CANADA PIPELINE ACCESSORIES

Celebrating **20 Years** of Expert Solutions

Liquid Phase Hydrocarbon Viscosity and Density for Free - Sign Me Up!

The most distinguishing feature between the liquid and gas measurement businesses is the approach to meter calibrations. The gas business calibrates once, off site, at a specialized calibration facility. Then the meter carries this characteristic through to its next calibration, which may take place years away, regardless of any changes to the fluid state.

By comparison, the liquid business calibrates on site continuously with an on-site meter prover. Any change in fluid characteristics requires a new calibration, possibly numerous calibrations per day. This is due to the unavailability of density and viscosity on site in an affordable fashion. However, there is another way.

Kids, Mr. Reynolds is coming for dinner, clean up all your math laying around and put it in the meter station

A fluid, is a fluid, is a fluid, is a fluid. In thermodynamics, phase is critical (pardon the pun) but in fluid flow measurement or fluid dynamics, phase is irrelevant. The ubiquitous Osborne Reynolds (1842-1912), or Uncle Re as we like to call him (or just Re for short), is the person responsible for all of this silly thinking.

Instead of wearing yourself out constantly asking, what is your "velocity, pipe diameter, density, temperature, pressure, composition and viscosity?", just ask "what is your Re number?" Amazingly, Uncle Re seems to have collected all the important flow information into one simple unitless number.

$$Reynolds\ number\ (Re) = \frac{(Pipe\ Diameter \times Velocity \times Density)}{Dynamic\ Viscosity)} = \frac{(Pipe\ Diameter \times Velocity)}{(Kinematic\ Viscosity)}$$

$$dynamic\ viscosity\ \mu \left(\frac{kg}{ms}\right) = kinematic\ viscosity\ \gamma \left(\frac{m^2}{s}\right) \times \rho \left(\frac{kg}{m^3}\right)$$

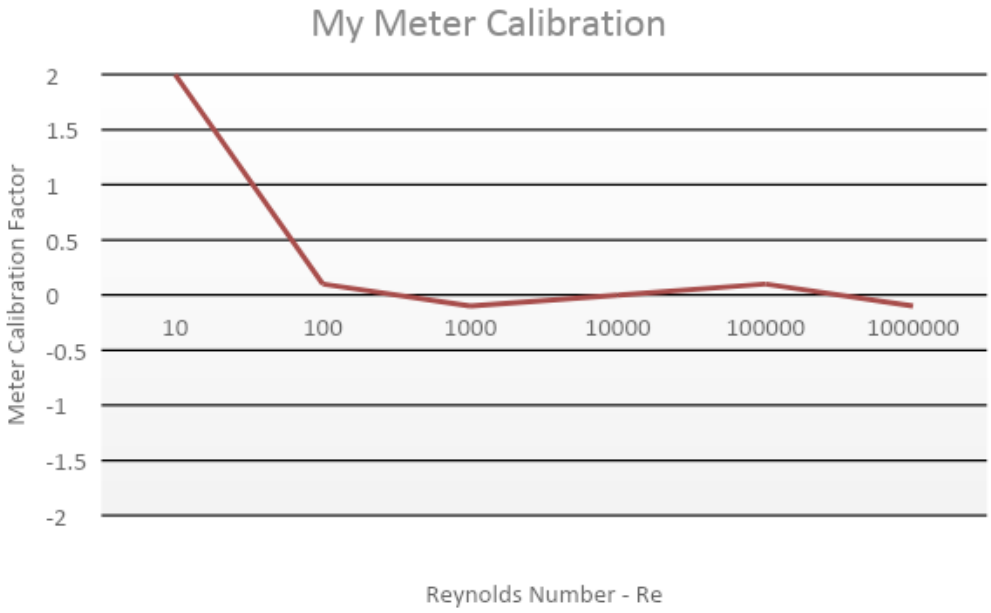
Where:

ρ = density kg/m3
μ = dynamic viscosity 0.001 kg/mS, PaS, cp
γ = kinematic viscosity 1x10-6 m2/s = 1 cSt

1cp	**0.001 kg/ms**	**0.01 p**	**0.001 Pas**
1cSt	**$1x10^{-6}$ m^2/s**	**0.01 stokes**	

And how is this important to me?

The best part of all this (besides keeping your airliner airborne and your boat afloat) is if we know the Re of the fluid, then we can then measure its flow rate. It is as simple as calibrating against Re instead of flow rate. In graphical form it looks like this:



It's easy to get Re to the calibration lab, but how do we get it to the meter station?

Now here's the fun part.

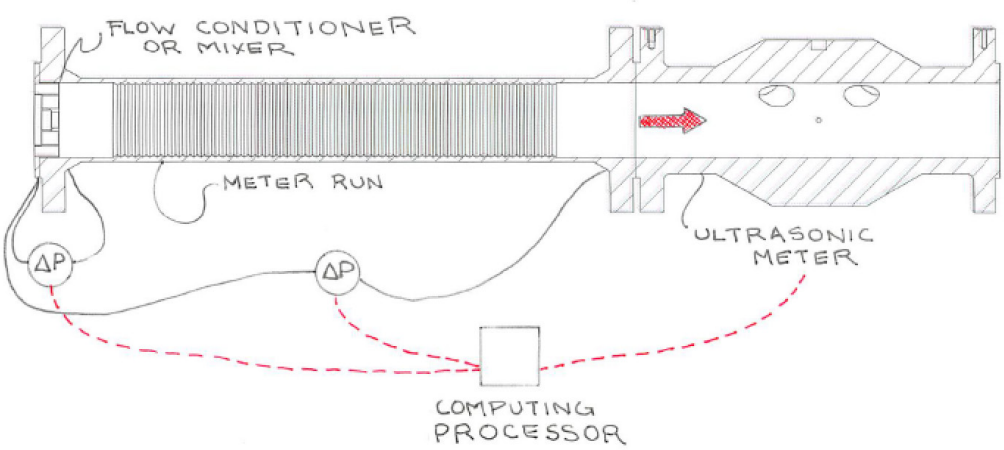
In our measurement bag of tricks we have:

1. A volumetric meter - like a turbine meter or an ultrasonic meter (USM) - that has a k factor or calibration curve that can be made relative to Re;
2. A flow conditioner(s) or mixer (or both) that have a repeatable pressure drop envelope;
3. A section of pipe, located between the flow conditioner or mixer and the meter, that has a repeatable pressure drop envelope;
4. Differential pressure transmitters.

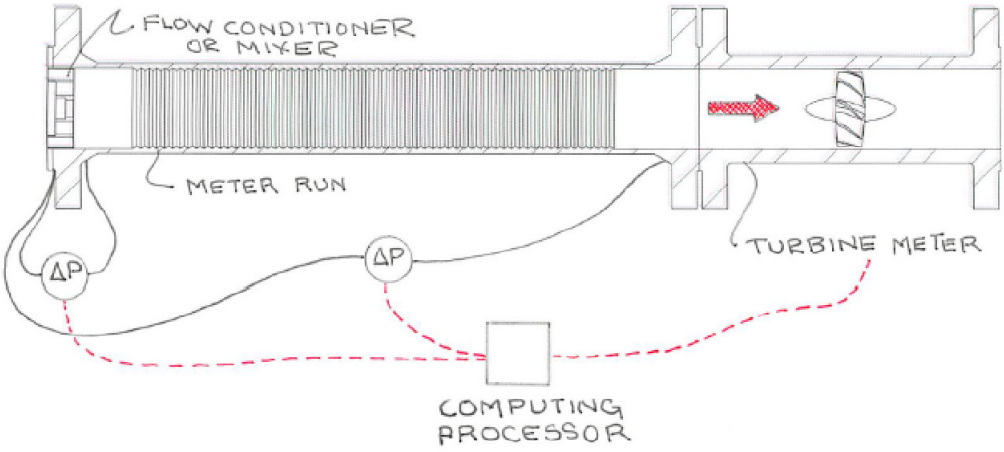
Also in our measurement bag of tricks we know:

> We can link mathematically the volume output of the meter to the differential pressure relationship of the pipe and the flow conditioner or mixer.

In graphical form we have this for the USM:



And we have this for the turbine meter:



Conclusion

We won't go into the math in detail, but basically we have a system of two unknowns (density and viscosity), and two equations (pipe pressure loss and a fitting pressure drop). Properly programming the computing processor to solve for these parameters can obtain the fluid density and the fluid viscosity. This means that at any time, the Re for the meter can be established. This means that a one time calibration for the meter can be utilized for the meter k factor or calibration factor. Just like the gas business. No expensive meter proving required.

To learn more about fluid flow measurement and how to improve your measurement accuracy, contact Canada Pipeline Accessories today.

CANADA PIPELINE ACCESSORIES

*Celebrating **20 Years** of Expert Solutions*

10653 - 46 Street S.E.

Calgary, Alberta

Canada T2C 5C2

Phone: 403-236-4480

Fax: 403-236-0019

Email: info@cpacl.ca