NORTH SEA UNITED

Smarter Together – for Enhanced Safety and Efficiency

Imagine that you are in a football match. On the field there are 15 teams all playing at the same time and fighting over seven balls. Two of these balls are volleyballs. As a striker, your job is to place the ball behind one of the five keepers who are guarding the six goals. Just before intermission, half your team leaves the field to be replaced by 20 players you have scarcely seen before; the third coach for the day grits his teeth as he prepares for a weekend at the cottage.

Most of us would reject this picture as utterly absurd when it comes to real-life football. However, in real-life offshore drilling and production, which represents a major part of the GNP in this country (making it slightly more important than football) this picture is not that far-fetched. During an offshore drilling operation there are about 15 different companies working on the platform at the same time. They utilize different technologies and tools in pursuit of different goals, working shifts on a schedule of two weeks on – four weeks off. Even though some own goals are scored, most of the time things go reasonably well. But try to imagine what operations could be like if more people played together, aiming at the same goal. The difficulty of achieving this is obvious, as is the potential for increased safety and profit that lies in enhancing operational interplay.

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With these thoughts in mind, SINTEF researchers – in close collaboration with offshore drilling representatives – have developed the "Smarter Together" approach. The core values of "Smarter Together" are "Most people think better thoughts together, than alone", "Good answers require good questions", and "Powerful solutions rely on broad participation and ownership". The aim of this process has been to enhance safety and efficiency through enriched learning processes among individuals, companies, and across the offshore – onshore interface within and between companies.

To date Smarter Together has been a success: not because the four-phased process (from identifying challenges to implementing solutions) is groundbreakingly original, but because these phases have been filled with the right ingredients. The approach draws on the diverse but complementary fields of knowledge management, organizational development, risk analysis, drilling- and petroleum technological competence. In the search conferences (where the good questions have been asked) roughnecks as well as operational managers have participated on equal terms. In this way both those who directly experience the problems out on the floor and those who "make the rules" own the solutions. Moreover, by applying the logics of traditional risk analysis in our search for solutions, it has been possible to co-construct actions addressing root causes. As a result, the actions implemented have been both potent and broad-spectred, affecting several operational problems stemming from one common cause.

Merging of droplets

High voltage as an alternative to chemical emulsion breakers for oil water separation
New insight in fundamental electrocoalescence processes

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New understanding of coalescing droplets

In 1990 Dr. Pierre Atten analyzed the function of a compact AC - coalescer and found that its function was based on mainly two effects: using AC created dielectrophoretic forces pulling adjacent drops together, while a shear movement from turbulence helped create drop collisions. This was the starting point of our project. Two research groups have worked together: One group of material specialists focused on optical studies on coalescing water drops and another group of CFD specialists are designing fluid dynamic models of drop movement, where accurate models for analyzing the drop movement in an electric field are included.

The challenge

In oil production and processing, oil and water often exist together in an emulsion. Water is normally removed from crude oil by large gravity separators. Not only their size is a problem on oil platforms where costs of "land" are high, but also their efficiency can also be a challenge. To improve their efficiency chemical emulsion breakers and high voltage fields are used. The problem with the first being chemical discharges to the environment, while the problem with the other is that they do not always work as expected.

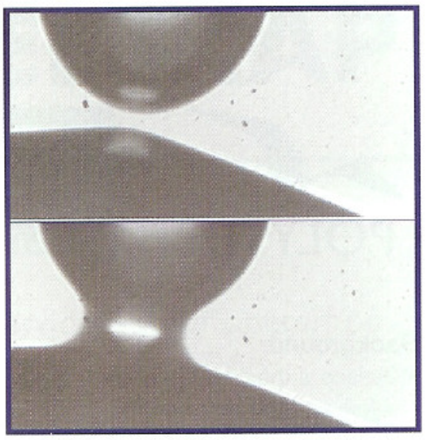
The traditional view

Even if used since 1911, the electrocoalescence process is not properly understood. DC and so-called pulsed DC are often used, but also AC can be used. In the latter case there has been a search for the optimum frequency. The goal is to get water drops in the emulsion to merge so that their sedimentation speed increases. This allows for faster separation and smaller tanks. One has so far merely explained the electrocoalescence by the electrostatic forces that may occur on and between droplets helping to pull them closer faster so that they merge when in contact. However, the picture has been shown to be much more complex, with both attractive and repulsive forces.

Why use AC and is there an optimum frequency?

Sometimes the electrodes are insulated to avoid electric breakdowns in the emulsion. When compact designs are searched for, this becomes more important. Introducing electrode insulation creates a problem in case of DC solutions because the electrophoretic charging process is hindered. Furthermore for DC, the electrode covering "steals" the field. Due to the resistive field distribution under DC the field in the oil becomes weak.

To compensate this one can use AC or pulse the DC. Many studies focus on finding the optimum frequency of the high voltage. A sounder approach is to compare the frequency with the dielectric time constant of the liquid and - in case of uncovered electrodes - drop crossing times between electrodes.



Beginning instability and final coalescence between two water drops

How do the drops merge?

The most important result is the insight achieved in the coalescence process itself. When two polarized drops get very close (i.e. well within one drop radii) the electric forces between the drops becomes so strong that the surface of the larger drop, having a lower internal pressure, is pulled towards the other drop as seen in figure 2. Finally, this develops further into an instability where one drop is "shot" into the other. This electrohydrodynamic (EHD) instability helps to remove problems like film draining between drops, and emulsion stabilizers like asphaltenes will be thinned at the tip of the instability cone (Marangoni effect) as has been verified in cooperation with the Prof. Johan Sjøblom.

Impacts of research

This new knowledge gives a possibility to get an analytic analysis of which conditions that may help or hinder the electrocoalescence. Manufacturers gets better basis for designing equipment and the users get a better basis for both specifying and operating such equipment

The research has been important in developing and designing new in-line electrocoalescence equipment. And the installation has been realized on Troll C.

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In 2001 SINTEF Energy Research got a research contract on a project directed towards a 4 year study of fundamental aspects of electrocoalescence from the Research Council of Norway.
Partners: Statoil, Norsk Hydro and ABB Offshore Systems. In 2004 Petrobras entered the project
Total budget: 13.5 MNOK. From the Research Council of Norway 8.4 MNOK
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The project also involves 4 researchers and 3 PhD students. Important liaisons to Johan Sjøblom from the Ugelstad Laboratory at NTNU - a capacity on emulsions – and Dr. Pierre Atten from CNRS in Grenoble in France –a capacity on electrohydrodynamics – were established.