VersaFlo™ Rises to the Challenge

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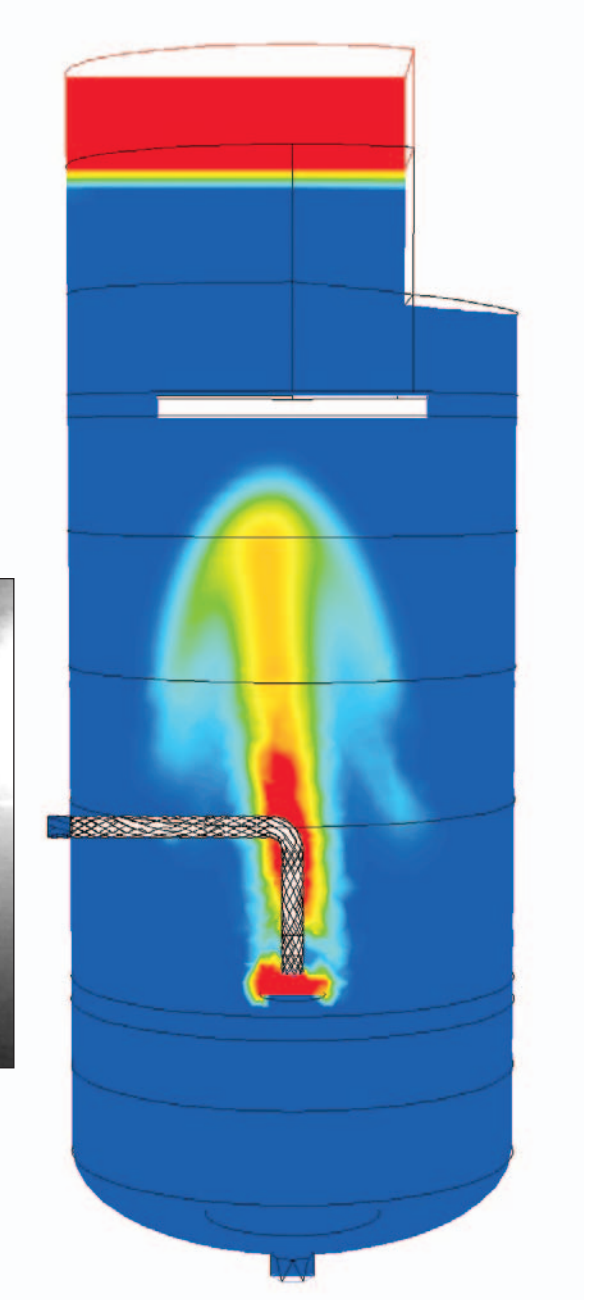
When crude oil is pumped from wells, water is also produced, and this water must be cleaned of oil and suspended solids prior to disposal. Induced gas flotation (IGF) systems are separators that can be used to clean the oily water to the required purity level. These systems work by introducing small gas bubbles, 100 to 500 microns in diameter, into the vessel along with the contaminated water. The hydrophobic oil droplets and oil-coated solids attach to the water-gas interface and float to the surface, where they are removed by a skimming mechanism. By controlling the gas flow rate, vessel internals, and gas inlet geometries, the gas bubble sizes can be optimized for the most efficient lifting of contaminants.

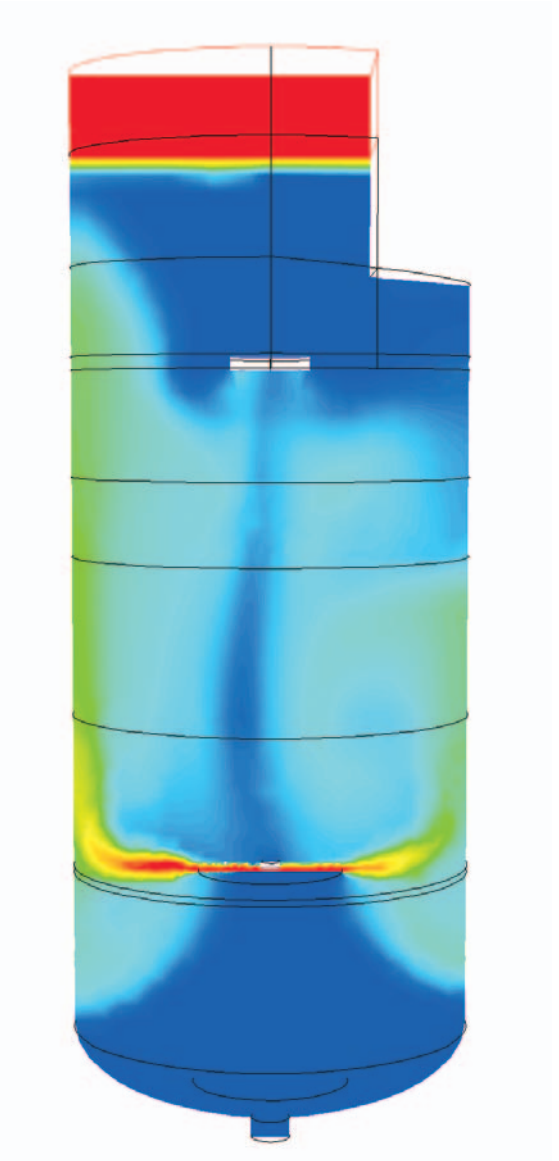
Traditional IGF systems consist of four flotation cells in a horizontal tank. Oily water enters the unit from one end and passes sequentially through the series of cells. To save weight and space on offshore platforms, the industry is moving towards a single-cell vertical column configuration. These devices pose a major design challenge because the same level of separation – the removal of 90% of the oil – must be accomplished in a single cell rather than in four cells. To meet this need, the gas bubbles must be uniformly dispersed in the vessel so that they contact all of the contaminated water. Unfortunately, most vertical IGF systems suffer from short-circuiting and as a result, poor water cleaning efficiency.

At NATCO, a series of Eulerian multiphase calculations using FLUENT were done to improve the performance of a vertical IGF system. The initial work focused on improving the performance of an off-the-shelf eductor, a gas bubble injection device. The results showed that the injected bubbles created a straight, fast-rising plume up to the top of the vessel. The plume strengthened recirculation zones that further increased the tendency towards short-circuiting. Physical tests have validated the CFD results.

A number of design variations for the vessel and eductor were subsequently studied using FLUENT. Based on the results, NATCO engineers developed a new eductor design with a radially-directed discharge that offers performance far superior to conventional

In the original design, air entering the vessel was not well distributed, as illustrated by the photograph and CFD simulation





The introduction of a radial eductor (above) resulted in much better gas distribution in the separator (below)

designs used in other IGF systems. They obtained additional performance improvements by testing different configurations of internal baffles, which control the downward flow of oily water, prevent the development of recirculation zones, and promote a more uniform gas bubble distribution.

NATCO engineers went one step further by using the volume of fluid (VOF) model with user-defined functions to simulate the six degrees-of-freedom, ocean wave motion-induced sloshing effect, and to study how it affects the performance of IGF vessels installed on floating offshore platforms. Based on the results, improved wave motion suppression baffles were installed in the skimming region inside the offshore version of the IGF system. The final system configuration, under the trade name of VersaFlo™, with US and PCT (Patent Cooperation Treaty) patents pending, dramatically improves upon existing designs by providing a uniform distribution of gas bubbles across the vessel while effectively eliminating the recirculation zones. An initial installation of VersaFlo on a floating platform in the Gulf of Mexico is very effectively cleaning the produced water and easily meeting overboard discharge quality requirements. Several additional installations will be operational in the short term. ■

Editor's Note: *The VersaFlo™ vertical column IGF was one of fifteen innovations to receive an Offshore Technology Conference (OTC) Spotlight on New Technology Award in 2004.*

From left to right: Patrick McCarthy, President, Robert Curio, Senior VP of Technology, Kevin Juniel, Product Manager of Water Treatment Solutions, and Chang-Ming Lee, Engineer, of NATCO Group Inc.; and Heshmat Massah of Fluent Inc.