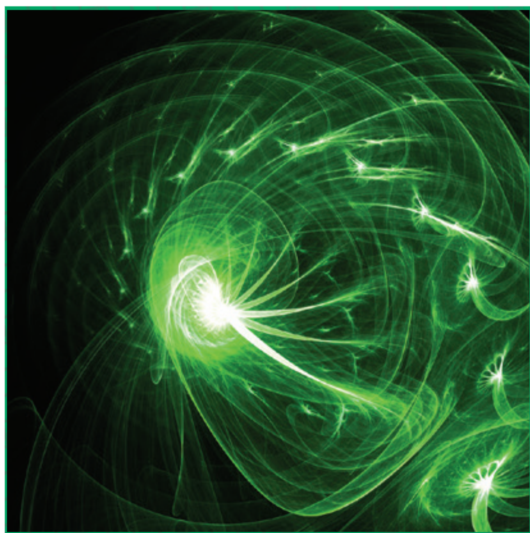

The Kontorr Flow Meter

A New Choice in Flow Measurement

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Accurately measuring the flow of liquids is one of the most critical needs in the petroleum industry. The ability to perform precise and correct flow measurements can make the difference between bottom line profit and loss. In some cases, inaccurate flow measurements can create hazards to personnel, equipment, or the environment. Depending on the type of media to be measured, many different types of flow metering devices have been developed which have served the industry well for many years. Although each type of device is considered to be tried and true with respect to the application for which it was designed, new technology continues to be developed that addresses difficult to measure media and the need for one device that is customisable for a wide range of applications. One advanced design on the horizon is the Kontorr Flow Meter which promises to surpass limitations inherent in existing measurement technology.

Flow devices such as orifice, venturi, positive displacement, turbine, and other meter types have been well accepted in the market place, but they have presented problems in flow measurement when dealing with multiphase and viscous fluids as well as initial and long term cost. They are highly "co-dependent" on Reynolds numbers and entail demanding installation requirements to achieve projected accuracies. Entrained particles or separate phases will cause wear on critical dimensions, which translates into loss of meter accuracy, i.e. "loss" of product, not to mention other issues such as "plugging".

In pipeline measurement, there are several types of meters that incorporate differential pressure to calculate flow. When a fluid is being transported in a pipeline, various forms of resistance will cause a difference in pressure measurements between any two linear points which, in turn, can be used to calculate flow. A higher pressure will exist at the point nearest the pump, or prime mover. The difference in pressure (delta P) directly correlates, and is proportional, to the square root of the flow media's rate through the pipeline.

Orifice Meters have traditionally been used to determine flow for almost a century. This meter demands that the flow of fluid is smooth both upstream and downstream and will require piping runs at specific lengths to attain this profile. In new installations, designs versus actual operating conditions are usually different and will affect the performance and reliability of Orifice meters. When the fluid reaches the orifice plate, the fluid is forced to converge to go through the small hole. The most vulnerable point of the orifice plate is the sharp edge of the small hole that begins to wear the moment it is placed in service. Sharp edge wear creates serious detrimental error in measurement of the fluid.

Positive Displacement (PD) Meters are another universally used device. Instead of an inferential calculation, PD flow meters measure the volumetric flow rate of a moving fluid or gas by dividing the media into fixed volumes. PD meters have many mechanical parts in relation to the flow measurement into fixed volumes. These mechanical parts are susceptible to wear and corrosion that affects meter accuracy and "K" factor (meter factor). Viscosity will also have an effect on the low end of PD meter's flow range ability. The PD meter accuracy adjuster is mechanical, and subject to wear and corrosion which will affect the meter accuracy. These meters also create a considerable restriction and drop in pressure of the fluid flow that will prevent the selection of this meter in applications.

Venturi flow meters utilise the Venturi effect, which is the reduction in fluid pressure that results when a fluid flows through a constricted section of pipe. Venturi meters measure the differential pressure, like an orifice meter. The big difference between these types of meters is the Venturi does not cause as much permanent energy loss as the Orifice meter. Disadvantages include the high cost of manufacturing this type of meter.

Turbine Meters use rotors that spin to measure the flow rate. The rotors are angled for a narrow viscosity range to obtain linearity. A ball/ballistic prover is needed to check turbine's repeatability and linearity for a given product under operating conditions (at a specific gravity and viscosity). Unfortunately, rotors are not interchangeable. Turbine Meters operate with a "K" factor, or pulses per gallon. The "K" factor changes if flow parameters (sp. gr. or viscosity) are changed. Turbine Meters also do not work well with multiphase fluids.

The segmental wedge is a "V" shape restriction placed in the top of a pipe, with an opening at the pipe bottom to allow free passage of the fluid and any entrained solids (particles). Due to low velocity of the fluid at the "V" point, there is no wear on the point thus insuring long life. This restriction creates a differential pressure drop. The restriction will conform to the square root relationship between flow rate and the differential pressure over a wide range of Reynolds numbers. The media being pumped, or conveyed, through the pipeline can exist either as a gas, liquid or multiphase fluid.

Other types of inferential flow meters that have gained success in the petroleum industry are the ultrasonic and coriolis meters. The ultrasonic meter transmits a sonic signal through the fluid and infers flow by measuring frequency shift using the Doppler Effect. Its advantages include zero restriction in the pipeline and no moving parts to wear out. Disadvantages include a high initial cost and unsuitability for certain kinds of media. The coriolis meter moves the fluid through a U shaped tube where the Coriolis Effect can be used to calculate flow. Advantages include its suitability for a wide range of media. Disadvantages include its high cost, vulnerability of internal tubing, and need for long term calibration.

An advanced design that is undergoing the testing phase is the Kontorr Flow Meter (KFM) developed by Engineering Partners International in Houston, Texas. The Kontorr flow meter works by principles similar to meters that use differential pressure to calculate flow. The KFM is capable of measuring the flow of a wide range of materials: gas, liquid, or slurry. The KFM is a hybrid design, combining the advantages of the segmental wedge (wedge) and venturi flow meters. An important aspect of the KFM design is customisable modularity that neither wedge nor venturi meters provide. The KFM has been designed with exchangeable elements that can vary the differential pressure depending on different flow parameters as processes change.

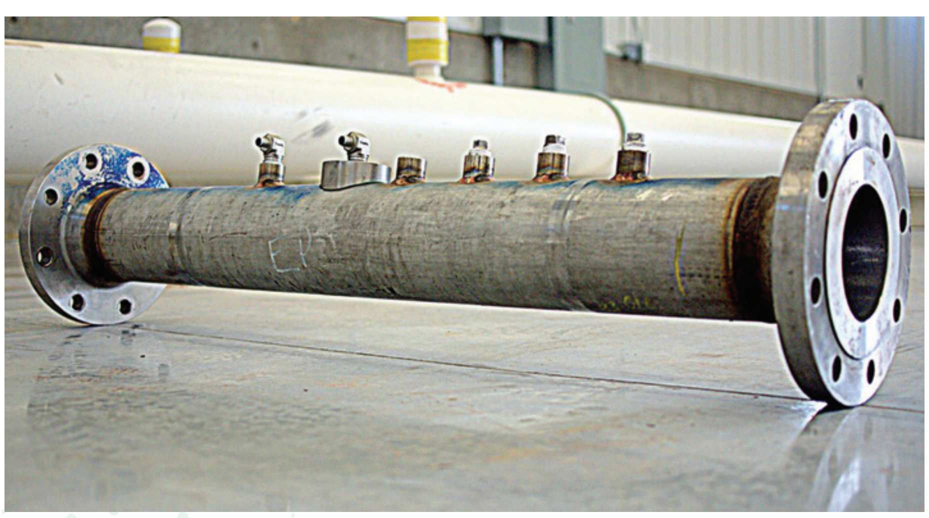

Figure 1: Kontorr Flow Meter (KFM)

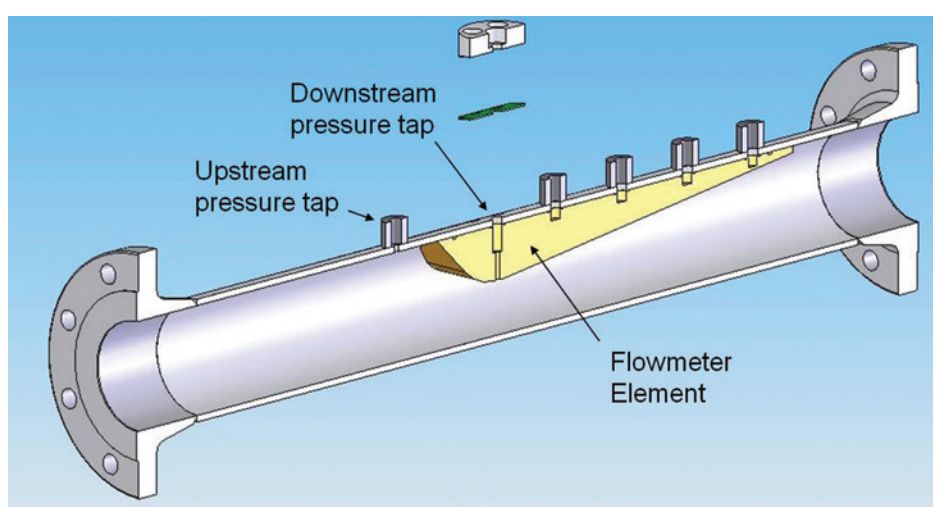

Figure 2: KFM Construction

The KFM meter provides the advantage of minimal wear unlike most other differential flow meters. Orifice meters must have a sharp edge and when this edge is worn the meters accuracy drops considerably. The cost of checking an orifice plate and the cost of replacing one in a timely manner for the life of a tubular system far exceeds the cost of one Kontorr flow meter. The KFM can measure any type of fluid accurately, whether it is a particle-entrained fluid (slurry) or an extreme temperature fluid (super-heated steam). The Kontorr flow-metering assembly represents an unusually advantageous advance in the art of flow metering.

The design of the KFM meter is such that it can be tailored to the process systems needs or the designer's needs. For any given application, a prefabricated element can be chosen to produce the desired differential pressure for accurate measurement. The Kontorr flow meter is optimised using computational fluid dynamic (CFD) software. CFD software enables the optimised location of the flow meter within the system it is to be used. More importantly, the CFD software enables the selection of non-standard beta ratios that can easily be inserted and used if a standard beta ratio does not fit the purpose or desired differential pressure. Using the CFD software, we can easily calculate the desired design in a short amount of time and take this resulting design to be machined to the exact specifications and in any material needed.

Testing trials with specific flow rates yielded repeatable average pressures, which had less than one percent difference. Comparing trials with identical flow rates showed that the maximum standard deviation for these trials was 0.0175 psi. Repeatability is crucial in flow measurement devices and the Kontorr Flow Meter gets the job done, repeatedly.

Key Features of the Kontorr Flow Meter

- Low initial and long term costs compared to many traditional meters
- Low-pressure drop when compared to other delta P meter styles
- Produces less downstream turbulence
- Can be designed with upstream piping taken into consideration
- Standard Construction: 316 s/s and Viton O-rings; other materials available
- Designed to conform to applicable ASME codes
- Superior wear resistance

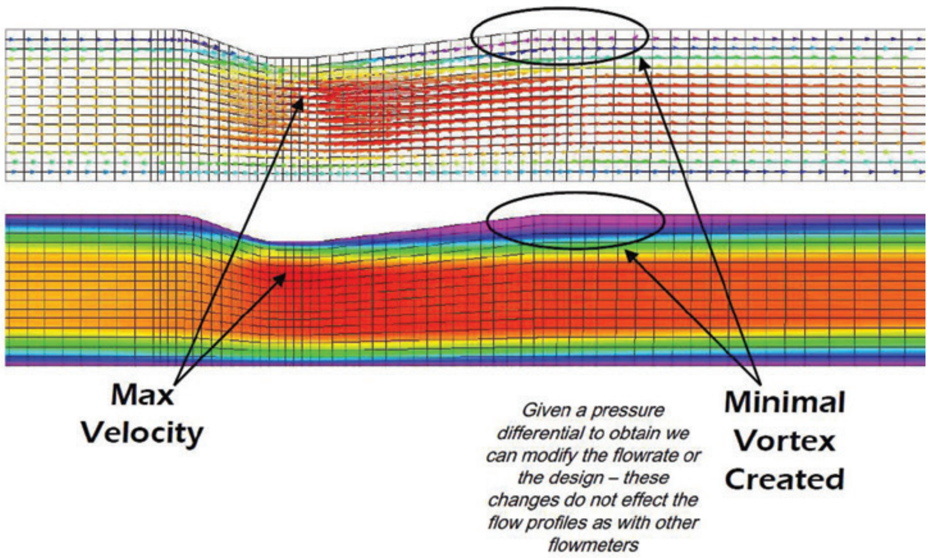

Figure 3: KFM Fluid Dynamics

- Can measure clean and dirty multiphase fluids
- Minimum maintenance and long life
- Flexibility of interchangeable elements

The Kontorr Flow Meter is undergoing further tests in selected labs measuring flows of a variety of media such as gas, liquids, and slurries of varying properties to confirm and refine its accuracy and precision as well as its durability. The KFM promises not only to surmount problems found in traditional methods for measuring flow, but to do so at lower initial and long term costs.

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