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Novel Coalescer Technology in First Stage Separator Enables One-Stage Separation and Heavy-Oil Separation

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Abstract

Vetco Aibel (former ABB Offshore Systems) has for a long time carried out fundamental research on compact separation. A great part of the development has been to incorporate robust electrostatic coalescers into three-phase separators. The current technology enables one stage separation and accelerates separation of oil and water. The most recent product developed to enable one stage separation is the LOWACC (Low Water Content Coalescer). The LOWACC is an electrostatic coalescer element enhancing and accelerating the separation in an oil/water/gas separator. It is designed to be located downstream VIEC (Vessel Internal Electrostatic Coalescer), which is a bulk separating device, in a separator. A prototype LOWACC, together with a VIEC, has been tested on several different real crude oils ranging from API 17 to API 29. For the API 29 crude, LOWACC successfully reduced the water in oil content below 0,5% without the use of chemicals. For the challenging API 17 oil, the oil in water was reduced to below 2-5%. All the test results verified good separation even with tough separation conditions that created stable complex emulsions and small droplets. The produced water leaving the separator contained 2-200 ppm oil in water.

Introduction

The traditional oil, water and gas separation train consist of a first stage gravity separator, a second stage gravity separator and an electrostatic coalescer unit with naked electrodes. The free gas and most of the water is removed in first and second stages so that a low water content oil phase is passed on to the coalescer. A careful tuning of the water content, retention time and temperature together with de-emulsifying chemicals is necessary to obtain a satisfying separation process. For heavy oil compositions, the process becomes very difficult and often unstable.

By introducing an electrostatic coalescer with isolated electrodes already in the first stage separator, a much more efficient separation process can be achieved[1-3]. This is demonstrated through the use of the VIEC and LOWACC described in appendix A and B. In fact, it will be shown that the traditional coalescer unit can be eliminated and that it is even possible to reduce the need for the second stage separator in many cases.

This paper describes the one stage separator design and the latest experimental results. The new data clearly demonstrate that this technology enhances heavy oil separation and improves produced water quality.

Possible applications of this technology are for oil producers on fields struggling with separation problems and to solve problems related to hydrate formation in subsea separation processes. By implementing the one stage separation, the footprint and weight of separation equipment topside will be significantly reduced. In addition, the operational expences could be lowered as the requirement for emulsion breaker chemical is also significantly reduced. The technology can be very useful for subsea applications as it enables long tie-backs due to reduced water content in oil.

Theory

The main feature of electrostatic coalescers is the effect of the electrostatic field strength on the conductive droplets (water) in an insulating media (oil). The water droplets in oil acts as dipoles with a positive and a negative end. The electrostatic field from high voltage between two electrodes exerts a force on the droplets that press them together and helps drain the liquid film between them. This enhances coalescence to larger droplets.

It is well known that the separation of water from oil is governed by the size of the water droplets. Using Stokes law as an approximation, the terminal fall velocity of a droplet is proportional to the square of the droplets diameter. That is, the larger the droplets the faster the sedimentation process.

Based on the above consideration, it is advantageous to have a droplet size distribution with predominantly large droplets coming into the separator vessel. The droplet size distribution is governed by the shear history of the oil-water mixture prior to the separator vessel, and is therefore hard to control. A way to remedy this difficulty is to introduce an electric field inside the separator vessel. In an electric field, the water droplets will be polarized and attractive forces will be set up between the droplets. As an example, one can