Implementation of quality control to measure flow rates in the oil pipelines using the Transient Time Method and radiotracers

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Typically, an oil flow rate measurement is done using an invasive device, and calibrating this flowmeter is not an easy task because it must be disconnected from the pipeline and transport to the reference laboratory. This operation is expensive, and it requires certificated procedures and highly qualified staff to perform. Using a proper radiotracer for the specific material moving inside the pipeline is possible to measure the flow without any disturbance in the pipeline's regular operation. The volumetric flow rate Q can be calculated by measuring the mean flow velocity using: [1,2,3,4].

$$Q=\frac{\pi D^2}{4}.\bar{v}(1)$$

$\bar{v}$- mean flow velocity
D - internal duct diameter

Measuring a flow rate is relatively easy. .It is done by installing two detectors, injecting an ideal radiotracer, and calculating the transient time between the two measuring points. The method proposed uses four scintillator detectors (D1, D2, D3, D4) separated by 0.30 m and three radiotracer injections (T1, T2, T3). The transient time between two measured positions is calculated using the mean residence time and the detector's distance. Out tracer group develops a technical report with the procedures to improve the experimental conditions applied to measure oil flow rates in circular and straight ducts using the Transient Time Method and radiotracers. The best situation to use the method is in the steady turbulent flows, and this happens when:

- Reynolds Number is greater than 5000.
- Fluid should fill all the ducts.
- The fluid velocity at the measure position is constant and does not change as time passes.
- Flow is irrotational; there is no vortex motion.
- Fluid is incompressible.

The experiments were carried out in an oil flow rig with PVC ducts with a turbulent flow profile and the injection containing 2.0 ml of ^{123}I-labeled oil. Table1 shows mean flow velocity (cm/s) for each measure position for Q = 800 LPH and in Table 2 for Q = 1000 LPH.

Table 1 - Mean Flow Velocity (in cm/s) for injections T1, T2 and T3 and Q = 800 LPH (Reynolds Number= 8085)

D1D2	D1D3	D1D4	D2D3	D2D4	D3D4
76.95	78.36	77.53	77.59	76.87	77.87
76.89	77.99	78.09	77.87	78.22	77.96
76.83	78.39	77.60	77.99	78.14	78.19
Mean Flow Velocity =			(77.74 ± 0.27) cm/s		
Oil Flow rate =			(797.72 ± 6.57) LPH		

Table 2 - Mean Flow Velocity (in cm/s) for injections T1, T2 and T3 and Q = 1000 LPH (Reynolds Number= 9600)

D1D2	D1D3	D1D4	D2D3	D2D4	D3D4
97.26	96.95	98.89	97.14	97.78	97.08
96.86	98.22	97.13	96.99	98.08	97.68
98.46	97.21	98.09	97.39	97.01	97.95
Mean Flow Velocity =			(97.57 ± 0.31) cm/s		
Oil Flow rate =			(1001.14 ± 8.16) LPH		

For the experiments, the flowrate results correspond to a relative standard uncertainty RV near 0.8% and according [5] it is classified as a Class 1 method.

References

[1] ISO 2975-7:1977, “Measurement of water flow in closed conduits Tracer methods -- Part 7: Transit time method using radioactive tracers”.

[2] BS ISO 5168:2005 Measurement of fluid flow - Procedures for the evaluation of uncertainties

[3]. OGA - The Oil and Gas Authority, UK, Guidance Notes for Petroleum Measurement, Measurement Guidelines – Issue 9.2, 2015

[4] UPP, E. L.; LANASA P. J., Fluid Flow Measurement: A Practical Guide to Accurate Flow Measurement, Butterworth-Heinemann, Second Edition, 2002.

[5] R117/INMETRO 64/2003, Regulamento Técnico de medição de Petróleo e Gás natural - RTM, 2003.