

FACTS

SINTEF Petroleum Research

SINTEF – Large Scale 3-Phase Test Facility

March 2016

The extended Tiller facility

SINTEF Multiphase Flow Laboratory consists of a medium-scale multiphase flow laboratory (A), an HPHT laboratory (B), a CO₂ capture laboratory (C), and an office building (D). Along with the three-phase high pressure large scale flow loop (E) this test facility is a foundation for continued development of subsea oil and gas production technologies.

SINTEF has established a truly unique subsea field development test laboratory which will be able to actively simulate flow assurance challenges for complex three-phase flows in a variety of pipe sizes and configurations. Well streams with compositions, rates, pressures and temperatures covering a wide industry-realistic range will be provided, as well as pipes, instrumentation and equipment to allow studies of all major Flow Assurance challenges.



Gas hydrates are one of the most important Flow Assurance challenges which depends on the chemistry of the system. Photo: Geir Mogen

- A = Medium scale MPF Lab
- B = HPHT Lab (Hydrates)
- C = CO₂ Capture Lab
- D = New Office infrastructure
- E = Large Scale Loop

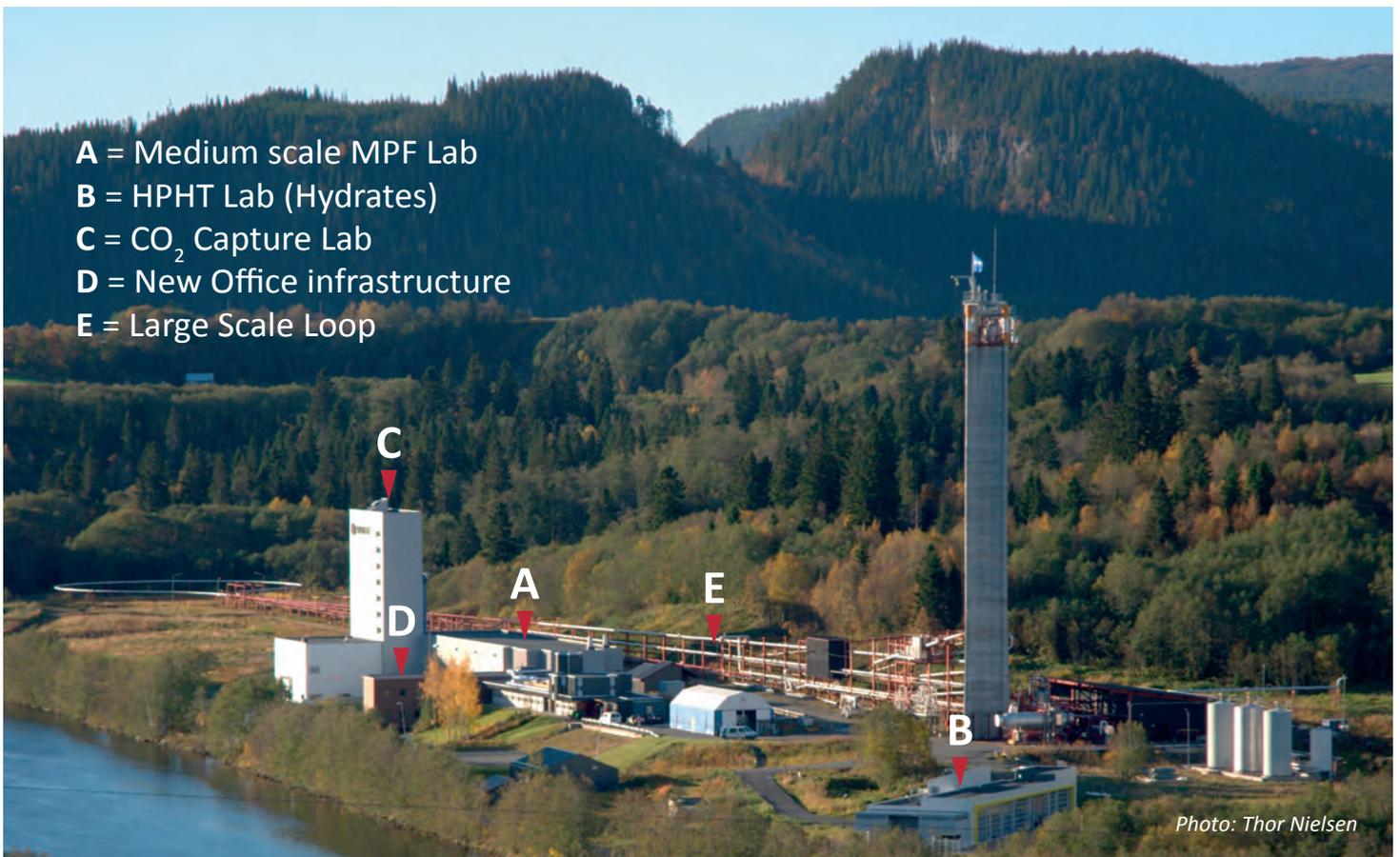


Photo: Thor Nielsen



The Large Scale Loop

The large scale loop is an industrial scale three-phase flow facility with EX control. The main features are a 500m long pipe rack and a 60 m high riser tower. A typical loop configuration has a total length of 850 m.

The Medium Scale Loop

The medium scale loop is located indoor in a 60 m long laboratory hall. By using SF₆ as the gas phase, gas densities equal to that of methane at 88 bar can be reached. This facility allows the study of multiphase flow in much greater detail than what is possible in large scale. For example: oil droplets, gas entrainment into oil and droplet entrainment into the gas phase, may be studied in this facility. A 11 m³ separator provides long retention

times so that less easily separable fluids, such as viscous oils can be used.

The Small Scale Real Crude Loop

The use of actual hydrocarbons breaks an important barrier enabling studies of complex chemistry-dependent phenomena. SINTEF's Small Scale Real Crude laboratory allows work on high-pressure high-temperature (HPHT) fluids. The test loop consists of a 50m long 1in pipe which can be pressurized up to 100bar, and temperature-controlled room from -10°C to +50°C. In addition, high-pressure wheel-shaped flow loops are available up to 1000 bar.

| | | Typical max operating pressure | Minimum pressure | Temperature range (typical) | Line sizes | Horizontal line length | Inclinations | Vertical line length |
|--------------------------|---|--------------------------------|------------------|-----------------------------|-----------------|------------------------|------------------------|------------------------|
| | | bara | bara | °C | | m | deg | m |
| Large Scale Loop | Three-phase flow loop | 90 | 5 | 10 to 50 (30) | 8" (4" and 12") | 800 | 0, 0.5, 1 | 55 |
| Medium Scale Loop | Three phase flow loop + solids (sand) | 10 | atm. | 5 to 50 (20) | 2.5", 3", 4" | 50 | -4 to 4 | 35 |
| Small Scale Loop | Three-phase flow loop + solids (hydrates. etc.) | 100 | atm. | -10 to 50 (4) | 1" and 2" | ~50 m | 0 to 90 | 2 (flex. conf.) |
| Wheel Flow Loop | Three-phase flow loop + solids (hydrates. etc.) | 1000 | atm. | -10 to 80 (4) | 2" and 5" | 6.3 m (circular) | NA (vertical mounting) | NA (vertical mounting) |

| | | Flow rate, gas | Flow rate, oil | Flow rate, water | Oil | Water | Gas |
|--------------------------|---|--------------------|-------------------|-------------------|--|-------------------------|--|
| | | Am ³ /h | m ³ /h | m ³ /h | | | |
| Large Scale Loop | Three-phase flow loop | 1500 | 480 | 175 | Refined oil, Crude oil (no precipitates) | Fresh water/brine pH>10 | Nitrogen (any inert gas) |
| Medium Scale Loop | Three phase flow loop + solids (sand) | 160 | 80 | 120 | Exxol D80 (any non-flammable HC) | Fresh water | Sulphur hexafluorid (any inert gas), air |
| Small Scale Loop | Three-phase flow loop + solids (hydrates. etc.) | 3 | 5 | 5 | Any crude or model oil | Any water chemistry | Any (excl. H ₂ S) |
| Wheel Flow Loop | Three-phase flow loop + solids (hydrates. etc.) | 36 | 36 | 36 | Any crude or model oil | Any water chemistry | Any (excl. H ₂ S) |



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