TYPHONIX COALESCING PUMP

Introduction and user benefits

Conventional centrifugal pumps break oil droplets while pumping produced water. Often the consequence is reduced efficiency of downstream treatment processes. Positive displacement pumps (PDP) sometimes counteract oil droplet breaking. However drawbacks of PDP's (maintenance requirements, noise and vibration, gearboxes etc.) makes centrifugal pumps more attractive. Typhonix Coalescing pumps combines the low shear features of PDP's with the operational features of centrifugal pumps. Overall user benefits of the Typhonix pumps are:

- More energy efficient produced water treatment and increased capability to handle process upsets and variations in produced water quality.
- Cleaner produced water and reduced oil and chemical discharges to the sea.
- Increased reliability reduced mechanical maintenance and increased lifetime compared to positive displacement pumps.
- No need for noise protection enclosures or pressure relief valve systems.

How does it work

The Coalescing pump is a multistage centrifugal pump with high hydraulic efficiency. The pump layout and configuration of the individual stages are custom designed to control shear forces and optimize oil droplet coalescence. The coalescing performance of the pump is adapted to match individual applications, taking into account the head requirements, crude viscosity and produced water treatment system requirements. **Figure 1** shows the main principles and configuration of the Coalescing pump. Generally, the pump is a multistage centrifugal pump using low-shear impellers and magnified diffusor structures. Droplet coalescence in produced water, flowing through the Coalescing pump, is optimized by reducing the level of turbulence from one pump stage to the next. The overall coalescing effect is strongly affected by the inlet oil droplet size and concentration. Generally, the worse the water quality is, i.e., small oil droplets in high concentration, the higher is the coalescing effect.

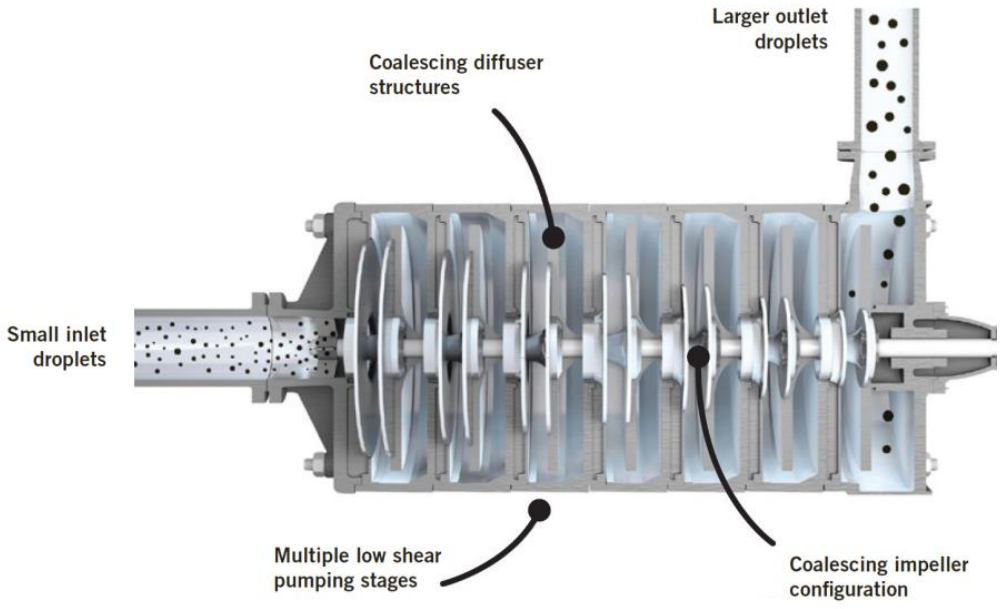

Figure 1. Illustration of the Coalescing pump principle and layout.

The development

The Coalescing centrifugal pump is a product of years of development work through several Joint-Industry-Projects, financed by leading oil companies and the Norwegian Research Council. Initially, the main objective was to develop a pump possessing the low shear feature of a positive displacement pump (new, with minimal slip flow), while also having the operational benefits of a centrifugal pump. On the course of the development, particular solutions to control turbulence and shear forces while pumping were found. Moreover, in the Coalescing pump the turbulence is controllable to a level where it applies constructively to oil droplets of a produced water flow. Rather than break oil droplets, the Coalescing pump is designed to let the oil droplets collide and coalesce. The development project mainly focused on maximizing the coalescing effect and making a commercial product, meeting the high technological standard required by the oil industry. **Figure 2** shows to the left a picture of laboratory test pumps and to the right some typical results. The graph to the right compares the oil droplet performance of a Coalescing pump (blue curves) with performance of a standard single-stage centrifugal pump (black curves). It is visualized that the outlet droplets of the Coalescing pump always are larger than the inlet droplets, while the standard pump always break the inlet droplets. The pumping pressures in this experiment were from 7 to 13 bar, a typical range for most produced water applications. The crude was API 44, and the size of inlet oil droplets to the pumps were adjusted from dv(50) 5 to 20 µm, figures representative for typical produced water applications.

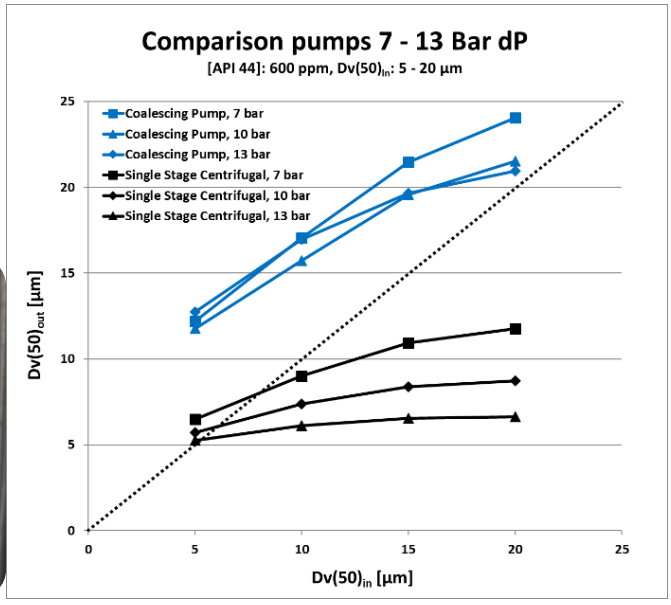

Figure 2. Left: Laboratory test pumps. Right: Example of test results of Coalescing pump.

Next, **Figure 3** shows a photo and example results from the testing of a full-scale Coalescing pump. In this test, produced water samples were collected inline from the individual stages of the pump. The graph present percentage growth in oil droplet size in the produced water passing through the individual stages of the pump. It is clearly demonstrated how droplets grow continuously from stage to stage. The total pumping pressure was 18 bar in this test. The two curves of the graph are for API 19 and 44 crudes, respectively.

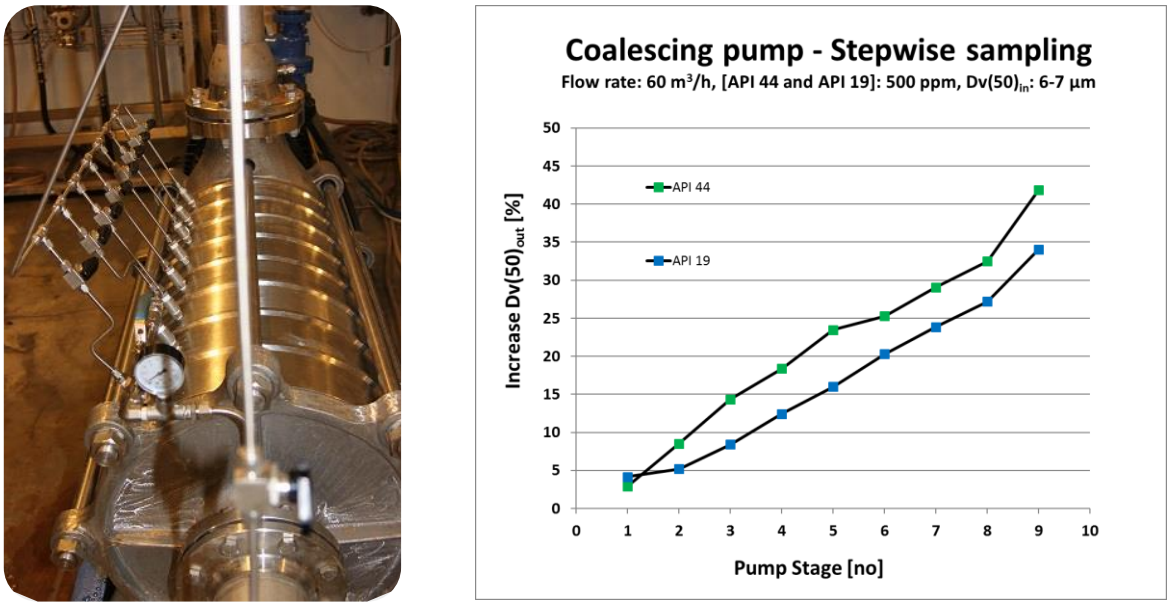

Figure 3. Left: Full-scale Coalescing pump. Right: Example of stepwise sampling of Coalescing pump.

Full-scale test

During the Coalescing pump development work, comparative tests were performed using commercial pumps. **Figure 4** shows photos and results of full-scale pumps used in a test concluding the project. In the test, the oil droplet performance of a Coalescing pump was compared to performances of two commercial pumps typically used in produced water applications; an eccentric screw pump and a single-stage centrifugal pump, seen at right in the photos of Figure 4. The test involved a variety of test conditions including API 44 and 19 crudes, two oil concentrations and two inlet droplet sizes. The test conditions are overviewed schematically lower-right in Figure 4. Lower-left is a graphical representation of all results of all pumps. The different test conditions is found on the x-axis, and the y-axis represent the percentage change in oil droplet size from pump inlet to outlet. The blue, green and red bars are for the Coalescing pump, eccentric screw pump and single-stage centrifugal pump, respectively. It is clearly demonstrated how the Coalescing pump always enlarges oil droplet sizes of the produced water. Further, the eccentric screw pump has a slight coalescing effect, while the single-stage centrifugal pump always breaks droplets.

Generally, the coalescing performance of the Coalescing pump is a design factor. Hence, a well-designed pump will simultaneously match both the hydraulic duty point and the required droplet performance. Typhonix Coalescing Pumps are BB4 style, built according to API 610. The main target applications are within produced water treatment, upstream separation processes depending on oil droplet sizes.

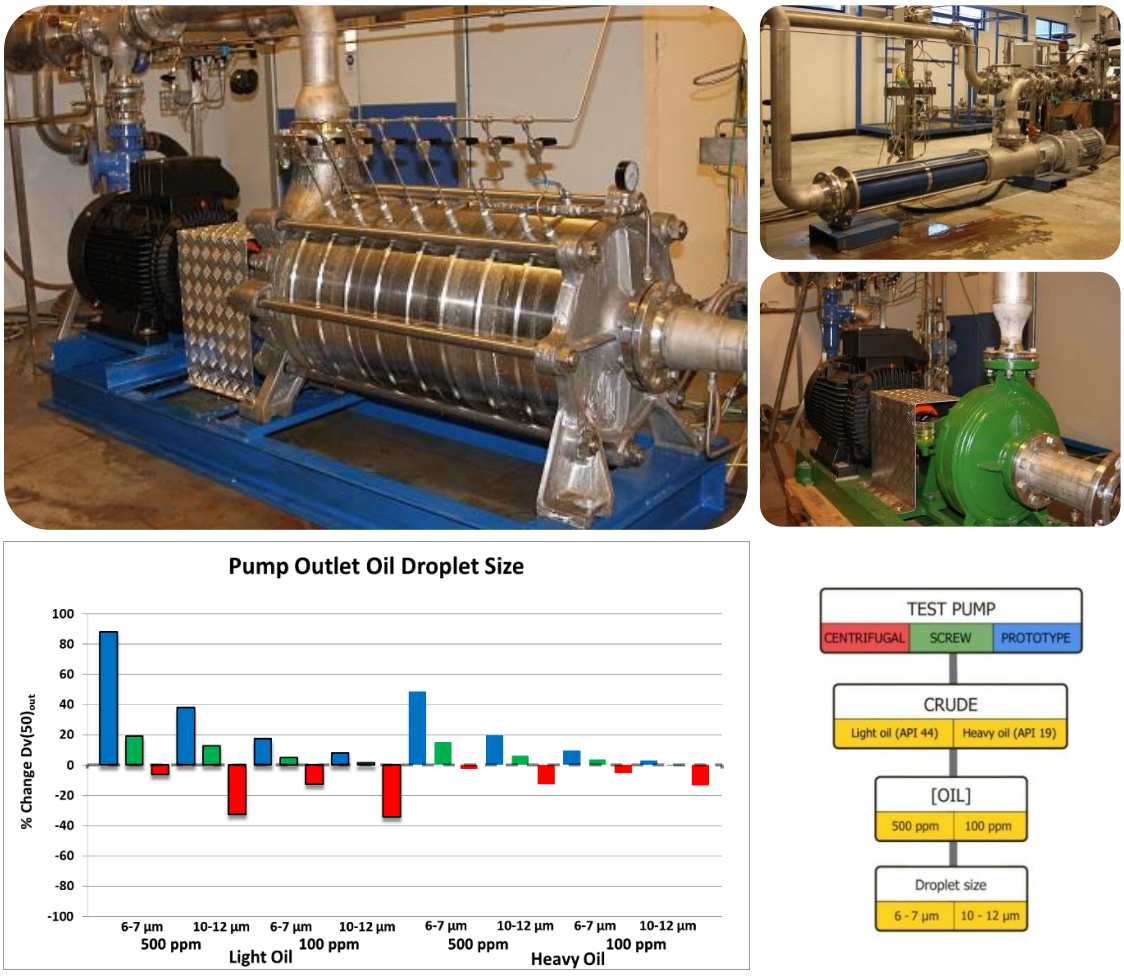

Figure 4. Photos of test pumps in final qualification test. Top-left: Coalescing pump. Top-right: Eccentric screw pump and single-stage centrifugal pump. Bottom: Test results and test conditions.

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