GENESIS™
MODELS ED1 & ED2

Multiphase Detector

Collaborative 3rd-Party Testing with International Oil Company

Executive Summary

AMETEK LMS and a major international oil producer worked together with a 3rd-party test facility in France to perform a comprehensive set of tests on the Genesis Model ED1 Multiphase Detector. These tests were intended to simulate conditions often found in difficult interface applications such as separators, electrostatic coalescers, and various other separation vessels in Upstream oil and gas process operations. Successful measurement was found in a variety of dynamic oil/emulsion/water interface conditions produced during the test, which has now allowed the Genesis Multiphase Detector to be placed on the customer Approved Vendor List (AVL).

Background

AMETEK LMS was approached by a major international oil producer (hereafter referred to as "end user") to discuss issues they were experiencing with competitive nucleonic equipment installed on an offshore platform. The discussion centered around inconsistent interface level measurement in Separators.

While measurement of multiphase levels can be achieved by means of various technologies presently available on the market, limitations and challenges for successful and accurate measurement often exist when a dynamic emulsion layer is present. It should be noted that several of these technologies also require stable process media characteristics such as density, dielectric constant, or even salinity.

The end user added that the measurement of multiphase levels in production separators within the O&G industry is even more difficult because these measurements are:

1) Often required in the presence of oils of varying viscosities.
2) Affected by varying amounts of paraffins and asphaltenes.
3) More limited when applied in corrosive environments found in the fields of upstream production.

Knowing that AMETEK LMS had recently developed the Magnetrol Genesis Multiphase Detector, a unique Time Domain Reflectometry (TDR)-based instrument, the end user invited us to be part of a private test at Cedre, a 3rd-party test facility located in Brest, France.

Cedre has been operating in France and abroad for nearly 40 years, with a multidisciplinary team composed of 50 technicians, engineers, and scientists. Their knowledge and attention to detail was crucial in the successful execution of the testing described below.

Test Protocol

For this full battery of tests, it is very important to understand that:

1) The end user defined the specific, experimental test protocol to best simulate the "real-life" conditions they have experienced first-hand in the field.
2) The performance of the Genesis Multiphase Detector was qualified by several simple, but very useful criteria, also defined by the end user:
   - Ease of Use
   - Number of instrument modifications required during the test (including start-up)
   - Any downtime experienced during the tests
   - Multilayer measurement
     - For all level measurements, performance was defined by comparing the four (4) Analog Outputs of the Genesis to a tape measure secured to the test tank.

Test Equipment

As shown in the figure above, seawater was stored in two dedicated Intermediate Bulk Container (IBC) tanks ① and injected into the test tank with a pneumatic diaphragm pump and an injection pipe ②.

For each trial, the oil and emulsion were stored in two different IBC tanks placed on retention containers ③. Oil and emulsion were injected into the test tank through 3-inch injection pipes ④.

- The injection pipes ② and ④ were strategically located to inject each liquid phase at the proper interface level within the vessel.

The flushing skid ⑤, which was designed and supplied by AMETEK LMS, was placed on the platform above the test tank ⑥, into which the 6-foot (2-meter) long probe was installed about 10 inches (250 mm) from the wall.

The stainless steel test tank is of hexagonal shape with four of the six walls made of glass.

Shown to the right is an internal stainless steel tray approximately 4" (10 cm) tall that was fabricated to bury the end of the probe in coarse sand. (While the end user was not interested in measuring the sand level during this test, he did want to ensure that sand accumulating at the bottom of the probe did not adversely affect any of the actual liquid level measurements).

Media used:

Water

Seawater pulled directly from the Bay of Brest (with salinity ~35 g/L) was used during the tests.

- In order to recreate the end user's required conditions, fine sand was dispersed within the seawater at 20 mg/L.

Oil

For each trial, fresh oil (and then emulsion formed from the same oil) was injected into the test tank.

- The end user suggested a target viscosity of about 100 cSt.
    - To reach this target viscosity, two refined oils were mixed:
        - Heavy Fuel Oil (HFO 380)
        - Dearomatized kerosene

Emulsion

Per the end user, a target water content of 50% was used for the emulsion phase.

- Emulsion was carefully prepared outside of the test tank to control its properties (water content, viscosity, specific gravity, and homogeneity).
- Fine sand was also dispersed within the emulsion at 20 mg/L.

It must be noted that, as the tests were conducted in a static mode (no agitation within the test tank), it was recognized by all parties that it was extremely likely that separation began to occur within the emulsion immediately following injection into the test tank.

Wax

A wax crust approximately 1.5 inches (4 cm) thick and 8 inches (20 cm) long was created and located just above the water/emulsion interface during one of the tests.

Bitumen

The probe was coated with bitumen containing calcium carbonate ($CaCO_3$), barium sulfate ($BaSO_4$), and iron oxide (Fe_2O_3) during one of the tests.

Coarse Sand

The coarse sand that was used to bury the end of the probe originated from that used for roadwork.

- Nominal grain size ranged from 0.04" to 0.16" (1 to 4 mm).

Fine Sand

Fine sand, called Archifine®, was dispersed within all of the liquid phases; and, also into the bitumen.

This sand is a non-siliceous abrasive based on alumina silicate, chemically inert, devoid of any metals (ferrite, copper, lead, etc.) or crystalline silica (quartz).

- Grain size ranges from 80 µm to 20 µm.

The Testing

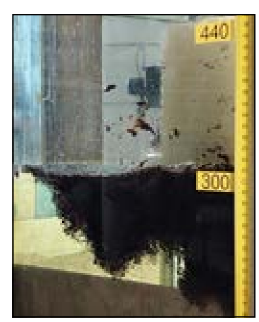
Test 1:

The probe was placed into the test tank and several liquid phases, previously mixed with fine sand, were successively introduced: First the sea water, then the water/oil emulsion, and finally, pure oil.

Levels variations of each phase of liquid were generated during the tests and the level measurement data provided by the Genesis was compared to the variations visually monitored within the test tank.

Test 2:

The test was then repeated after prior thick coating of the probe with wax to recreate end user's conditions.



Test 3:

Finally, the sequence of steps were repeated after the probe was finely coated with the bitumen.

For each level measurement, the difference between the expected value (the visual level reading) and the measured value (that from the Genesis Multiphase Detector) was calculated. Several measurements were taken, enabling the calculation of an "average variance."

The LCD contained within the Genesis Detector was used in conjunction with a Graphtec recorder and the Genesis Device Type Manager (DTM), along with PACTware.

Genesis LCD

Graphtec Recorder

Genesis DTM Home Screen

Conclusion

The Genesis Multiphase Detector was clearly able to accurately measure, profile, and report the levels of water, oil, and emulsion throughout all of the tests.

It must be acknowledged that the test protocol does present some limitations that can induce differences with respect to that of an actual upstream separator application:

Ambient temperature

This testing was performed at ambient temperature of approximately 19 °C, as compared to typical operating temperatures between 175 and 350 °F (80 and 175 °C).

Atmospheric pressure:

This testing was performed at atmospheric pressure whereas typical application pressures are above 14.5 psi (1 bar).

Static conditions:

No agitation was introduced during this testing, allowing the different phases to partially settle down with time. In a field separator, the fluids are continuously arriving which induces a constant mixing of them.

Limited volume:

The volume of the test tank is much less than that of actual field separators, which are typically 10–15 feet (3–4 meters) in diameter and 30–50 feet (10–15 meters) long.

The tested probe

The 6-foot (2-meter) probe length is shorter than that used for field separator applications.

Based not only on the overall ease of use and installation, but also the impressive test results, the Genesis Model ED1 Multiphase Detector is now on the end user's Approved Vendors List (AVL); and, we have the unique opportunity to replace those erratic nucleonic devices presently installed.

Quotes directly from the end user:

"These excellent results demonstrate that the Genesis Multiphase Detector is able to measure multi-layers (water/emulsion/oil) and is mature enough for implementation at site. You will soon be notified as to the qualification process in our database."

"Your technology will really help us improve many of our existing multi-layer measurement challenges."