Advanced Heavy Oil Metering

Both oil density and viscosity can vary with changes in oil grade and temperature. These fluid properties can be difficult to know in real time, and yet these parameters are required to know the flow's Reynolds number. Flow meters are sensitive to Reynolds number. Erroneous fluid property entries results in erroneous Reynolds numbers and therefore erroneous flow rate predictions. Hence, heavy oil flow metering is challenging. Industry tends to discuss the issue of heavy oil viscosity uncertainty but less is said regarding density uncertainty.

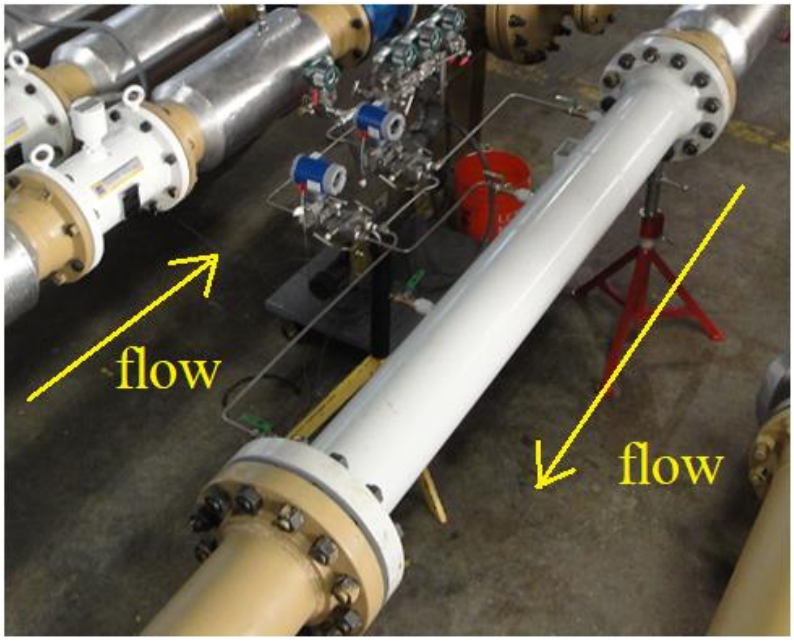

Fig 1. 8" Wedge Meter with Prognosis in Series with an 8" Helical Turbine Meter in CEESI's Heavy Oil Facility.

Figure 1 shows an 8" wedge meter with Prognosis in series with an 8" helical turbine meter. The meters are installed in the inlet and outlet of a U-Bend respectively. Both the wedge and helical turbine meters are sensitive to 'Reynolds number', i.e. density and viscosity.

Combining the wedge meter with Prognosis and the turbine meter information supplies the viscosity and density, and hence the heavy oil flow is metered with no externally supplied fluid properties required. Figure 2 shows the combination of the information:

Graph 1: The wedge meter's Prognosis DP ratios are sensitive to Reynolds number and hence Prognosis predicts the Reynolds number.
Graph 2: This Reynolds number prediction predicts the wedge meter discharge coefficient.
Graph 3: This Reynolds number prediction predicts the helical turbine meter flow coefficient.

With the helical turbine meter's flow coefficient known, it supplies the volume flow prediction. Substituting this volume flow prediction into the wedge meter volume flowrate finds the fluid density, and hence the heavy oil mass flow. With the Reynolds number, fluid density, and mass flow known the fluid viscosity can be derived.

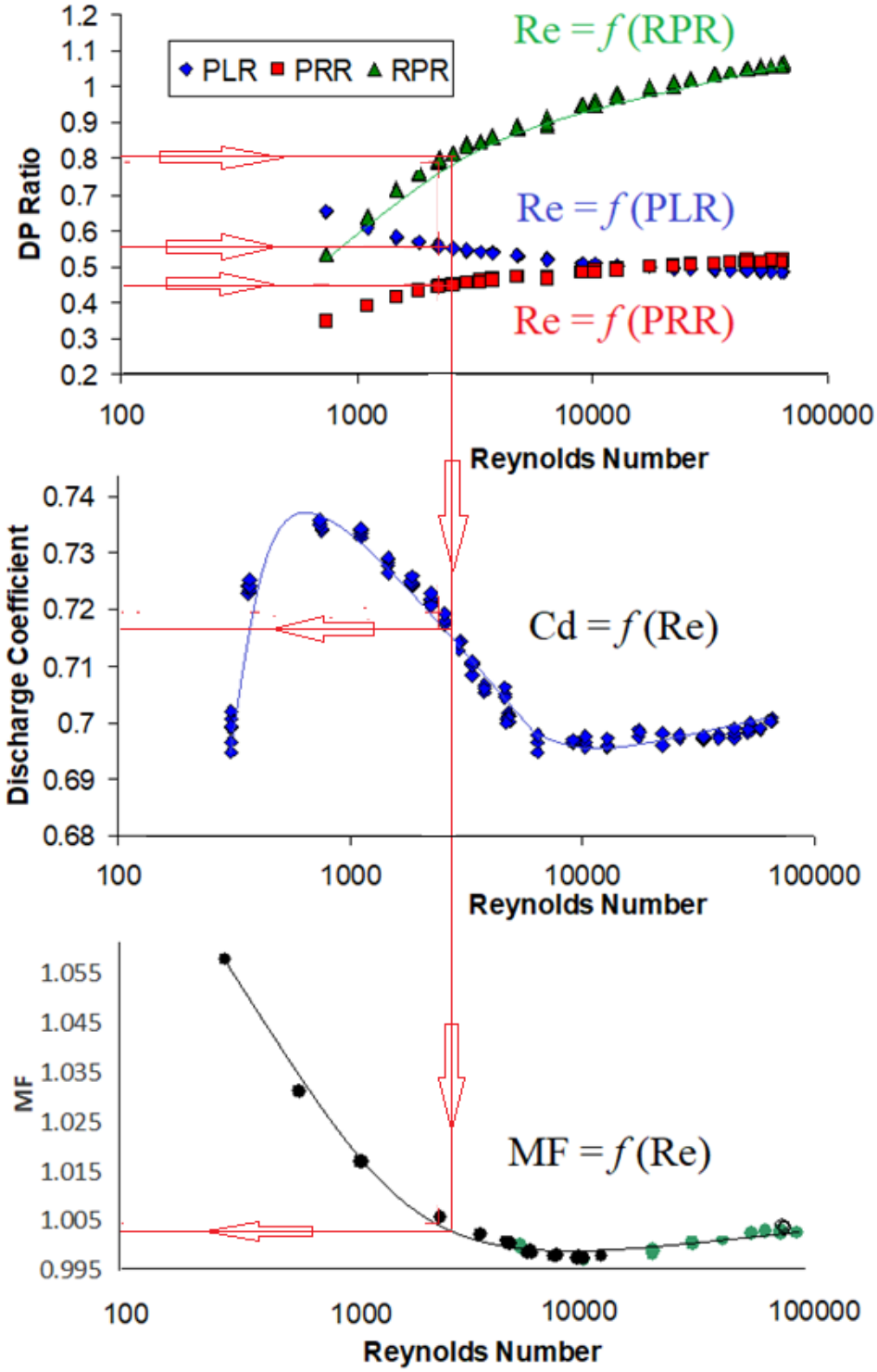

Figure 2. Combined Wedge / Helical Turbine Meter Heavy Oil Meter Example.

Prognosis on a heavy oil DP meter predicts Reynolds number. When combined with a volume meter (e.g. a helical turbine meter) the system can meter heavy oil without density and viscosity estimations being required.