Pipeline Meter Selection

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The following "General Rules for Good Metering" should be considered in selecting meters for a pipeline meter station.

1. In large custody transfer metering systems the type meter which will provide the best overall measurement accuracy for the application should normally be chosen. When initial cost savings are carefully weighed against the cost of possible inaccuracies, it is normally discovered that the most accurate measurement system is the most economical in the long run.

   For example: At 400,000 BPD (16,700 BPH) the value of the petroleum metered (at $40 per barrel) is $16 million per day or over $5,000 million per year. Thus, an accuracy improvement of just 0.02% is worth over $1 million per year.
2. If there is no strong reason to select a turbine meter over a P.D. meter, it is best to use the P.D. meter because it is a direct volumetric measuring device which is less susceptible to large accuracy shifts due to unusual circumstances such as debris adhering to or damaging rotor blades, etc.
3. Strainers should always be installed ahead of meters to protect these very accurate instruments against damage by pipeline debris.
4. If it is possible to get significant amounts of air into the flow stream, it must be removed before reaching the meter to protect the meter from damage and to assure good metering accuracy.

The following is an outline of the steps typically followed to determine the proper (or best) type, size, and trim meter(s) for a custody transfer petroleum pipeline metering application.

Step 1:

Tentatively decide whether P.D. meters or turbine meters are best for the application. Factors to consider are:

a. **Maximum Viscosity.** If the maximum viscosity exceeds 10% of the reference viscosity for the possible size turbine meters to be considered (see Figure 6 of Reference 1), P.D. meters would normally be more accurate and thus selected.

   If only low viscosity refined products such as propane, gasoline, kerosene, diesel oil (e.g., white oils) are being metered, turbine meters would normally be selected because of their longer service life (for continuous duty operation) and normally equal or better accuracy on these type products.

b. **Maximum Flow Rate.** If total flow rate required at the metering station exceeds about 100,000 BPH, many parallel (16") P.D. meter runs would be required so turbine meters would normally be selected.

c. **Maximum Pressure.** If the meter pressure rating must be greater than 600# ANSI (1,440 psig), a P.D. meter could not be used.

d. **Back Pressure.** For a turbine meter the back pressure (pressure at meter outlet) should be at least 25 psig at maximum flow rate for low vapor presure fluids and 1.25 times the maximum vapor pressure for high vapor pressure fluids (e.g., propane). Low back pressure is of particular concern if the turbine meter station is to be located close to a receiving tank. With P.D. meters the back pressure must only exceed the vapor pressure by a slight amount.

e. **High Paraffin Content.** Turbine meters should not be used on liquids having paraffin or other similar substances which can precipitate out on the surfaces of the meter, changing its cross-sectional flow area.

Step 2:

Tentatively select the number and size of parallel meter runs for the metering station.

a. Normally, the parallel meters are all the same size.

b. It is best to have one more meter run than is necessary to handle the maximum station flow rate. Then if one meter run is down for service, the remaining meters can still handle the total flow. Also, the meters (especially P.D. meters) will run longer if normally operated below maximum rate.

c. Normally, the cost of the prover and the block and bleed valves determines the most economical number of meter runs for a metering station. From 3 to 5 meter runs per station is most common.

Step 3:

Refine the meter type, size, and trim by considering the following:

a. **Minimum Flow Rate** (Meter Turndown Ratio). A P.D. meter has a greater turndown ratio than a turbine meter on all but the lightest petroleum liquids.

   Turbine meter turndown is limited to about 10:1 on low viscosity liquids and generally becomes less with increasing viscosity.

   P.D. meter turndown increases greatly with increasing viscosity.

b. **Viscosity Range.** Turbine meters should be avoided on higher viscosity liquids (greater than 5 to 10% of reference viscosity in Figure 6 of Reference 1) if the viscosity varies substantially between meter provings (usually due to temperature changes).

   The calibration of P.D. meters shifts very little with viscosity or flow rate changes at viscosities greater than about 10 centipoise.

c. **Temperature Range.** If fluid temperature varies more than a few degrees, Automatic Temperature Compensation (ATC) of some type should be added to the measurement system.

   Turbine Meters

   If fluid temperature exceeds 225° F (106° C), a special pick-up coil is required. Otherwise, the meter is good for all temperatures normally encountered in petroleum metering.

   P.D. Meters

   Standard trim P.D. meters are generally good to 200° F (94° C), except above approximately 150° F

(65°C) - lower on meters over 4" - special high temperature blade tip and top clearances are necessary to allow for the difference in the thermal expansion rate of the aluminum blades and the cast iron housing.

Above 200°F (94°C) the aluminum blades must be changed to all iron. In doing this the meter maximum flow rate is reduced by 25%. This could thus alter the size meter chosen.

Also above 200°F (94°C) other trim and accessory options such as Viton elastomers and ventilated counter extension may be necessary.

d. **Fluid contamination** (water, salt H_2S, sand, catalytic fines, rouge, etc.):

Meter life can be severely shortened, which can result in accuracy problems, due to severe fluid contamination. For good meter service (accuracy and life) severe fluid contamination should be eliminated prior to metering.

Turbine Meter

All stainless steel construction would be better for petroleum which is significantly contaminated with water or salt water.

P.D. Meter

All iron trim is often used when fluid contamination is significant. Other types of special trim modifications have also been used to help solve particular problems.

Step 4:

Select the meter accessories (e.g., transmitters and/or counters) necessary to provide the analog and digital flow information required.

a. **Analog Output** (4-20 mA or 0-1 mA). Whenever an analog signal proportional to flow rate is required, a high frequency meter pulse output into a frequency to analog converter (e.g., Model 1681) is required. This output is standard on a turbine meter. Normally, a PEX transmitter must be added to a P.D. meter.
b. **Proving Output.** Again the standard high frequency output from the turbine meter is used directly; and a PEX transmitter (or Right Angle Drive and portable photo-electric transmitter) is used on a P.D. meter.
c. **Low Speed Pulse Output.** Typically a low speed pulse output from a remote factoring totalizer is used for turbine meters. For p.d. meters, a low speed contact closure device (e.g., Type "E" or LNC transmitter) is used. These are used to pace samplers, supervisory control, remote ticket printers, etc.
d. **Counters and Printers.** If mechanical counters or printers are used (either local or remote), the speed of the right hand wheel is of concern. Typically the speed of the right hand counter or printer wheel cannot exceed 250 rpm. However, in some remote electromechanical counters and printers this limit is closer to 100 rpm.

The number of digits and the units of registration must be specified for each counter or printer.

Reference 1

"Turbine Meters for Liquid Measurement," **Bulletin TP02001 (Technical Paper 103A),** by Philip D. Baker and Raymond J. Kalivoda, Smith Meter Inc., A Moorco Co., Erie, Pennsylvania, November, 1980.

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