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# **Engine Oil Aeration**

## **Lab Simulation and Correlation to Engine Testing**

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# Aeration properties of lubricating oils

**Terms: Air entrainment, Microfoaming, dispersed gas**

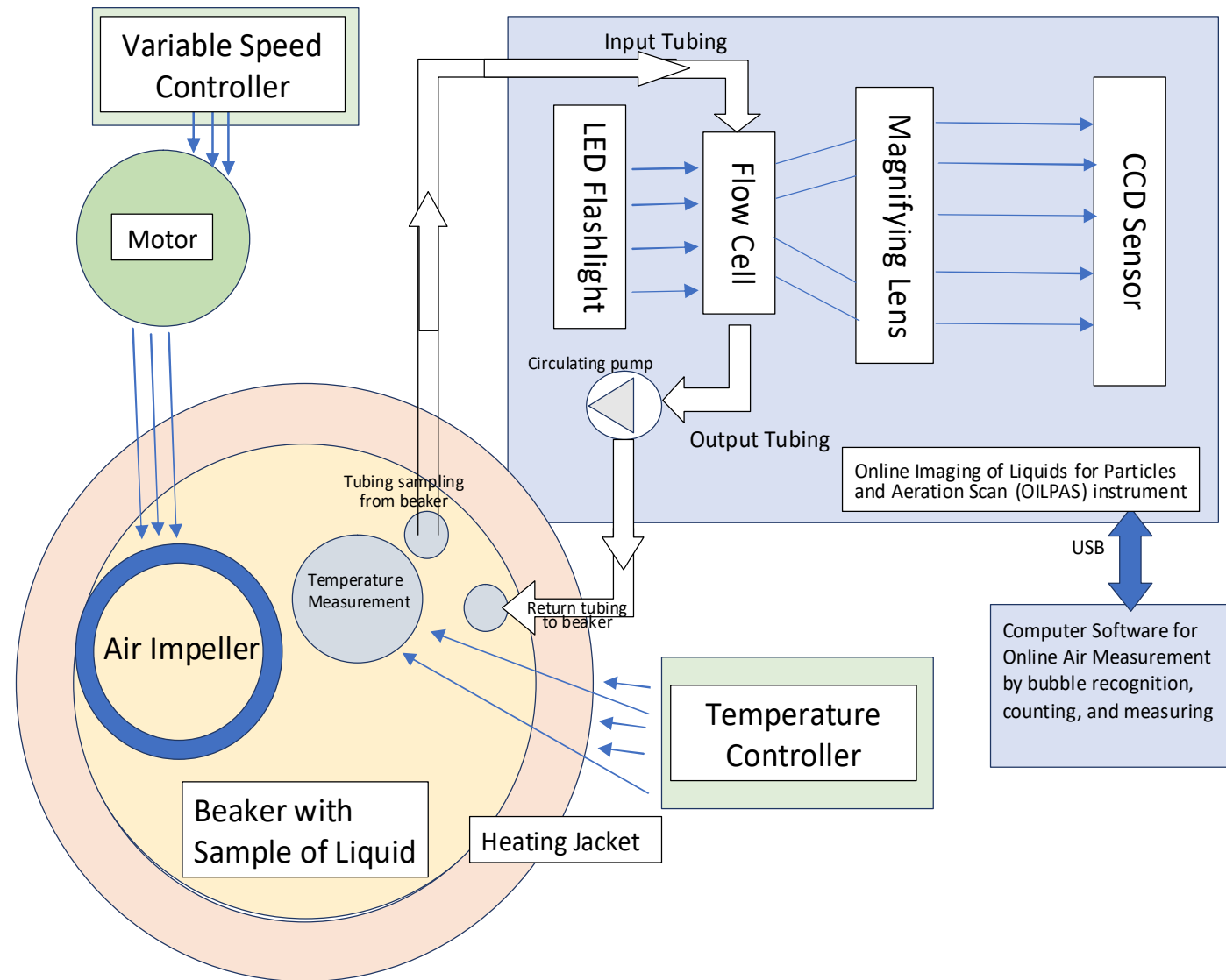
**DEFINITION:** Aeration is a characteristic of an oil for its tendency to retain free air above the absorption limit at a given pressure and temperature.

- Oil aeration is important for good mechanical operation. Free air impairs mechanical performance because of:
  1. Cavitation in components by absorption and release
  2. Wear by irregular (potholed) oil film
  3. Oil compressibility (“sponginess”) affects response in hydraulically driven component operation
  4. Oxidation reactions in a larger area of contact with oxygen and pressure cycles affects drain cycle and deposit/varnish formation

# Aeration, Air Release, Foaming

- Previous test methods for aeration testing:
  - ASTM D-8047 Engine oil aeration resistance in CAT C13 heavy-duty diesel engine. COAT replaces D6894 as part of the PC-11
  - Air release test ASTM D-3427 and foaming test ASTM D-892 are insufficient to characterize air/oil interaction in performance drivetrain components
  - ISO 12152 Flender foaming test, stops test to measure increased volume in a ruler

# Diagram of Testing Device

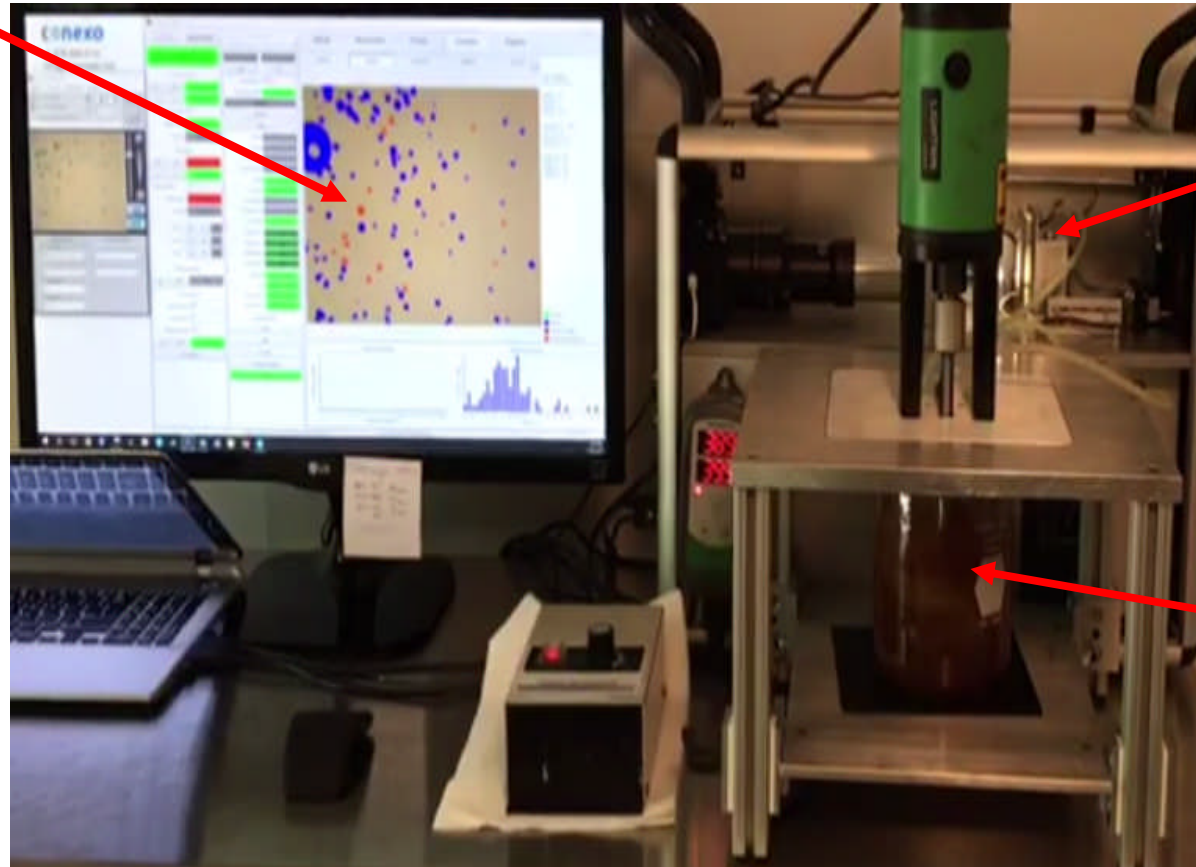


# New test method to measure Oil Aeration

- Measures dynamic gas holdup in lubricating oils
- Principle of operation/test description
  - Aeration by simulation of a air vortex into the oil
- Aeration measured in steady agitation
  - 700 ml test fluid; Sample heating (25°C - 120°C temperature control), time 30 minutes
  - Turbine mixer develops vortex action to entrain air, Peristaltic pump moves a slipstream to test cell
  - OILPAS Optical imaging device measures bubbles in the test cell
  - The OILPAS algorithm evaluates online the dispersed gas ratio % in oil
  - Deaeration measured in time to release and speed of release
- Repeatability demonstrated

# Set-up – Bench Test 2

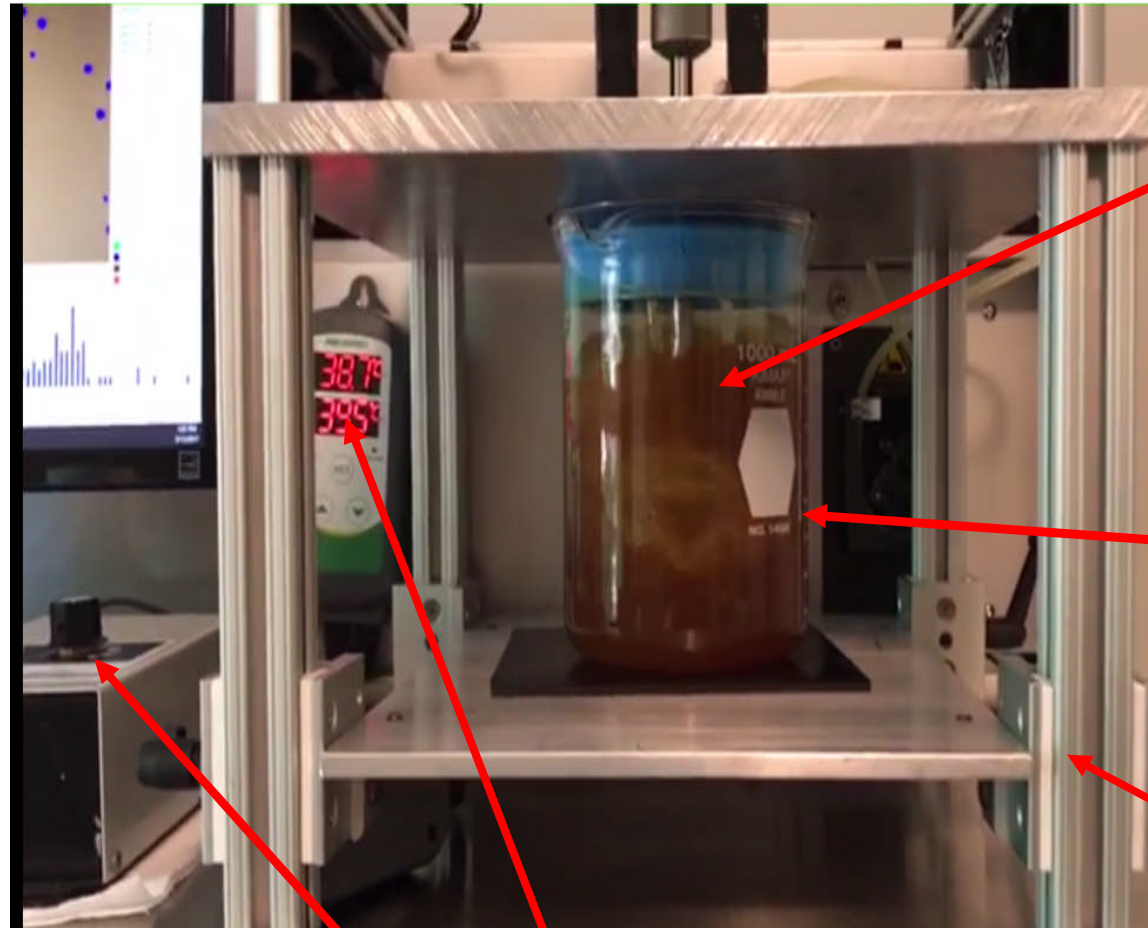
Calculation the aeration %  
based on bubble  
measurement



**OILPAS**  
Pump/Test Cell/  
Microscope/Ima  
ging

Aerator, conditions  
control Speed,  
Temperature, Gas  
can be simulated in  
a dynamic cycle

# Fluid Aeration Live Testing



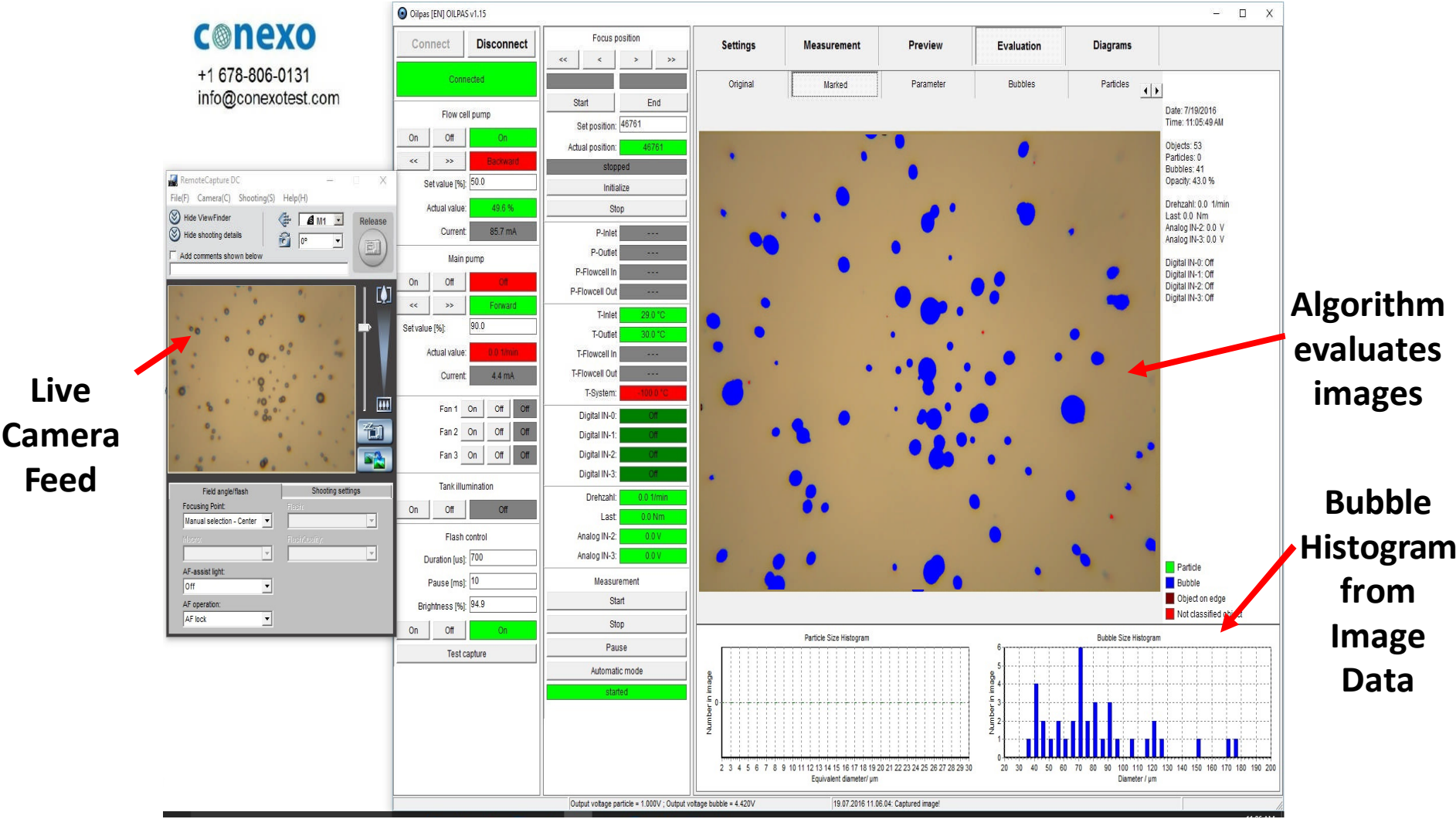
Aerated Sample

Samples can be easily changed, allowing for scanning a large number of samples and formulations

Speed and Temperature can be adjusted to simulate a dynamic driving cycle

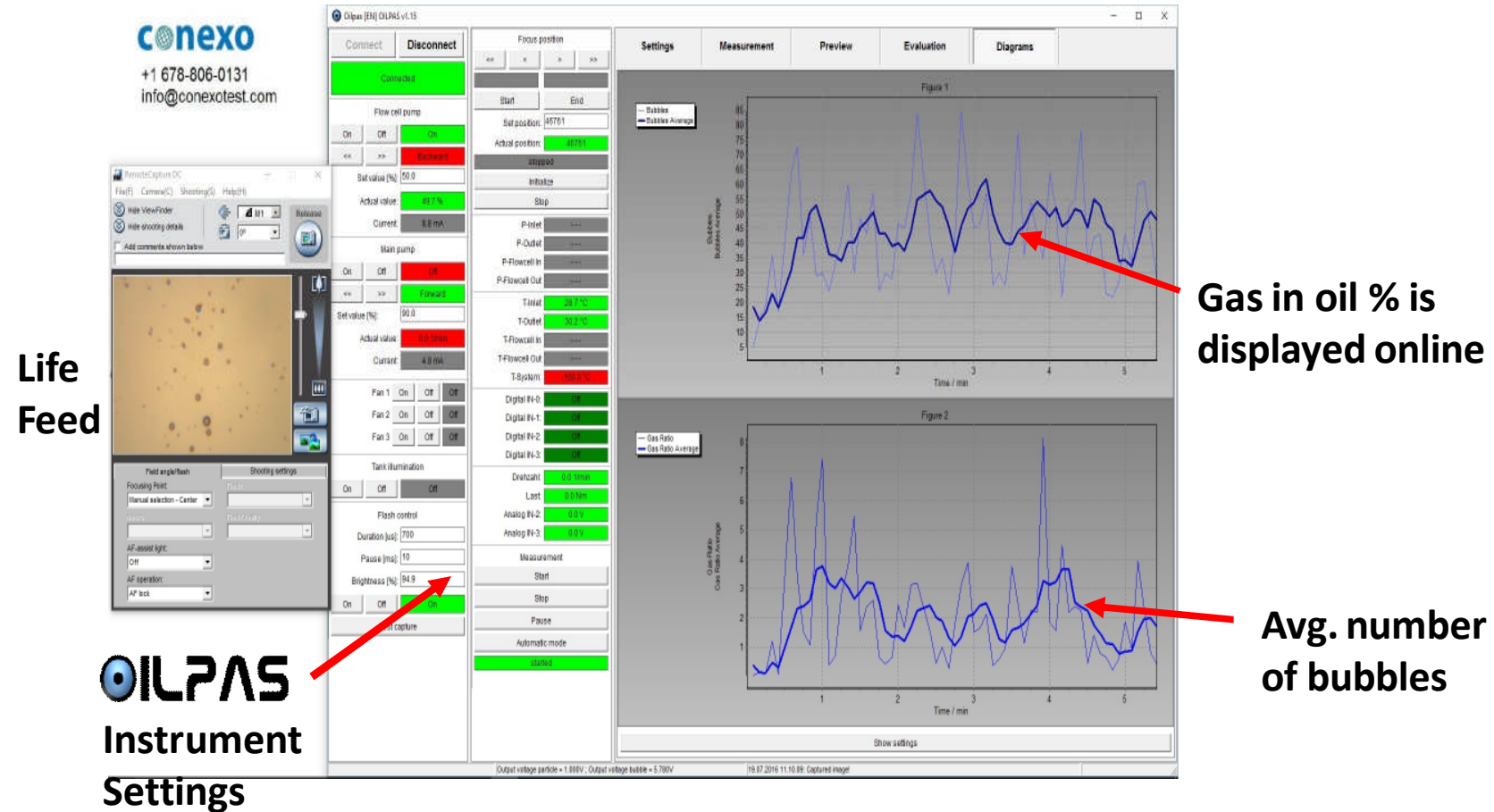
Adjustable frame for different sample sizes up to 5 liter

# Software – Evaluation

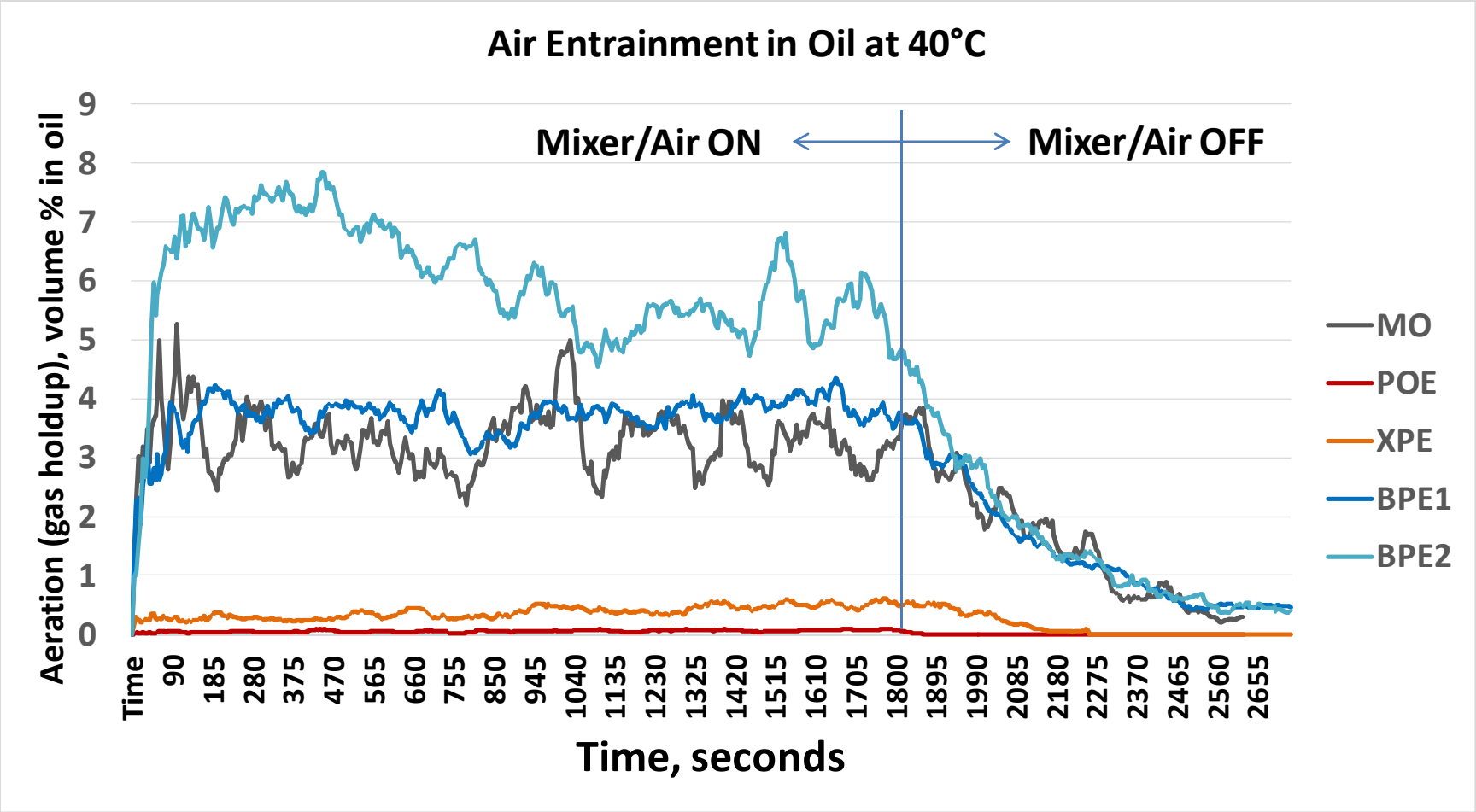




# Software – Data Diagrams



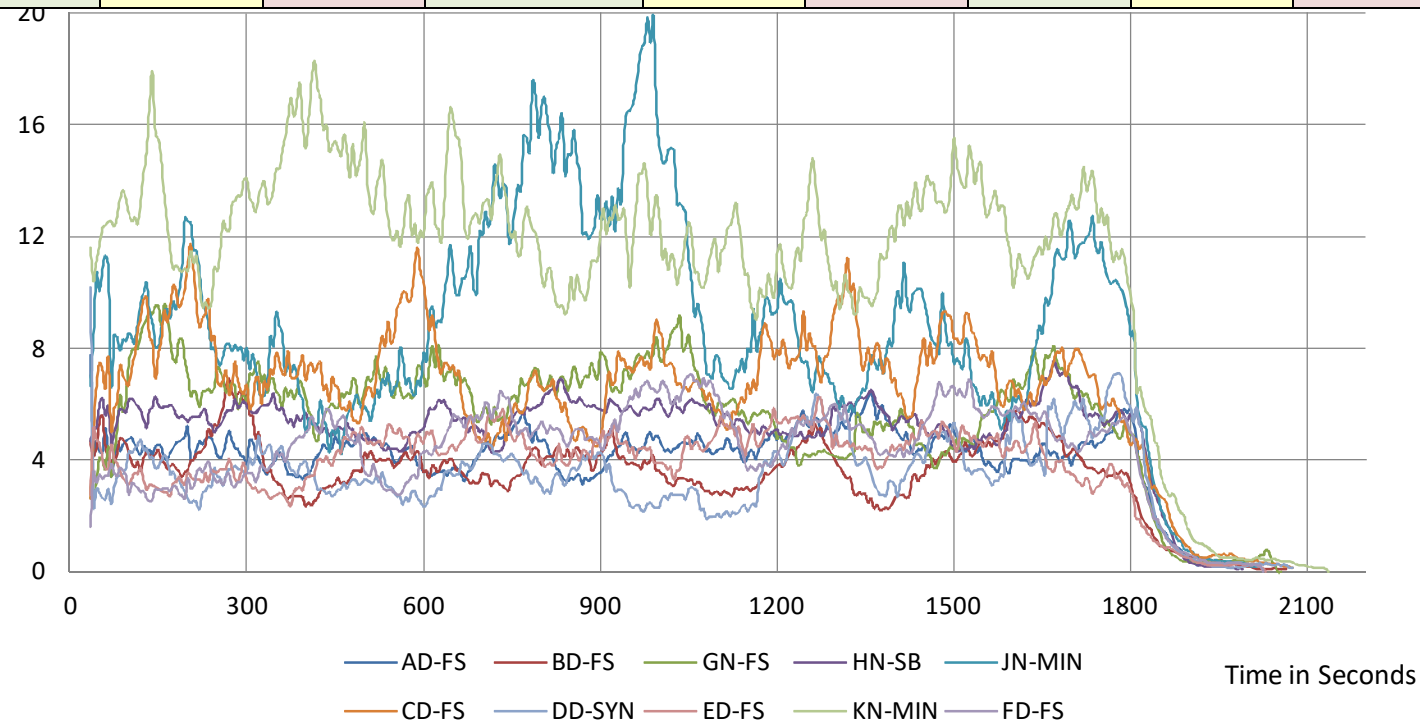
# Aeration Study: Air Entrainment and Deaeration



# Aeration Comparison 10 Engine Oils

All Samples are engine oil API SN grade 5W-30

| RESULTS                 |                        |                        |                        |                            |                    |                        |                    |                        |                    |                        |
|-------------------------|------------------------|------------------------|------------------------|----------------------------|--------------------|------------------------|--------------------|------------------------|--------------------|------------------------|
| Oil Code                | AD-FS                  | BD-FS                  | GN-FS                  | HN-SB                      | JN-MIN             | CD-FS                  | DD-SYN             | ED-FS                  | KN-MIN             | FD-FS                  |
| Description             | Dexos 2 Full Synthetic | Dexos 2 Full Synthetic | Dexos 2 Full Synthetic | Non Dexos, Synthetic Blend | Non Dexos, Mineral | Dexos 2 Full Synthetic | Dexos 2, Synthetic | Dexos 2 Full Synthetic | Non Dexos, Mineral | Dexos 2 Full Synthetic |
| Aeration (%) AVG Tested | 5.50                   | 3.86                   | 4.30                   | 5.61                       | 9.87               | 5.54                   | 4.25               | 3.30                   | 11.08              | 4.23                   |
| Deaeration Speed (Min)  | 2.5                    | 3.3                    | 4.1                    | 2.2                        | 3.3                | 4.3                    | 2.3                | 3.6                    | 5.0                | 3.7                    |



5/25/2018

# Correlation to Engine Testing

|                               |                 |                |                              |
|-------------------------------|-----------------|----------------|------------------------------|
| Oil Sample A: 0W-20           | Engine Test WOT | Aeration Bench | Comments                     |
| Mean Aeration During Test (%) | 10%             | 9.1%           | ~ 10% correlation margin     |
| Time for Deaeration (minutes) | Not reported    | 3:05           | Time to release 99.8% of air |

|                               |                 |                |                              |
|-------------------------------|-----------------|----------------|------------------------------|
| Oil Sample B: 5W-40           | Engine Test WOT | Aeration Bench | Comments                     |
| Mean Aeration During Test (%) | 19%             | 20%            | ~ 5% correlation margin !!!  |
| Time for Deaeration (minutes) | Not reported    | 2:45           | Time to release 99.8% of air |

A direct correlation could be found between the bench test rig  
and the engine test at WOT regime

# Conclusions

- Aeration screening in the lab can quickly benchmark the natural characteristic of an oil to retain free air
- Method was verified at testing a large number of different lubricating oils, additives and other fluids
- Measures both dynamic gas entrained and air release time,
- It shows correlation with ASTM D3427 test method
- Provides a measure of dynamic gas holdup and bubble size distribution (not provided by Coriolis sensor), thus adding further insight into the aeration characteristics of an oil.
- Provides OEMs/Equipment Builders and End Users an alternative method to test candidate fluids for aeration properties
- Test Method Guides OEM to design components considering the aeration characteristic of for the oil that is recommended for the specific application



**Thank you for your attention.  
Any Questions?**



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