Flow Assurance Specialist

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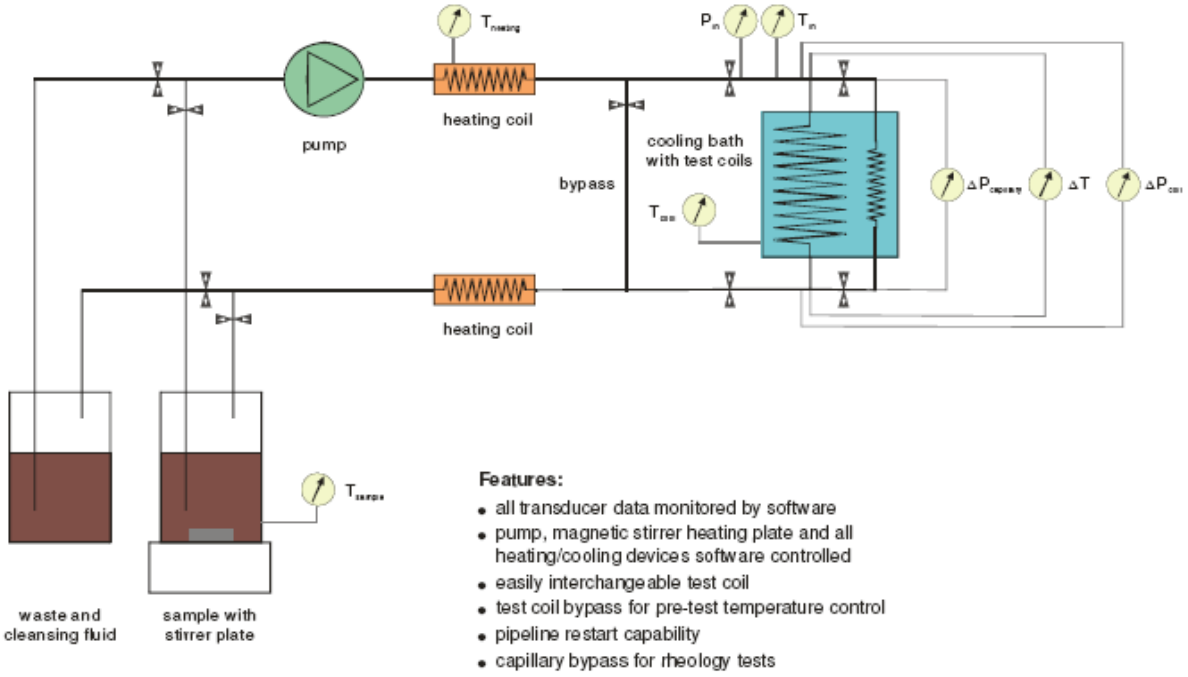
Wax Flow Loop with Pipeline Restart Test Capability & Bypass for Rheological Tests
(Dead Crude)

Overview

The Wax Flow Loop consists of a sample container (flask or beaker) which is placed on a magnetic stirrer plate for pre-heating. The sample is pumped out of this container by an HPLC pump (50 ml/min) into an electrically heated coil which provides a constant inlet temperature to the test coil. The test coil is cooled in a water bath (+5 °C to +70 °C) which is placed at the side of the plant for easy access. The test coil is interchangeable. For wax precipitation and deposition tests, a 1/8" test coil of 2 m length is used. For pipeline restart tests, a 8 mm test coil of 20 to 30 m length is recommended. After leaving the test coil, the sample enters a second heating coil and flows back into the sample container or a waste container. This provides the ability to pump the sample in circles. Additionally, the waste container can be filled with a cleaning fluid to clean the loop after a test.



Features:
- all transducer data monitored by software
- pump, magnetic stirrer heating plate and all heating/cooling devices software controlled
- easily interchangeable test coil
- test coil bypass for pre-test temperature control
- pipeline restart capability
- capillary bypass for rheology tests

There are switch valves at the wax loop's inlet and outlet to switch between circulation/non circulation and cleansing mode. Additional valves are located at the test coil's inlet and outlet to close the line when the test coil is interchanged. The test coil has a bypass which is opened while the sample is pre-heated and will be closed when the test starts. Using the bypass avoids pre-precipitation of wax during the time the test coil is cooled down to its set temperature.
The wax flow loop test coil is interchangeable by the pipeline restart test coil.

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Parallel to the test coil, a small capillary is installed as a bypass (on the right in the picture). This capillary is used for rheological tests of the sample. (We are still thinking about installing the ability to connect the capillary in line to the big test coil if wanted. This can be done by two additional 3-way-valves.)
All pressures and temperatures, especially the differential temperature ΔT and differential Pressure ΔP_{coil} over the big test coil and the differential pressure $\Delta P_{capillary}$ over the capillary are monitored.

Instrumentation

The Loop is equipped with several temperature and pressure transducers:

T_{in}	Test coil inlet temperature
ΔT	Test coil differential temperature
$T_{heating}$	Heating coil set temperature
T_{sample}	Magnetic stirrer heating plate set temperature
T_{cool}	Cooling bath temperature
P_{in}	Test coil / capillary inlet pressure
ΔP_{coil}	Test coil differential pressure (max 20 bar)
$\Delta P_{capillary}$	Capillary differential pressure (max 5 bar)

Control and Data Acquisition Software

The plant is controlled by a PC software, which leads the user through a test. Tests can also be programmed. The valves are operated manually. The pump, the stirrer and the heating and cooling equipment are directly software controlled.
All temperatures and pressures are monitored and displayed, especially the differential temperature and pressures.
The software has the following modes:

1. Rheology Mode: The sample is pumped through the capillary. This can be done at increasing/decreasing flow rates or temperature ramps. Another feature is the constant flow rate/constant $\Delta P_{capillary}$ test. This means that $\Delta P_{capillary}$ is monitored while the flow rate is kept constant or that the flow rate is controlled to keep $\Delta P_{capillary}$ constant. This requires special control algorithms.

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2. Wax Flow Loop Mode: The sample is circulating in the system and is pre-heated to a set temperature while the cooling bath is cooling to its set temperature. The bypass is opened during this time. After reaching the set temperatures, the bypass is closed. The differential pressure and differential temperature are monitored. The test ends after
   a. a set differential temperature is reached and/or
   b. a set differential pressure is reached (constant flow rate mode) or a set flow rate limit is under-run (constant ΔP mode) or
   c. a set time period is over

3. Pipeline Restart Mode: The cooling bath is cooling to its set temperature. The sample is heated above WAT and is circulating in the system for short period of time with the bypass opened. Then, the bypass is closed and the pump stops. After a set time, the pump restarts to measure the differential pressure. If the differential pressure is still below a set value, the pumps stops again. This is repeated until the differential pressure exceeds the limit. The pump starts again with very low but increasing volume flow. The pressures are monitored and indicate the restart.
   The constant flow rate/constant ΔP feature can be used in this mode, too.

4. Combined Modes

5. Free Mode: The operator is setting valves, volume flows and temperatures arbitrarily. Just security features (pressure, temperature) keep to be software and hardware controlled.

6. Cleansing Mode

Options

1. Fully automated system with all electrically actuated valves
2. Third container for cleansing fluid for automatic cleansing after a test (requires option 1)
3. Alternative, interchangeable test coils