APPLICATION NOTE

Vortex Flowmeter in Water/Steam Injection

Industry: Oil & Gas
Product: digitalYEWFLO Vortex Flowmeter

Introduction

After conventional recovery techniques have recovered all the hydrocarbons possible, there may be still a high percentage of the original oil left in the reservoir. This oil can be worth recovering if prices are high. The major methods of improved oil recovery are water flooding and steam injection. "These technologies make a tremendous contribution to recovering additional oil from old wells as well as improve primary recovery of operating oil fields."
When applying these techniques, measurement of the flow of water and steam is desirable for control and optimization of the process. Historically orifice plates with differential pressure transmitters have been used for this measurement. However, vortex flowmeters offer a number of features and advantages in these processes and are being applied in greater numbers.
It introduces the details of these processes and the effectiveness of the vortex flowmeter in the following chapters.

Expected Benefits

Expected benefits of using the vortex flowmeter in these processes are particularly as follows:

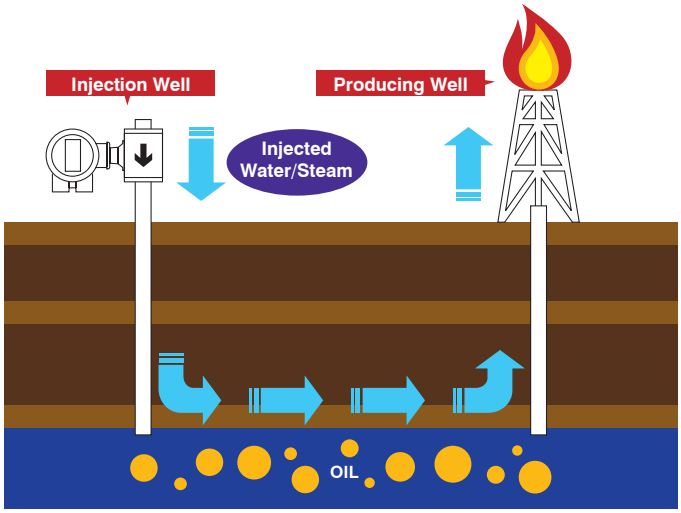
- Reduced piping and wiring costs up to 1/3 of orifice
- Reduced sealing points up to 1/10 of orifice from the viewpoint of ISO14000
- Good accuracy 3 times as orifice for process noise proof and precise cost calculation
- Low pressure loss 1/3 of orifice for influence decrease on the process and for energy saving
- High process temperature (+450 deg C) and pressure (ANSI 2500# rating) proof

Process Description

With water flooding, injected water enters the reservoir and displaces some of the remaining oil toward producing wells in the same reservoir. The producing wells then pump up the oil and water.
Steam injection involves generating steam on the surface and forcing this steam down injection wells and into the reservoir. The steam heats up the oil and reduces its viscosity. The heat from the steam also causes hydrocarbons to form gases which increase flow. The gases and steam provide additional gas drive and the hot water also moves the thinned oil to the production wells.

With these processes, operating temperatures and pressures can reach 90 deg C (194 deg F) and 290 bar (29 MPa, 4200 psi). Flange ratings up to ANSI 2500# are necessary to accommodate these conditions.
Accurate flow measurement of the water and steam is one of the primary factors influencing the productivity of the wells. The measurement is also important to improve efficiency and control operating costs. While orifice plates have historically been applied to make these measurements, they have some limitations and drawbacks:

- Low accuracy
- Limited rangeability (3:1 or 4:1)
- High permanent pressure losses
- Square root relationship
- Relatively high installation costs and high cost of ownership
- The need for impulse lines which may require heat tracing and may also plug
- Zero adjustment required
- High number of fugitive emission sources
- Accuracy grossly affected by wear and/or damage of the orifice plate



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Application Solutions

Yokogawa's vortex shedding flowmeter, "digitalYEWFLO", offers a number of inherent advantages over orifice plate technology and is finding greater acceptance in these applications.
As mentioned above, the reason why piping and wiring costs can be reduced is that the impulse line is not needed and that flange mounting enables in-line measurement.
Decrease of sealing points leads also to reduction of routine maintenance cost and energy saving, as well as free zero/span adjustment helps easy tuning under start-up.
Rangeability (turndown) of 10 times as orifice is also available for energy saving as well as pressure loss.
Compared to orifice flowmeters, vortex flowmeters have the other following advantages:

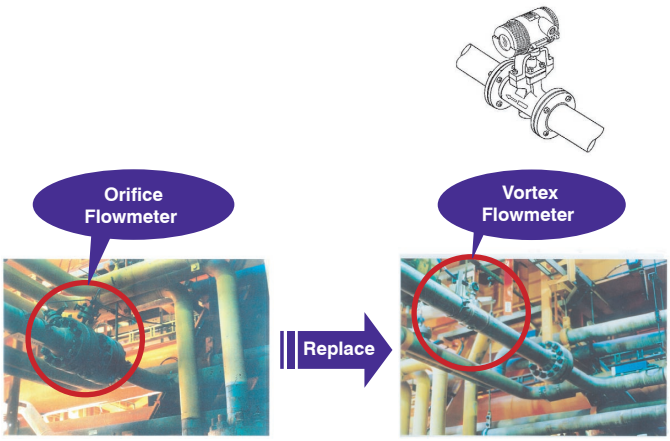
- Stable long term accuracy and repeatability
- Digital measuring principle (orifice meters use analog)
- Linear transfer (non-square root)
- Lower cost of installation than traditional orifice-type meters
- No impulse line system
- No routine maintenance required
- Reduced possibility of process fluid leakage
- No moving parts to wear
- No special protection needed against extreme weather conditions

Furthermore, digitalYEWFLO is able to address the high temperatures and pressures encountered in these applications.

Process temperature ranges from -200 to +450 deg C (-328 to +842 deg F) are available as well as flange ratings to ANSI 2500#. In addition, digitalYEWFLO offers dual sensor designs for redundancy and special control/alarm functions, which is frequently required for safety instrumentation in refineries, as well as self-diagnostic functions for predictive maintenance. These functions are realized on the high reliability of MTBF 400 years. A multi-variable design is also available. With the multi-variable option, a built-in integral temperature sensor allows the meter to make a true mass flow measurement of saturated steam by referring to steam tables embedded in the software. This eliminates the need for separate pressure and temperature sensors and a flow computer. In addition, FOUNDATION fieldbus™ protocol is utilized for device management.

Conclusion

Yokogawa's digitalYEWFLO has taken the number 1 market share in the world, and the shipment total has been over 250,000 devices since the launch in 1979.
This technology definitely optimizes today's oil/gas recovery at the best efficiency.



	Vortex Flowmeter 'digitalYEWFLO'	Orifice Flowmeter
Accuracy	+/- 0.75% of reading (liquid)	+/- 3% of reading
Rangeability (Turndown)	10X improvement	—
Pressure Loss	1/3 lower	—
Capital Expense	1/3 less	—
Operating Expense	1/10 less	—
Impulse Tubing	not needed	required
Zero/Span Adjustment	not needed	required
Nominal Sizes	15 to 400 mm (1/2 to 16 in.)	25 to 3000 mm
Process Temperature	-200 to +450 deg C (-328 to +842 deg F)	-40 to +120 deg C (-40 to +248 deg F)
Ambient Temperature	-40 to +85 deg C (-40 to +185 deg F)	(same as left)
Pressure Rating	up to ANSI 2500#	up to 420 bar (working)

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