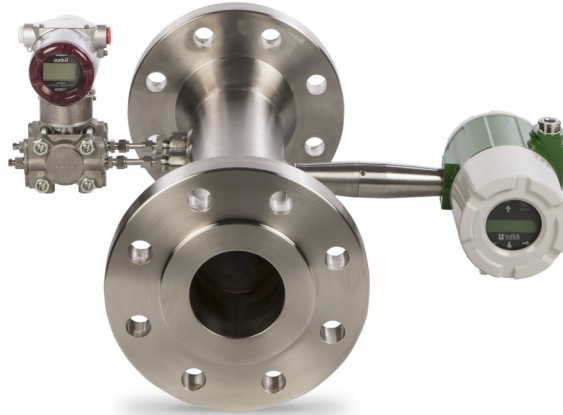


Case Study

Steam Quality Metering in Enhanced Oil Recovery (EOR) with VorCone™



Saturated steam flows are commonplace throughout industry. To control and maintain optimum efficiency of a saturated steam process it is necessary to know the steam's quality and flowrate. However, saturated steam flow of quality ' x ' < 100% is two-phase flow, and two-phase flow metering is notoriously challenging. The use of standard single-phase gas meters with such saturated steam flows produces steam flow prediction biases and does not produce a steam quality measurement. Furthermore, the few steam quality measurement systems there are available tend to operate over limited high-quality ranges (e.g. $x > 80\%$) only. VorTek Instrument's VorCone meter measures both steam quality and total mass flow across a wide range of quality.

The VorCone meter is a fully integrated hybrid vortex and cone flow meter. These two dissimilar metering principles complement each other giving far more information than either standalone meter. In saturated steam service, the VorCone meter measures steam quality and total mass flow rate.

"Heavy Oil" is a term that indicates highly viscous oil. This high viscosity inhibits the oil's extraction from reservoirs. As such, the Enhanced Oil Recovery (EOR) technique of injecting saturated steam to increase the oil's temperature, thereby reducing its viscosity and making it easier to extract, is widely used. However, it's important to control the steam flowrate and quality. Too high a quality makes the process inefficient; i.e. more heat is supplied than necessary. Furthermore, too high a steam quality can cause scaling of the pipes. However, too low a steam quality means not enough heat being supplied and the process is sub-optimal. Optimizing the process requires measurement and control of the steam quality.

The steam quality desired at oil pad injection sites is typically about 60% to 70%. As existing steam quality instruments are usually for higher quality ranges (e.g. $x > 80\%$) they are not well suited to this application. However, VorCone meters can operate at $x > 40\%$ and have been proven to do so with service in heavy oil field applications. E.g., Figure 1 shows a 3" VorCone meter at a heavy oil field. This VorCone meter's quality measurement follows the quality as it is varied by the operator across a $40\% < x < 80\%$ range. Figure 2 shows results when this meter was connected to a portable reference system. This VorCone meter uses the measured quality with a saturated steam flow correction to also meter the steam flowrate.



Fig 1. 3" Saturated Steam VorCone Meter at a Heavy Oil Field Injection Point.

A 4" VorCone meter was also installed at the outlet of a heavy oil field boiler. Whereas the operator traditionally had no independent boiler quality setting confirmation, this VorCone meter confirms a quality of 73%, closely matching the boiler nominal setting of 75%. The VorCone meter gives the field operator a different level of control over his production process than was achievable before, assuring optimal process control and maximum efficiency of production.

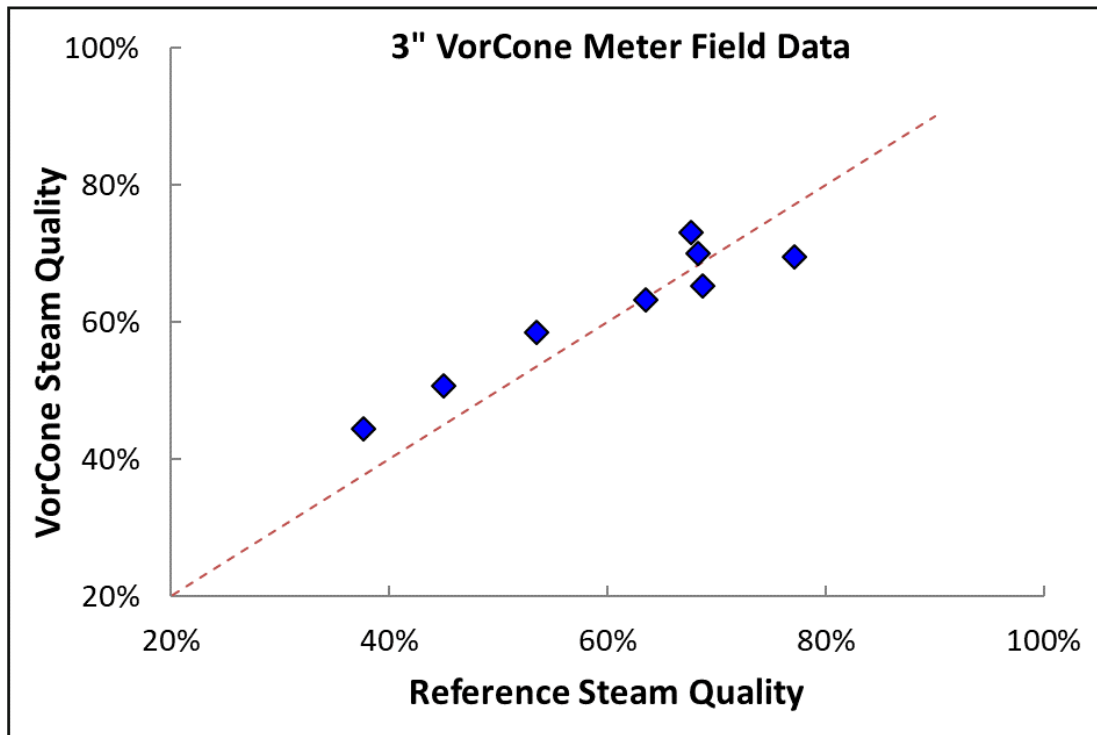


Fig 2. Results of Uncalibrated 3" VorCone Meter Steam Quality Measurement.

Saturated steam VorCone meters are now being considered for diverse applications such as EOR, pharmaceutical, tire factories, district heating systems, etc.

For more information visit

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