The Developing Role of Helical Turbine Meters
Class Number 289

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INTRODUCTION
The petroleum measurement industry is continually searching for the ultimate meter – a meter that is accurate, reliable and inexpensive. One of the latest entries is the helical turbine meter (See Fig. 1). However, it should be noted that this type of meter has been around for many years but did not find wide application outside of Europe until the last two to three years because of the proving difficulty posed by its inherent low pulse resolution. With the advent and API acceptance of pulse interpolation techniques for proving low resolution meters, the helical turbine meter is finding a wider audience.

Figure 1–Helical Turbine Meter

DESCRIPTION
Figure 2 shows a cut-away of the helical turbine meter.

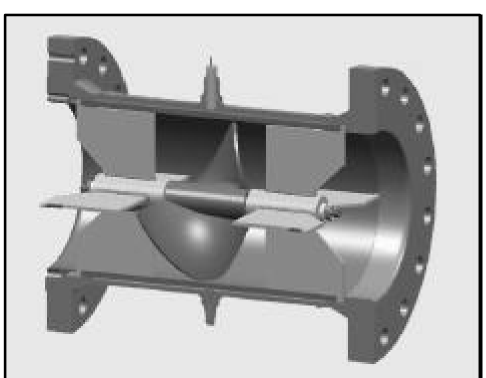

Figure 2–Helical Turbine Meter – Cut-away

It is similar to the conventional turbine meter with the following exceptions: the rotor has only two blades that are much wider and are helical-shaped (See Fig. 3), and the internals are mounted in a measurement tube that is removable from the housing (See Fig. 4).

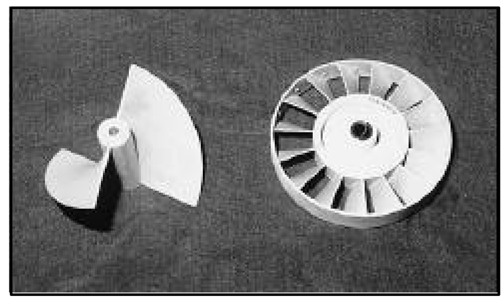

Figure 3–Helical vs. Conventional Turbine Meter Rotors

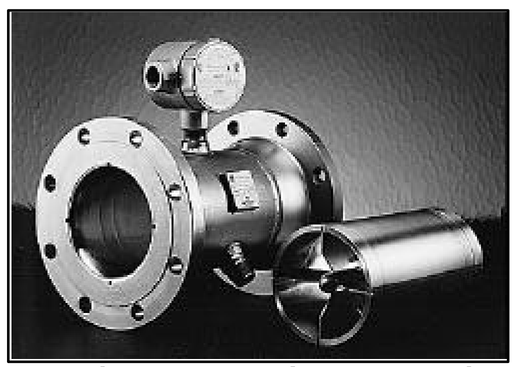

Figure 4– With Measurement Element Removed

The rotor can be made of nickel-plated aluminum or stainless steel. In some cases, where applications warrant, it is made of titanium. It rides on a journal bearing system typically made of tungsten carbide. There are small magnets imbedded in the tips of each blade that can be detected by the pulse sensor.

The measurement tube is made of stainless steel and holds the rotor mounting system. The tube is mounted into the outer housing such that all flowing liquid passes through.

VERSUS CONVENTIONAL TURBINE METER
The helical turbine meter offers several advantages over the conventional turbine meter.

Higher Viscosity Oils

The two-bladed rotor gives the meter the ability to accurately measure higher viscosity liquids. This can be explained by the reduced effect of the stagnant boundary layer that builds up on the rotor surfaces when higher viscosity oils are being measured. Figure 5 shows a comparison of the change in flow area with a 0.001" change in the thickness of the boundary layer for the conventional and helical 8" turbine meter rotors. The change in flow area directly affects the velocity through the meter and, therefore, the accuracy. The effect is over three times greater with the conventional turbine meter.

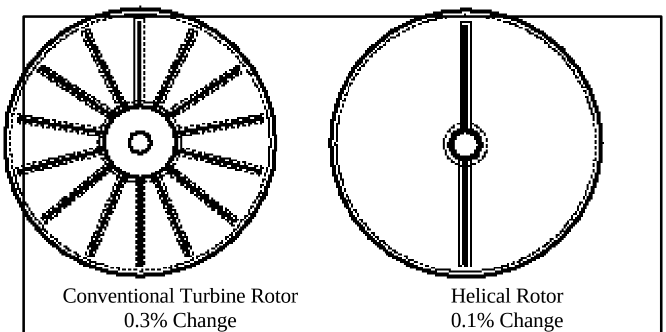

Figure 5–Boundary Layer - 0.001" Film on 8" Rotor

The conventional turbine meter is generally limited to application where the viscosity (in centipoise, cP) is no more than twice the meter size (inches). In other words, an 8 in. turbine meters is limited to applications where the viscosity is under 16 cP. Under these conditions the performance is reduced to where the linear flow range is no more than about 2:1 (50% to 100% maximum flow rate).

The helical turbine meter can perform on even higher viscosity applications with good linearity over a much wider range. Figure 6 shows the typical maximum flow rates for the helical turbine meter.

TABLE

Meter Size	BPH
3"	900
4"	1,900
6"	4,000
8"	7,500
10"	12,500
12"	19,000
16"	27,000

Figure 6–Typical Maximum Flow Rates for Helical Turbine Meters

The minimum linear flow rate can be determined from the chart in Figure 7 where the relationship of flow range and viscosity ratio are shown. The viscosity ratio is defined as the viscosity of the application (in centistokes, cSt) divided by the meter size (inches). The curve shows that as the viscosity ratio increases, the minimum flow rate must be increased to maintain the same degree of linearity (+/-0.15%).

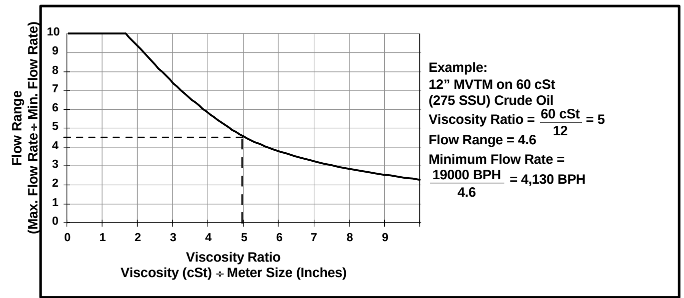

Figure 7–Helical Turbine Meter Minimum Flow Rates

Wax and Debris

Many crude oils have paraffins or asphaltines that can build up on the internals of the turbine meter in the form of deposits. The effect on the turbine meter is identical to the stagnant boundary mentioned above and, therefore, the accuracy shift is much less with the two-bladed helical rotor compared to the multi-bladed conventional rotor.

Many crude oils support filamentary debris that clings to the sharp leading edges of the rotor, reducing the flow area through the meter and interfering with accuracy. Since the helical rotor only has two blades, this effect is greatly reduced compared to the conventional, multi-bladed rotor.

Interchangeable Measuring Element

Another advantage offered by helical turbine meters is the elimination of inaccuracies caused by line pressure. In the conventional turbine meter, the housing is also the measuring tube. Line pressure has the effect of slightly bulging the housing. This causes an increase in the flow area, e.g., 500 p.s.i. on an 8" meter increases the flow area by 0.05%. This increase in flow area corresponds directly to a change in accuracy of the same magnitude. With helical turbine meters, the internal measuring element is not subjected to line pressure and is therefore immune to the "bulging" effect.

With a conventional turbine meter, there is enough variation in the internal diameter of the housing to prevent accurate measurement if the rotor and stators are swapped to another housing. With the helical turbine meter, the measuring tube is separate from the housing and thus eliminates this variable. This allows for the proving of a measuring element irrespective of the housing. In other words, in situations where the characteristics of the liquid being measured are well known, it would be possible to have an internal measuring element already proved on standby, thus eliminating the need for proving once it is put into service.

<u>Flow Conditioning</u>

As with the conventional turbine meter, flow conditioning is necessary prior to the meter run to insure there are now swirl or velocity distortions present in the flow stream. However, since the helical turbine meter is generally applied to those oils having higher viscosity, where pressure drop can be undesirably high, a high performance flow conditioner is generally used. This type of flow conditioner provides better flow conditioning and has significantly less pressure drop than the conventional type described in the API Manual of Petroleum Measurement Standards.

VERSUS PD METER

Since the helical turbine meter can measure higher viscosity oil, it can be used in applications that have previously been reserved for the PD meter.

<u>Initial Cost</u>

The cost of the helical turbine meter is lower than that of the PD meter, especially when considering larger sized meters. Figure 8 shows a cost comparison of the PD meter, helical turbine meter and the conventional turbine meter versus flow rate.

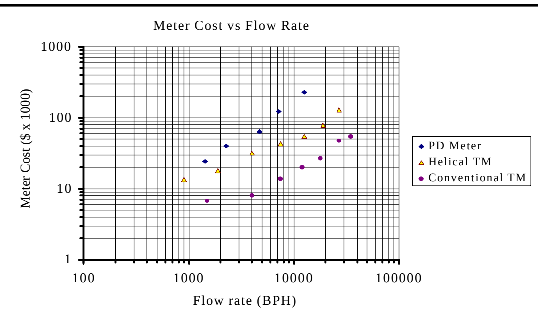

Figure 8–PD Meter, Helical and Conventional Turbine Meter Costs versus Flow Rate

<u>Maintenance Cost</u>

The complexity of the PD meter, with its many moving parts, can mean frequent and expensive maintenance. However, it should be noted that the frequency of maintenance is directly related to the throughput and the cleanliness and lubricity of the oil being metered. PD meters operating under severe conditions may require maintenance every few months, while under ideal conditions may go for years without maintenance.

Helical turbine meters have only one moving part – the rotor. It rotates on a journal bearing made of tungsten carbide that is much less prone to wear than the stainless steel ball bearings used in PD meters. Wear is less likely than damage caused by debris.

APPLICATIONS

Most oil companies have been cautious with helical turbine meters, using them only in internal measurement or check meter applications until they have gained sufficient confidence to use them for custody transfer.

As is the case with most new technology, helical turbine meters have been applied to situations beyond their capabilities. For example, one company conducted comparison testing of 6 inch helical turbine meters against PD meters on a crude oil pipeline. The oils varied in viscosity from as low as 10 cSt to as high as 100 cSt. They proved all meters for each batch of oil for several weeks. The results showed that the reproducibility of the meter factors of the helical turbine meters on the higher viscosity crude oils was around five times worse than the PD meters. This was beyond the acceptable limits and the helical turbine meters were removed.

FUTURE TRENDS

Helical turbine meters have found a niche in the petroleum measurement field and have proven their worth. Figure 9 shows the area where helical turbine meters can be used effectively, given the flow rate and viscosity.

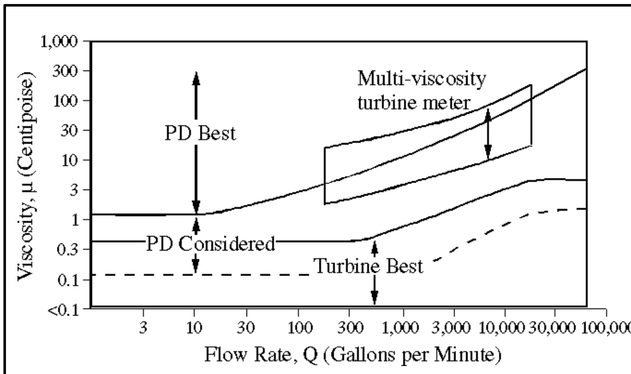

Figure 9–Helical Turbine Meter Application Area

With the advancement of electronic enhancement techniques which can compensate for the performance shifts associated with viscosity and flow rate changes, this meter is bound to find wider applications.