# TITLE:

# *In Situ* Visualization of the Phase Behavior of Oil Samples under Refinery Process Conditions

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# SUPPLEMENTAL FILE

# SETUP DESCRIPTION:

The main principle of the setup is to load the sample inside a reactor fitted with a sapphire window at the bottom, and place the reactor over the objective of an inverted microscope equipped with a cross-polarizer module, as shown on Figure S 1 [place Figure S 1 below]. The setup should allow the operator to manage sample pressure, temperature, and stirring.

The micro-reactor is made of an assembly of stainless steel fittings shown on Figure , with specifically designed elements:

* The bottom fitting can accommodate a face seal using a sealing ring. A sapphire window is fitted to the reactor using this face seal when the reactor is in operation.
* The top part of the micro-reactor is connected to the gas lines for gases to flow in and out of the reactor. The micro-reactor can also be connected to a rupture disc assembly for safety purposes.
* A thermocouple is inserted and sealed at the top of the reactor. The thermocouple runs along the length of the inside cavity and its tip should be positioned with a minimal recess from the face seal surface of the bottom fitting.
* A custom-machined permanent magnet (made of Aluminum-Nickel-Cobalt alloy) can be fitted on the thermocouple, to provide stirring to the sample during reactor operation.

The Process and Instrumentation Diagram (P&ID) of the setup is presented on Figure S 2. The series of lines and valves are used to manage gas flow and pressure inside the reactor [place Figure S 2 below].

The temperature inside the reactor is managed by a simple control loop, comprising:

* The measurement of the temperature inside the sample within the reactor using the aforementioned thermocouple (TT1 on Figure S 2).
* A Proportional-Integral-Derivative (PID) temperature controller (TIC1), which receives information from the thermocouple TT1, and accordingly supplies power to a coil heater.
* A coil heater, which is clamped around a machined stainless steel block wherein the micro-reactor sits.
* The heating efficiency is enhanced by placing the heater, the machined stainless steel block, and the micro-reactor inside a casing filled with ceramic wool.

Stirring is achieved by the custom-machined magnet inside the reactor, which is put into motion by magnetic coupling with a larger magnet located outside the reactor. The larger magnet outside the reactor itself is attached to a motor, which provides direct mechanical rotation.

# FIGURE LEGENDS:

**Figure S 1.** Reactor inside a heating block, placed over the objective of an inverted microscope.

**Figure S 2.** Process and Instrumentation Diagram (P&ID) of the experimental setup.