# Oil Refineries with Cramped Retrofit Projects get out of a Tight Spot with Space-Saving Flow Technology

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*Although there are relatively few new oil/gas refineries being built today, there is a continuous stream of upgrade and retrofit projects to keep up with the strong demand for fuel. A large number of these projects are designed to increase plant efficiency or meet new environmental regulations, and these projects require new equipment of all types. Inevitably, problems arise when the amount of equipment fails to fit within the existing plant real estate available. Inaccurate fluid flow measurement is a common result and complaint for a number of reasons, which can be solved by anticipating the problem and installing equipment properly.*

## Problem: Optimizing Liquid Flow Measurement

Many oil/gas and petrochemical refineries in general have two measurement challenges: accuracy and cost. The refineries must be able to measure an increasing volume of fluid throughput within older facilities, as well as control the costs associated with both utility energy and process measurement. Most flow meter applications were originally planned and implemented long ago as part of the original large-scale project to develop the plant when expectations for product volume, production efficiencies, quality control and environmental regulation were all quite different than they are today.

Refinery process and plant engineers are today frequently striving to expand capacity to meet demand for their products in the same 30+-year old plants. Often there is no more real estate left for expansion, which means the performance and size of all equipment, including process measurement and control devices, must be optimized to speed throughput, deliver more environmentally friendly clean fuel and related products, improve product quality, control polluting emissions and reduce costs.

In flow instrumentation, the biggest challenge is to analyze the application's requirements thoroughly and then select the right flow meter technology that delivers the best combination of performance and economy. There are many different fluid flow measurement technologies on the market today—all of them excellent depending on the specific application under consideration. Beyond accuracy and cost, other criteria that must be evaluated in refineries and petrochemical plants include:

- Heat and material balancing
- Installation—optimizing plant flow throughput
- Maintenance schedules (frequency)
- Environmental regulations

Many of our refinery and petrochemical plants came into service at a time when the predominant fluid flow measurement technologies were: orifice plates, venturi tubes and flow nozzles. They evolved with the rise of the petroleum industry, performed accurately, became popular choices and were certified early by engineering and safety standards organizations. In today's crowded plant environment, however, they require long upstream and downstream pipe diameter straight-runs to maintain their accuracy. This can be a problem frequently in retrofit projects where every foot of plant real estate is a premium asset.

Almost all of today's popular fluid flow measurement technologies require a minimum 10-diameter straight pipe run upstream from the point where the flow meter is placed in the process media. These flow measurement technologies also require a minimum 0-5 diameter straight pipe run downstream from the flow meter. Several popular technologies in use today require a much longer straight pipe run—up to 40 diameters upstream in some cases.

Straight pipe runs are necessary to ensure the process media achieves a stable flow profile at the point of measurement by the flow meter. Disturbed flows, such as swirl or irregular velocities, also frequently result when elbows, valves, pumps and other equipment are placed in close proximity to the flow meter. In the presence of irregular flows, flow measurement accuracy and repeatability suffer seriously. Many times flow measurement accuracy problems come as an unpleasant surprise in retrofit projects due to the addition of new equipment (other than flow meters) that requires changes to piping with unintended consequences.

## Solution: Flow Conditioning

Flow conditioners and straighteners are frequently used to eliminate irregular fluid, steam and gas flow profiles. There are different types of conditioners and some of the more popular choices include honeycombs, vanes, screens and tube bundles. Focusing on the process media—fluid, slurries or gases—and the installation requirements will frequently narrow the list of choices for a particular application or problem. Some technologies will perform better in clean fluids or gases, as opposed to dirty fluids or slurries with irregular particulates that can cause clogging that requires increased maintenance. Head loss is also potential concern, depending on the media, type of conditioner and installation requirements, which can reduce media throughput and increase energy costs.

For this reason, a growing number of flow meter manufacturers are focusing on developing flow measurement technologies that offer built-in flow conditioning. This approach offers a number of advantages, including optimized measurement, reduced equipment complexity and lower total installed and operating costs. For example, the V-Cone® Flow Meter (*Fig 1*) developed by McCrometer features a built-in flow conditioner that optimizes measurement accuracy in liquids, steam or gas while reducing the required pipe straight-run by up to 70 percent depending on the application and installation.

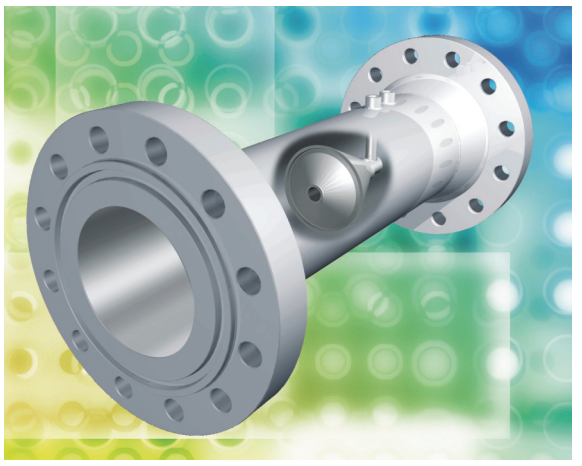

*Fig 1. V-Cone Flow Meter Oil/Gas Configuration*

The V-Cone Flow Meter accurately measures flow over a wide range of Reynolds numbers under all kinds of plant environmental conditions and in a variety of clean and dirty fluids. It operates on the same proven operation principle as other differential pressure type flow meters, using the theory of conservation of energy in fluid flow through a pipe.

*Fig 2. V-Cone Cutaway Showing Irregular Flow Profile*

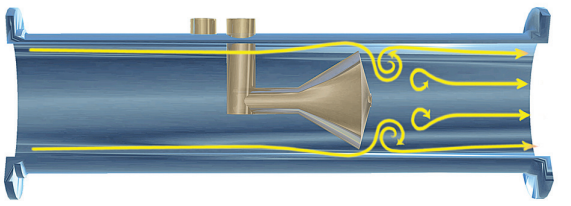

*Fig 3. V-Cone Cutaway Showing Conditioned Flow Profile*

With its unique design, the V-Cone's differential-pressure flow technology, however, actually conditions fluid flow to provide a stable flow profile that increases measurement accuracy. The meter's design features a centrally-located cone inside a tube (*Fig 2*). The cone interacts with the fluid flow and reshapes the fluid's velocity profile to create a region of lower pressure immediately downstream from itself.

The difference in pressure, which is exhibited between the static line pressure and the low pressure created downstream of the cone, can be measured via two pressure sensing taps. One tap is placed slightly upstream of the cone and the other is located in the downstream face of the cone itself. The pressure difference can then be incorporated into a derivation of the Bernoulli equation to determine the fluid flow rate.

Placing the cone's centrally in the line optimizes the velocity of the liquid flow at the point of measurement. It forms very short vortices as the flow passes the cone. These short vortices create a low-amplitude, high-frequency signal for excellent signal stability (*Fig. 3*).

The result is a highly stable flow profile for measurement accuracy to ±0.5% with ±0.1% repeatability over a wide flow range of 10:1. All of this is accomplished with a minimal straight pipe run of only 0 to 3 diameters upstream and 0 to 1 diameters downstream from the cone.

## Conclusions

In retrofit or upgrade projects for oil/gas or petrochemical refineries and other process plants, remember to consider the straight pipe run installation requirement for your flow meters--whether you are leaving them in place or upgrading them. Most flow meter technologies require a pipe straight-run upstream and downstream from the point of measurement in order to assure a smooth media flow profile.

The addition of new elbows, valves or pumps placed too closely to flow meters may degrade their accuracy and repeatability. Flow conditioners are a potential solution, which are built into some flow meters or available as a separate component. Be sure to consider the properties of the liquid you are flowing before selecting a flow conditioner technology to avoid pressure loss, which can be expensive in terms of slowing media throughput and increasing energy costs.