Oil-water separation in wash tank processes: effect of the water leg

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The current design of FPSO’s (floating production storage and offloading units) leads to expensive projects for deep water developments, mainly because of the sizes and weights of the topside process modules. In order to reduce the latter, and to benefit from the FPSO's hull capacity for liquid – liquid separation, Total has developed the "Wash Tank Process”, in which crude oil dehydration, desalting and stabilisation are performed using the wash tank technology implemented in the hull. Even though this innovative technology can lead to potential substantial savings, the installation of wash tanks – usually installed on onshore oil production sites and refineries – on new generation FPSO's induces major changes in usual design habits, mainly because the phenomena involved are quite different from usual horizontal gravity settlers.

Inside a wash tank, the entering water-in-oil emulsion is injected inside the water leg using carefully designed injectors. During the ascension of the emulsion globules inside the wash tank water leg, a first separation might occur, depending on the stability of the emulsion. Since wash tanks are to be implemented in the hull of FPSO's, their height is only limited by the height of their installation location. A compromise has therefore to be found between the height of the water leg and the one of the oil zone.

In order to optimize the height of the water leg, the efficiency of the oil/water separation taking place in this part of the wash tank was first investigated experimentally. An oil-in-water emulsion was injected at the bottom of a 3 meter high rectangular column, filled with water, and equipped with mobile cameras. The emulsion globule thus created was then followed by two cameras during its upward movement inside the water column. Thanks to image processing, it was then possible to monitor the evolution of the globule during its ascension, and therefore to quantify the volume of water lost.

Fig. 1. Rectangular 3 meter high water column, equipped with mobile cameras mounted on a motor

The system used was model oil, in which real crude oil was added in order to control the stability of the system with regards to oil/water separation. Thus, a large range of separation efficiencies was observed. From the results can be concluded that the stability of the system significantly impacts the separation efficiency inside the wash tank water leg.

A model, based on static separation inside the emulsion globule during its ascension inside the water leg, is then proposed. This model, based on previous works on oil/water separation in static conditions, takes into account such phenomena as coalescence between water droplets during sedimentation, as well as coalescence between the dense packed zone and the free water zone.

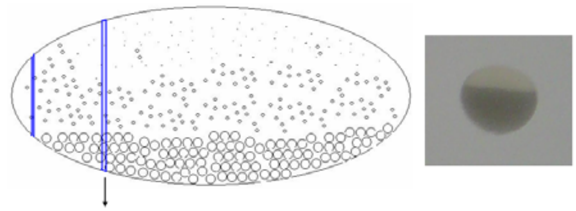

Fig. 2. Scheme of an emulsion globule, divided into a clear oil zone, a sedimentation zone, as well as a dense packed zone, compared to the experimental image obtained by one of the cameras

This model was validated with regards to the experimental data obtained, thus allowing extrapolating its results to operational designs and conditions.

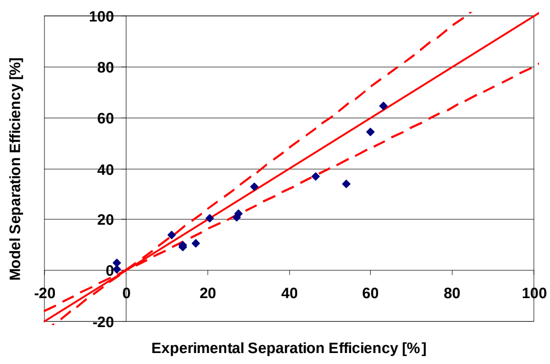

Fig. 3. Comparison between the experimental results (X-axis) and the model predictions (Y-axis)