MAKING THE CASE FOR WEDGE FLOW MEASUREMENT

Choosing the best type of flowmeter for any application requires careful consideration of a range of factors. Where differential pressure flowmeters are concerned, there are a range of options, each with their own advantages and drawbacks for certain types of applications. Steve Gorvett, Product Manager – DP Flow and Temperature for ABB Measurement & Analytics in the UK, explains why wedge meters should be the first choice for measurement of viscous flows.

Most flow metering devices face challenges when used on high viscosity or abrasive processes. Many devices offer limited effectiveness in demanding applications, due either to the nature of the metering technology used or by the effect that a high viscosity process or wear may have on any moving parts.

Wedge meters are an exception. Highly robust and resistant to wear, they offer the solution to measuring dirty, viscous or abrasive flows as well as those where there is a risk of fouling. This enables them to be used in applications which could quickly render other types of DP flowmeters useless.

The basic operating principle behind wedge meters is straightforward. A V-shaped restrictor in the flowmeter body reduces the available flow area, constricting the flow. This constriction increases the fluid velocity, causing a corresponding increase in the kinetic energy of the fluid being measured.

As per the conservation of energy principle, the increase in kinetic energy will see a corresponding decrease in potential energy, or the static pressure. When this happens, the fluid upstream of the restrictor will have a greater potential energy, and a higher static pressure, than the fluid downstream.

Placing pressure taps either side of the wedge meter enables the differential pressure produced by the difference in potential energy to be measured, which can then be used to directly calculate the flow rate. The symmetrical design of the wedge meter also allows the unit to be used in bi-directional applications. As well as providing both the flexibility to handle different flow directions in the same line, this capability can also prove beneficial in particularly arduous applications; in the event that wear occurs on one side, the meter can simply be reversed, prolonging its operational lifetime.

The design of wedge meters means they offer a number of operational advantages. The slanted upstream face of the restrictor, for example, helps to protect against erosion caused by any undissolved solids in the fluid being measured. The large opening beneath the restrictor also enables any secondary phase material to easily pass through rather than building up on the restriction. Moreover, the formation of eddies and back currents in the flow helps to effectively scour the internals, keeping them clean.

Flexibility for any flow profile

In contrast to other meter types, wedge meters are able to measure accurately in any type of flow profile, whether laminar, transitional or turbulent. This overcomes the problem often encountered in viscous or low flow applications where laminar and transition flow profiles can have an impact on the square root relationship between the flow rate and the measured differential pressure. In contrast to most other types of differential devices which are limited to Re values of 20,000 and greater, wedge meters can offer linear and accurate flow down to Reynolds Numbers (Re) of 500, thanks to the unique shape of the wedge restriction. This makes them especially ideal for measuring laminar flows.

A key benefit of wedge meters is their flexibility. They can be appropriately sized for a given application by varying the H/D ratio, which is calculated by the height of the opening below the restriction divided by the meter's internal diameter. By varying this ratio, it is possible to achieve the desired differential pressure for any specific flow rate, allowing users to select the best compromise between the cost of purchase and the acceptable pressure loss.

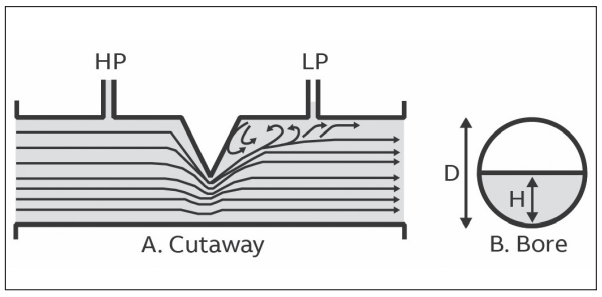
Wedge meters are also easy to install and do not require any special tools or training. Their design means that any solids or gases can pass straight through without hold-up or clogging. As wedge meter performance is largely unaffected by piping effects, there is no need for especially long straight inlet sections or flow straighteners upstream of the wedge meter, with the normal recommendation being five diameters upstream and three downstream. Moreover, the ability of wedge meters to handle dirty flows eliminates the need to fit strainers or filters in the inlet section.

Application example: Using wedge meters to measure molten sulphur

A by-product of crude oil refining and natural gas processing, molten sulphur is commonly used in the manufacture of a wide range of products, including insecticides, synthetic fibres, plastics, fertilizers, solvents, pigments and resins. Depending on the location of the measuring point within the process, viscosities can vary between 6 and 100 centistokes (cSt).

Given the highly viscous nature of molten sulphur, maintaining a steady flow is challenging as the process can readily foul and plug lines, resulting in production outages.

The solution is to use a wedge meter connected to a suitable secondary transmitter. With the ability of wedge meters to handle flows of Re 500 and above, they are ideally suited to the laminar characteristics of molten sulphur. By integrating the remote seals into the meter, the problem of plugging associated with conventional impulse lines is eliminated. It also means that higher process temperatures can be used, which helps to prevent the fluid from solidifying.

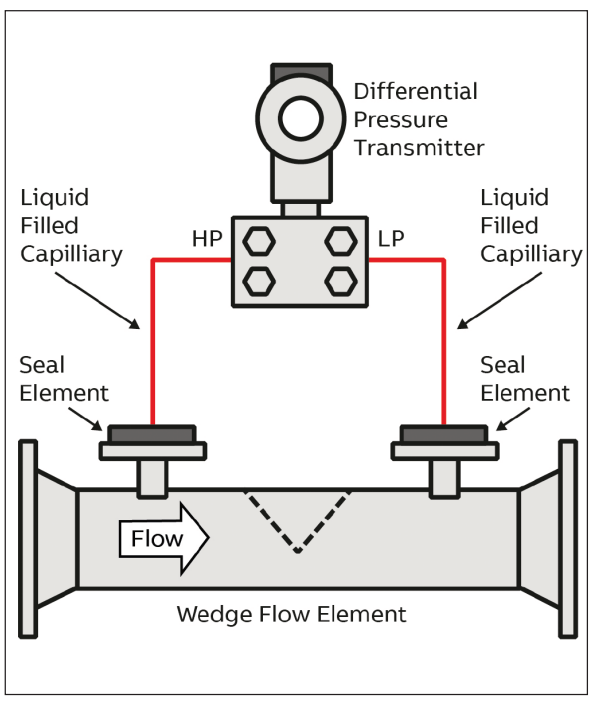


The benefits of wedge meters are highlighted by a customer application where they were used to measure molten sulphur at several key points, including at the recovery stage (refiner), during transportation and during tank loading and unloading. Meter sizes are usually in the range DN50 to DN150 (2 to 6 in.) for recovery stages; those used on transportation and terminal loading may range from DN100 to DN300 (4 to 12 in.). At this stage flows are generally between 1,500 and 8,000 tons/day. Loading points may have facilities to store between 80,000 and 300,000 tons of material.

Using an example flow rate of 450 tons/day, a 2 in. meter operates at an Re range of 4950 down to 500 or from 38000 to 4000 lb/hr under typical conditions for molten sulphur processing. An orifice plate of the same size and equivalent beta ratio would not only generate a higher differential (equating to higher pumping costs), it would be operating below the requirements of international standards for minimum Reynolds numbers.

Tips for optimum measurement performance when using wedge flowmeters

The ideal configuration of a wedge meter installation is shown below:



By mounting the installation horizontally, liquids, solids and entrained air are able to pass freely through the wedge restriction, in contrast to conventional orifice plate technology, where process material can build up on the measurement face, resulting in a 'damming' effect.

Where a horizontal configuration is difficult or impractical, wedge meters can instead be installed vertically, with flow passing upwards. This will make sure that the meter remains full of fluid at all times.

For corrosion and erosion compatibility purposes, the materials used for the meter should match the surrounding pipeline, alongside a the vast array of materials such as low alloy steels, stainless steels, nickel alloy steels. It is possible to apply coating such as tungsten carbide to elevate erosion and wear issues, to achieve as much as a tenfold increase in service life over base materials, proven by testing to international standard ASTM G65A abrasion testing.

Type	Clean liquids	Dirty liquids	Corrosive liquids	Viscous liquids	Abrasive slurries	Fibrous slurries	Low velocity	Vapour / Gas	High temp
Orifice									
Venturi									
Pitot tubes									
Flow nozzles									
Wedge									

Key

- Designed for these applications
- Applicable under certain conditions
- Normally applicable for these applications
- Not applicable for these applications

A truly versatile solution

The inherent benefits of wedge meters enable them to outperform other types of DP flowmeters and make them a versatile solution for a wide range of applications, as shown above:

They are particularly ideal for applications such as:

- Liquids with low electrical conductivity
- Viscous and non-Newtonian liquids
- Processes with high operating pressures and/or high operating temperatures
- Bi-directional flow measurement
- CO_2 or water injection to revitalize existing oil and/or natural gas fields
- Measuring media prone to agglomeration and gum formation

Summary

The above information provides a basic guide to the benefits of wedge flowmeters and their comparative advantages over other types of flowmeter. With decades of experience in the design and manufacture of a full range of flowmeter technologies for both industrial and utilities applications, ABB is well placed to advise you on the best solution for your requirements.

For more information or for a more detailed explanation of ABB's differential pressure flowmeter offering, please email enquiries.mp.uk@gb.abb.com or call 0870 600 6122 re. 'Wedge meters'.

Author Contact Details

Steve Gorvett, Product Manager - DP flow and temperature, ABB Measurement & Analytics.

• Howard Road, Eaton Socon St Neots, Cambridgeshire, PE19 8EU • Tel +44 1480 475321 • **Web: www.abb.co.uk**