Oil-In-Water, through an Innovative Particle Size & Shape Analyzer

“Beyond Particle Sizing”

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1. INTRODUCTION

It’s probably excessive to say how important and what the benefits are of gathering good quality, reliable data on the characteristics of produced water are paramount to enable the correct selection of separation technology and to give real time feed back into chemical and process optimisation trials

This paper introduces the innovative EyeTech particle sizing instrument manufactured by Ankersmid and the application to fluids characterisation studies in the oil & gas industry by Opus. The successor of the Galai CIS1002, the EyeTech, is based upon the same combination of proven technology, and packaged into a compact, user friendly analytical tool with simple yet powerful software for data acquisition and manipulation.

The EyeTech instrument, takes the 2 in 1 concept to an unequalled level as it is the only instrument that incorporates both laser and video measurements in a single measurement system. The technology discriminates between oil and ‘other’ solids to enable reliable and accurate measurements of droplets and particle sizes and its concentrations.

2. PRODUCED WATER CHARACTERISATION – A BRIEF EXPLANATION

Produced water is a complex mixture of components, both organic and inorganic in nature. The composition of produced water is also likely to change with field age. The reasons for this may include breakthrough and mixing of injection water into the formation water. The components present in produced water may consist of:

Dispersed and dissolved organic components, Inorganic components, Dissolved formation minerals, Traces of production chemicals, Produced solids, Dissolved gasses, etc…

Only by understanding the characteristics of the fluids and the interaction of the process upon them can the core issues of troubleshooting, or production optimisation is tackled. The main parameters of interest in produced water includes i.e.; Oil droplet size distribution measurement, Oil in water concentration, Suspended solids, concentration, Solid particle size distribution, etc..

Measurement of the above parameters can therefore be applied to provide operators with real data on the following:

1. Physical characteristics of the dispersed components in the water phase (Oil droplet size & concentration, suspended solids concentration & size);
2. Chemical composition (Anion/cation balance, dissolved oil concentration, scale forming tendency);
3. Suspended solids composition (Corrosion products, scale, and produced solids).

3. THE BENEFIT OF PRODUCED WATER CHARACTERIZATION

Produced water characterisation offers a number of key benefits in helping operators better understand the way their process is working and how it is impacted by operational conditions. It is highly important that skilled personnel are used to both carry out the analysis and the data interpretation to ensure maximum benefits from such a study.

One key factor is the oil droplet size, and thus as a result of this, good judgements have to be made about the Best Available Technology (BAT) when designing for new field development.

Measuring the oil droplet size, does provide useful information in determining sources of shear in a water treatment system, as illustrated in figure 1.

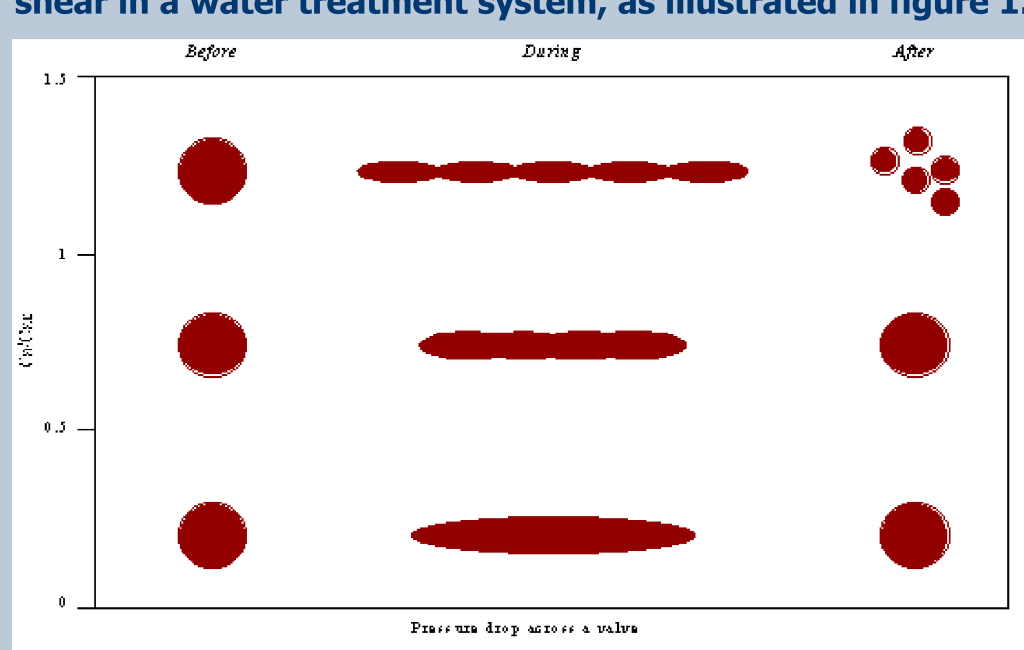

Fig. 1 - Effects of shear on droplet size

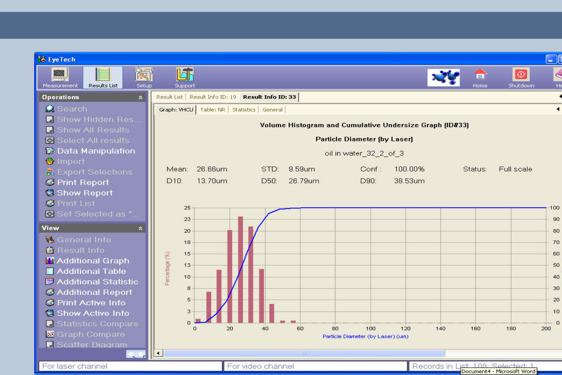

Fig. 2 – Droplet distribution upstream

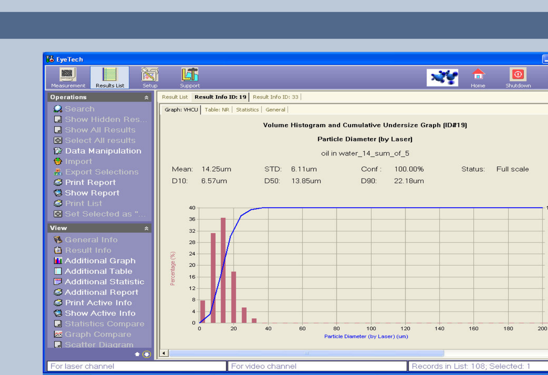

Fig. 3 – Droplet distribution downstream

The key benefits offered through produced water characterisation are following:

1. Mapping oil droplet size throughout the produced water treatment.
2. Small oil droplet size distribution as indication of shearing effects,
3. Chemical dosing can be optimised in relation to the impact it has on water quality, etc..

Analysis during trouble-shooting allows operators to monitor changes/improvements resulting from process, as real time results, etc…

The droplet size throughout a process can dictate the suitable technology for that particular application, as illustrated in figure 4, is an indication of the typical droplet size cut-off points for a number of existing separation technologies.

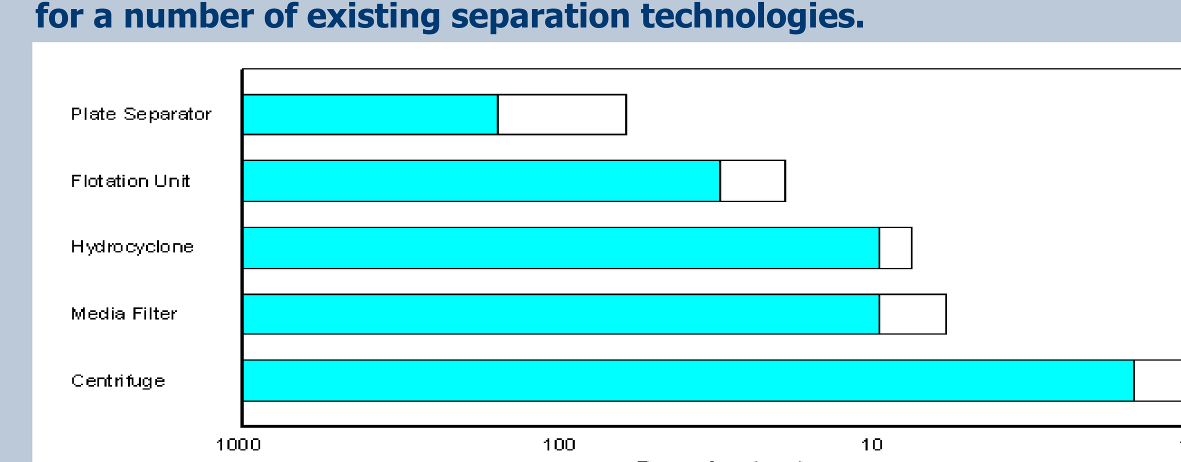

Fig. 4 – Typical Produced Water Treatment Equip. Efficiencies

4. EYETECH – TECHNOLOGY INTRODUCTION

The EyeTech is a new generation of particle size analyser, using a novel measurement technique known as Laser Obscuration Time. (LOT). The LOT technique is based on the same principles as the Time-of-Transition (TOT) that was introduced a many years ago with a new algorithmic approach, which is based on the interaction of the rotating laser spot with a particle which creates the Obscuration Time pulse. This is a single particle interaction, based upon time, and free from physical or optical interferences, and therefore no calibration is required.

Analysis of the Pulse Width (duration), yields the Size (diameter) of the particle, as illustrated in figure 5.

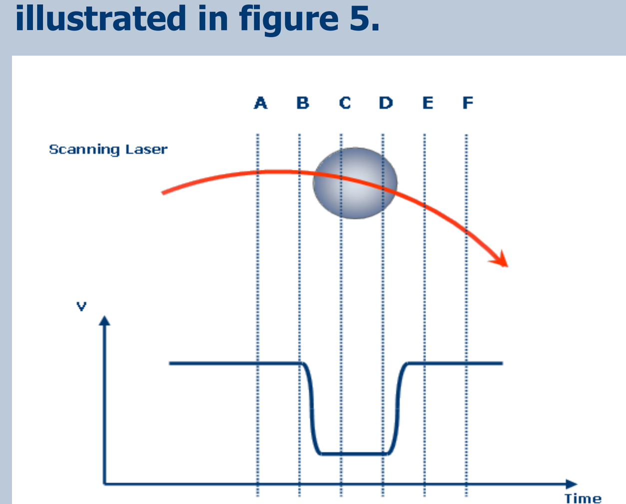

Fig. 5 - Beam –Particle interaction in an ideal case

The Obscuration Time (t) together with the know velocity of the laser beam (v) makes it possible to calculate the particle diameter (D), as per the formula:

$$D = v * t$$

In relation to the high velocity (12.000 RPM) of the laser beam, the particles are nearly stationary. This eliminates possible errors due to particle movement.

4.1 OFF-CENTER INTERACTIONS

When a particle is scanned away from its diameter, the effect on the interaction pulse is:

1. Pulse edges will be less steep with a narrow derivative signal, as the particle edge are more slanted along a chord, rather than a diameter,
2. Pulse amplitude may be smaller, as the laser spot may not be completely get obscured by the particle, while crossing it at its very edge.

Figure 6 illustrates a typical off-centre interaction between the circling beam and the particle, and shows that pulses with rise/fall times (pulse transitions) greater the a few times the minimum are rejected and thus do not have any effect on the resulting size distribution.

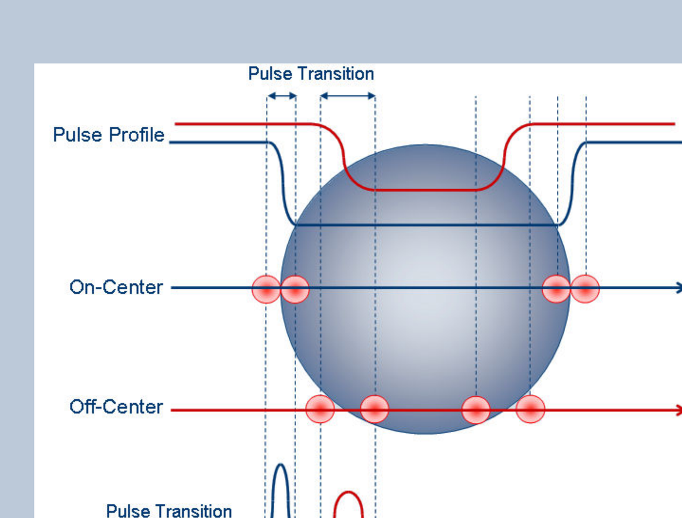

Fig. 6 - Beam –Particle interaction

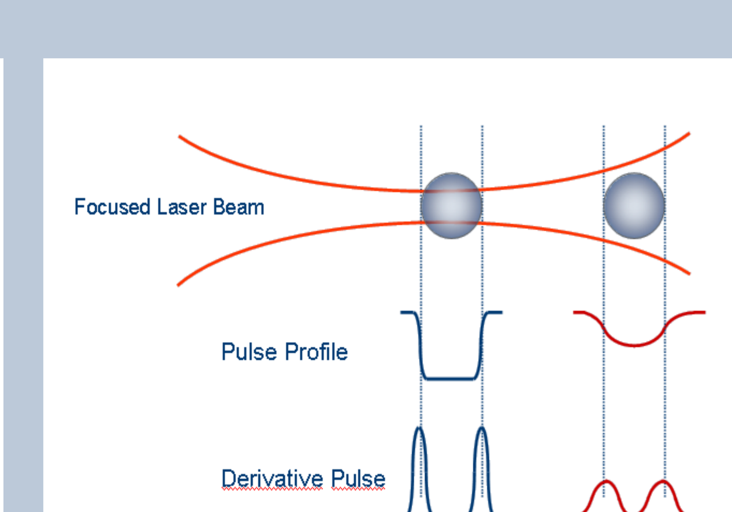

Fig. 7 - Expanded view of the focused beam

4.2 INDEPENDENT MEASUREMENT

In general with the LOT technology, the size analysis is independent of the refractive index of the particles. When an opaque particle is scanned, total laser spot obscuration occurs and the amplitude of the interaction pulse width is maximal, as illustrated in figure 8.

However, the pulse shape plays an important role in deciding if the pulse is processed or not. In special cases, with a-priori knowledge, asymmetric pulses are used to discriminate against two different particle types. This capability has been used to discriminate the particle size distribution of oil droplets remaining in sea water after processing in the presence of a background of sand particles, as illustrated in figure 9.

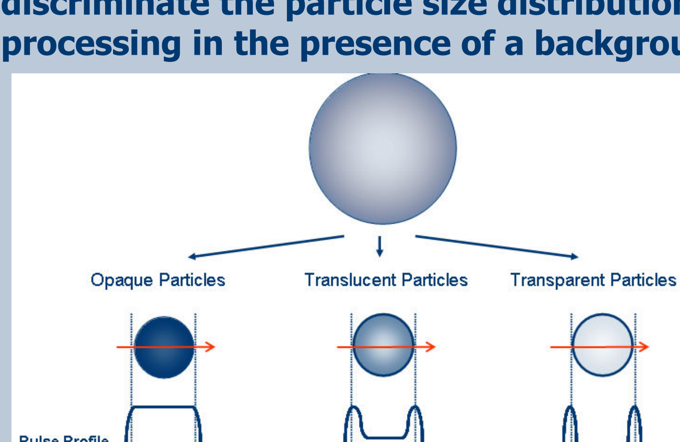

Fig. 8 – Particle Size independent of particles transparency

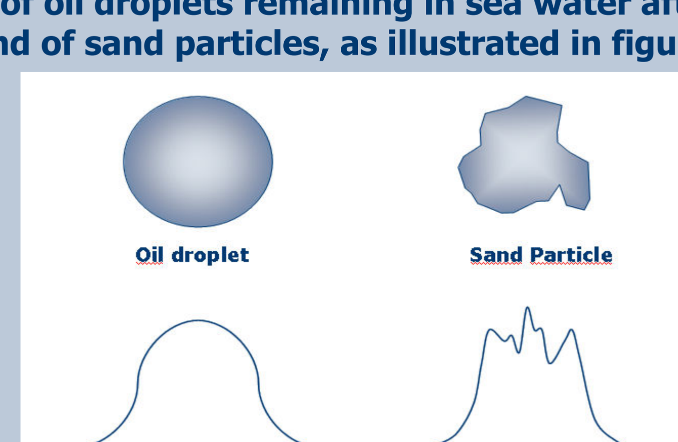

Fig. 9 – Symmetrical Oil pulses

An obscuration ratio is defined as the ratio of the (rise time)/(fall time). Opaque oil droplets have characteristically higher obscuration ratios at the same particle size than do sand particles.

5. FUTURE DEVELOPMENTS AND TRIAL RESULTS

The simplicity of the LOT optical design offers great opportunities for tailoring to specific applications. Future developments of the LOT measurements for offshore oil-in-water applications include improvement of the concentration measurement and optimisation of the oil-pulse selection algorithms. During 2006-2007, a series of technology verification trials were carried out to assess the applicability of the EyeTech to the task of produced water characterisation and to compare the technology to the existing “Industry Standard” droplet and particle size analysers.

The trials were carried out in Opus Plus Ltd’s Flotta test facility under a wide range of controlled, simulated field conditions, which included the following parameters:

1. Oil concentration
2. Oil droplet size
3. Suspended solids concentration
4. Solids particle size

The results showed very close size correlation with the reference analysers with equal or better reproducibility, and with a successful discrimination of oil droplets vs. solids.

6. CONCLUSION

The use of produced water characterisation techniques provide a powerful tool both in optimising existing process trains, and in selecting new technology. The EyeTech instrument utilising, both LOT laser and video technology can successfully provide operators with invaluable process information to carry out the following; Fluids characterisation, Separation technology performance characterisation and optimisation,

Chemical optimisation and PWRI monitoring.

The implementation of the new OSPAR regulations in 2006, regarding discharge of produced water will impose a requirement for higher treatment efficiencies of produced water treatment systems. The EyeTech can be the concept to actually view what is happening with the sample under investigation.

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