat velocity profile at the outlet of the pipe. This same tab-type flow conditioning technology also can be designed into an elbow flow conditioner (Fig 2).



Fig. 2. Tube and Elbow Tab-Type Conditioner Cut-Away View

Tab type flow conditioners are suitable for application in many different processes. For example, at an offshore oil pumping station the process engineering team needed to add a pump to increase capacity. Elbows feeding into the pump consisted of a 20-inch inlet and reduced down to a 12-inch section.



Fig. 3. Elbows for Offshore Oil Pumping Station

In this case, there was absolutely no room for the pump's required straight run and no way to expand the platform to accommodate the pipe run (Fig 3). Placing a tab-type elbow conditioner in the elbow itself solved the space problem by ensuring a properly conditioned flow entering the pump at a large cost savings and freed real estate for other possible uses.

An electric power plant needed to add two identical 14-inch centrifugal pumps to feed water into its main boilers. The line size drops from 16 inches at the elbow to 14 inches at the pump inlet. The pumps are powered by 350 hp electric motors.

During installation of the pumps, it was determined that the indoor facility did not have adequate room for an upstream pipe run into the pumps. In Fig. 4. Electric Power Plant Elbow and Pump, note the close proximity of the building's wall to the elbow conditioner.



Fig. 4. Electric Power Plant Elbow and Pump

The tab-type flow conditioner placed in the elbow compensated for the lack of straight run and provided an equally distributed flow profile entering the pumps.

A natural gas producer faced a space limitation problem when retrofitting a pipeline pumping station with a new compressor (Fig 5). Achieving the proper upstream straight pump run required for the 3500 hp compressor would have necessitated the removal of existing underground pipe at substantial expense. Instead of digging their way out of this problem, a tab-type flow conditioner was plumbed directly into the compressor's inlet.



Fig.5. Elbow Flow Conditioner, Interior View

Conclusions

If you're planning a facility expansion or retrofit, be sure to consider the straight run pipe requirements of all the equipment involved in your process. Valves, pumps, compressors, flow meters—they all can be affected by flow disturbances caused by poor piping layouts. The resulting problems can be costly to fix in terms of poor end-product quality, equipment repairs or failures and even line shut-downs.

When you're simply out of room or changing the piping configuration is cost prohibitive, flow conditioners are an excellent solution. There are several different types of flow conditioners—so be sure to consider the characteristics of your process media to avoid maintenance issues with clogging and potential pressure drop problems.