



CANADA  
PIPELINE  
ACCESSORIES

## CPA Tech Note

### Liquids, Gases (or Reynolds Number Range)

The CPA 50E flow profiler (flow conditioner) can be used in **LIQUID** phase or **GAS** phase metering applications.

In the Engineering world the study of thermodynamics has trained us to be phase sensitive. That is; we are quick to identify phase state because there are vastly different thermodynamic behaviors for various phase states of a fluid which affect the thermodynamic calculations.

In the study of Flow Measurement or Fluid Dynamics and specifically with respect to flow conditioning, we are not interested in the fluid phase. In the study of flow conditioning there are fluids and non-fluids. That is it. (We of course can not mix two or more phases at once in the pipe for proper fluid flow measurement)

A non dimensional term referred to as “Reynolds Number (Re)” is our measuring stick which we use in a much more sensitive manner than fluid phase. The Re equation is explained below:

$$Re = \frac{U\rho\phi}{\mu} = \frac{U\phi}{\gamma}$$

U = Mean Fluid Velocity (m/s)

$\rho$  = Fluid Density (kg/m<sup>3</sup>)

$\phi$  = Pipe Diameter (m)

$\mu$  = Coefficient of Viscosity or Absolute Viscosity (kg/ms)

$\nu$  = Kinematic Viscosity (m<sup>2</sup>/s)

We then use the Pipe fluid Re to estimate:

1. Is Flow Laminar or Turbulent.
2. What does the fully developed Velocity flow profile look like. See Figure 1 – Velocity Profiles verses Re.

At A Re of approximately 2000 to 4000 (heavy crude oil) the pipe flow may be laminar not turbulent. You can not use the CPA 50 E flow profiler in Re 4000 or lower due to laminar flow. If the Re is approximately 4000 or higher you are fine to use the CPA 50 E flow profiler.

At Low Re (4000 to 100,000) the flow profile required in the pipe will be slightly more “peaked” than what the CPA 50 E flow profiler is generating. This is acceptable because the meter tube pipe wall will adjust the flow profile from the CPA 50E flow profiler to match approximately fully developed flow profile in an extremely repeatable manner before the fluid arrives at the flow meter.

At Re (100,000) to 100,000,000 (infinite Re) you are absolutely fine to use the CPA 50 E Flow Profiler in compliance with recommended installation requirements.

