Flow Imaging Microscopy for Produced Water Analysis

A recent study by Feng et al. (2018) "Oil in water characterization by dynamic optical fluid imaging technology" in Fuel demonstrated the FlowCam to be a faster and more informative method to analyze produced water than spectrophotometry. This high-throughput method:

- Images produced water samples and analyzes particulates (Fig. 1)
- Differentiates oil droplets from solids using morphological characteristics
- Measures size of oil droplets and particles
- Calculates particle size distribution
- Enables the user to observe oil behavior with images during demulsification
- Calculates percent oil and percent solid of aggregates.

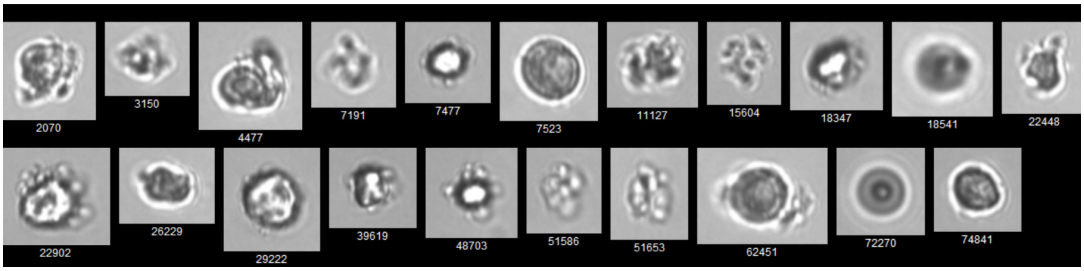

Fig 1. Oil droplets, solids, and oil-solids aggregates in a produced water sample imaged by the FlowCam Nano

HOW DOES FLOWCAM® FLOW IMAGING MICROSCOPY WORK?

- A syringe pump pulls the sample through the flow cell. Particles are back lit using flash illumination to prevent motion blur during image capture (Fig. 2).
- An image of the entire flow cell is captured by the camera.
- VisualSpreadsheet®, the FlowCam's image analysis software, extracts individual particle images from the flow cell image.
- 40+ physical parameters are measured from each particle including area, circularity, and length.
- A particle size distribution is calculated.
- Particle classifications can be built based on morphological traits. Classifications can aid in auto-identification.

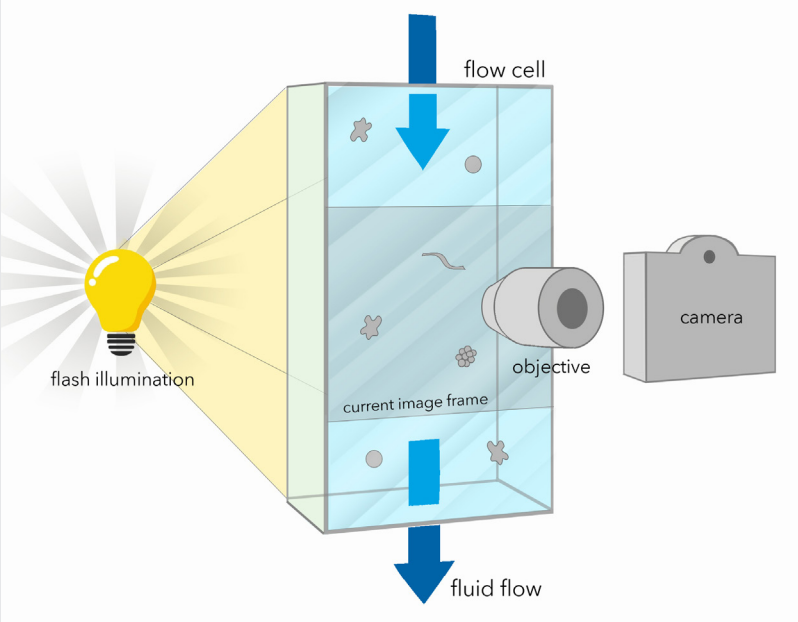

Fig 2. Schematic diagram of FlowCam imaging technology

IMPROVED ACCURACY WITH NANO-FLOW IMAGING® TECHNOLOGY

In 2017, Fluid Imaging Technologies introduced the FlowCam Nano®, the world's first Nano-Flow Imaging instrument. This technology:

- Images particles as small as 300nm (Fig. 3)
- Provides detailed images of oil droplets, solids, and aggregates, resulting in accurate particle size measurements.

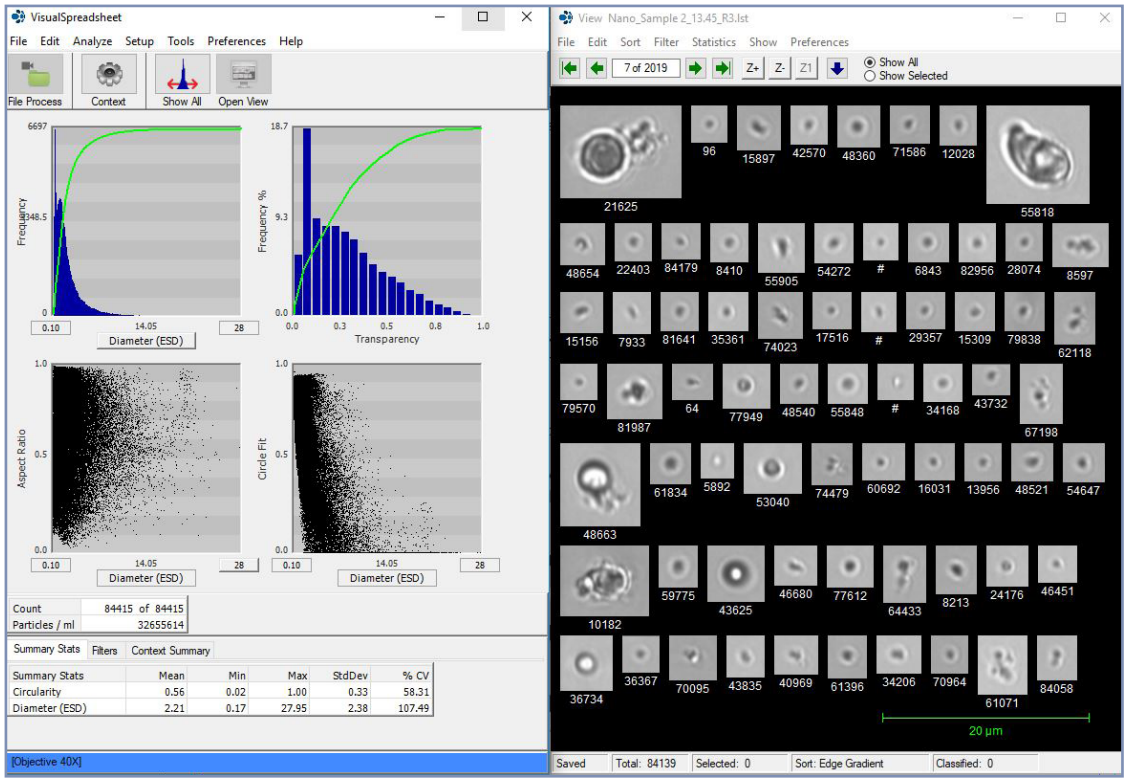

Fig. 3. Produced water imaged and analyzed by the FlowCam Nano using Nano-Flow Imaging

HOW IT WORKS: OIL IMMERSION FLOW MICROSCOPY

The FlowCam Nano introduces the concept of oil immersion microscopy to flow imaging. In traditional microscopy (Fig. 4a), the specimen is on a glass slide with air between the slide and the objective lens, which causes some light loss due to the refractive index between air and glass. With oil immersion microscopy (Fig. 4b), oil sits between the slide and the objective lens with negligible refractive index, thus delivering maximum light into the lens. The FlowCam Nano uses this concept in conjuntion with a 40x objective to provide highly resolved images never before available for particles in this size range.

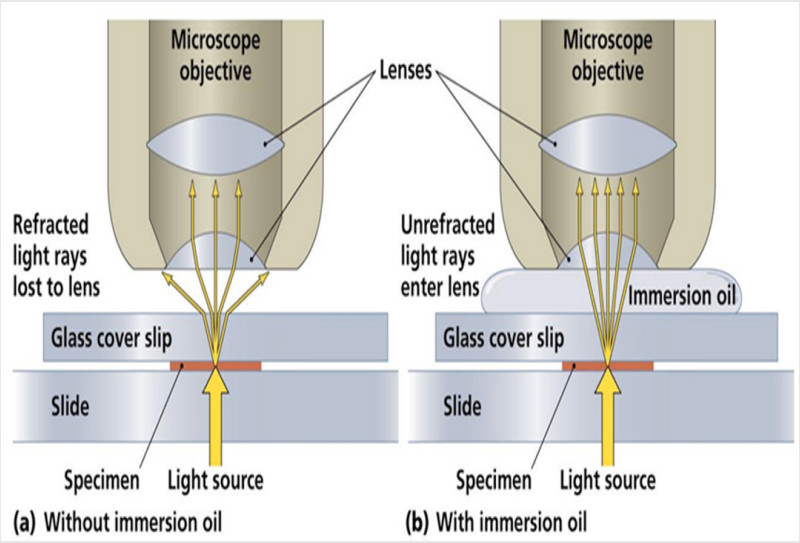

Fig. 4. Schematic diagram of traditional vs. oil immersion microscopy