

NORCE Multiphase Flow Loop

FEATURES

- Location: Indoor
- Fluids: Nitrogen, diesel fuel and salted (NaCl) tap water
- Two lines. Pipe diameter 6" and 3"
- Separator pressure: ≈ 5 bara
- Temperature range: 15 - 35°C (no temperature control)
- Gas flow rate: ≈ 1100 Sm³/h
- Liquid flow rate
 - ≈ 100 m³/h in 3" line
 - ≈ 250 m³/h in 6" line
- Pipe material: 316 L (acid-proof)



DESCRIPTION

NORCE (previously Christian Michelsen Research AS (CMR)) has been operating a multiphase flow facility since early in the 1990's, and has substantial experience and expertise on flow monitoring. In 2008 a new multiphase flow loop was constructed by CMR (now NORCE) with financial support from the Research Council of Norway and Roxar.

The Multiphase Flow Loop is an important tool when new multiphase metering technologies are being tested and verified during own R&D projects or R&D projects in cooperation with external customers.

The test facility consists of 6" and 3" flow loops, a 32 m³ separator tank, centrifugal pumps and reference instrumentation for determination of phase fractions, flow rates, flow pressures and temperatures. The fluid media are salted tap water, diesel and pressurised gas. The gas consists of nitrogen in the 95-100% concentration range; the rest fraction in the gas phase is air. The nitrogen is produced from air by a nitrogen generating system driven by a compressor. Another compressor drives the gas circulation through the flow loop.

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The flow loop and test areas are located in rig halls, with a 100 m² floor area available for test sections. The entrance door to the test hall is 5 m wide and 3.3 m high. A travelling crane with capacity of 5 tons and lift height of 6.1 m is available.

OPERATION



The separator is a three-phase gravity separator and it contains approximately 10 m³ of diesel and 10 m³ of water and 12 m³ of gas. The two liquid phases enter the loop through separate pipe legs with butterfly valves at each leg to adjust the Water-in-Liquid Ratio (WLR). Two sets of liquid outlets exist; one for the 3" line, the other for the 6" line. Downstream of a water-oil mixing junction (T-piece), the liquid enters the centrifugal pump. The pump is, together with a downstream Coriolis meter and the butterfly valves, part of an electronic control loop connected to automatic flow controllers. This control loop is used to set the liquid flow rate and the WLR to a chosen pre-defined set point.

The nitrogen gas from the compressor is stored in a separate tank at a pressure of 13-14 bara. Before injection into the liquid lines the gas flow rate is measured at a pressure of 10 bara by Coriolis meters. Two meters can be used, one for gas volumes up to 325 Sm³/h, the other for gas volumes up to 1100 Sm³/h. There is also a control loop for the gas valve.

The gas returns to the compressor for recirculation after passing through the separator, forming a closed loop. Calibration of reference instruments take place once a year, normally in July.

MECHANICAL OUTLINE

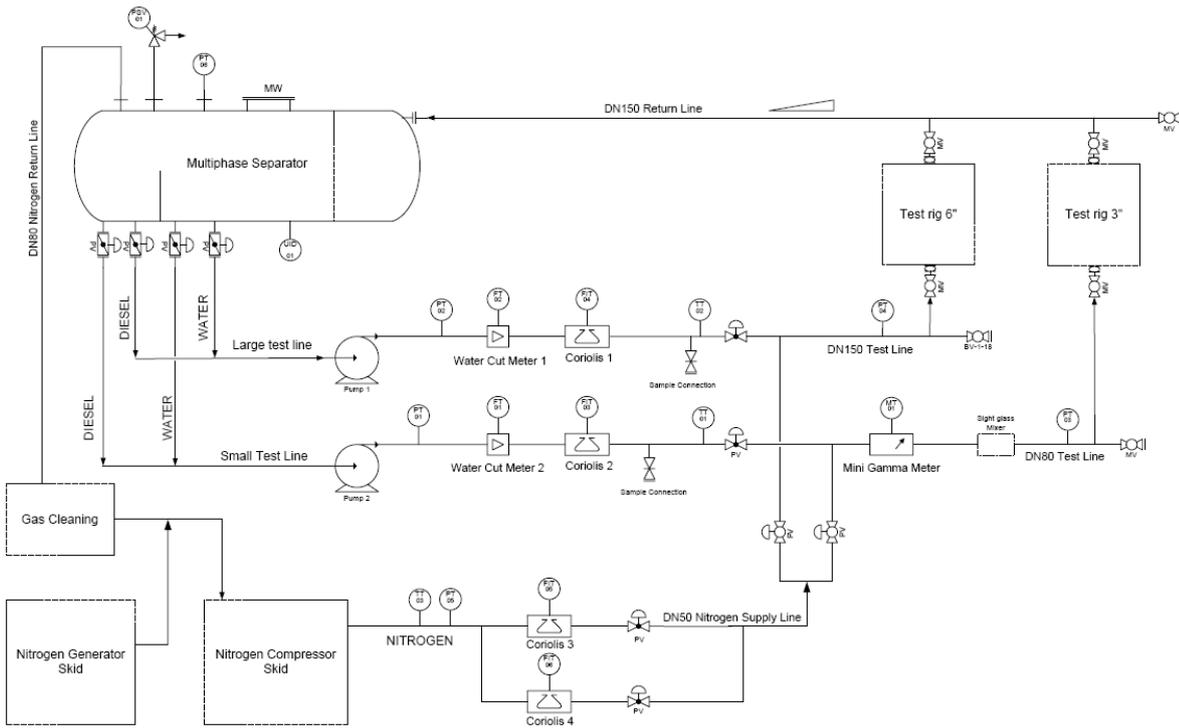


Figure 1: Simplified P&ID of the NORCE Multiphase Flow Loop.



Figure 2: The NORCE Multiphase Flow Loop. Test area to the left, separator and reference instruments to the right. The nitrogen generation facility is not included in the drawing

TECHNICAL SPECIFICATIONS

Key Specifications

- Location: Indoor
- Fluids: Nitrogen, diesel fuel and salted (NaCl) tap water
- Pipe diameter: Two lines: 3" and 6"
- Separator pressure: ≈ 5 bara
- Temperature range: 15 - 35°C (no temperature control)
- Gas flow rate: ≈ 1100 Sm³/h
- Liquid flow rate: ≈ 100 m³/h in 3" line. ≈ 250 m³/h in 6" line
- Pipe material: 316 L (acid-proof steel)

Table 1: Reference instrumentation in the NORCE Multiphase Flow Loop

Tag	Instrument	Range	Expected uncertainty (95% conf. level)
FT-01-001	Coriolis meter, Liquid	3-100 m ³ /h	< 0.5 %
FT-01-002	Coriolis meter, Liquid	7-250 m ³ /h	< 0.5 %
FT-01-003	Coriolis meter, Gas	345-1400 kg/h	< 1 %
FT-01-004	Coriolis meter, Gas	30-390 kg/h	< 1 %
PT-01-001	Pressure transmitter	0-10 bar	0.2 % (abs.)
PT-01-002	Pressure transmitter	0-10 bar	0.2 % (abs.)
TT-01-001	Temperature transmitter	0-50 °C	0.15 °C
TT-01-002	Temperature transmitter	0-50 °C	0.15 °C
TT-01-003	Temperature transmitter	0-50 °C	0.15 °C
TT-01-004	Temperature transmitter	0-50 °C	0.15 °C

Table 2: Uncertainties (95 % conf. level) in flow parameters in the NORCE Multiphase Flow Loop

Flow Parameter	Uncertainty	Unit
Gas flow ($Q_{\text{gas}} > 24$ Sm ³ /h)	< 1.2	% rel.
Liquid flow	< 0.5	% rel.
WLR	< 1.1	% abs.
GVF	< 0.5	% abs.

The flow parameter uncertainties given in Table 2 are calculated from the uncertainties in Table 1. The calculations follow the procedures given in the ISO "Guide to the expression of uncertainty in measurements" (1995). All reference instruments are calibrated at accredited laboratories and traceable to international standards. The reference instruments are subject to regular calibration. Calibration certificates are available on request.

NORCE has a HSE and QA system in accordance with ISO 9001.