Quantex Technologies Inc. Three-Phase Centrifuge Technology for Minimizing Petroleum Waste

by M. Dalla Nora CET **March 2005**

Oil companies in the North America generate several million barrels of unusable oil each year. This oil is discarded, wasting a national energy resource and creating an environmental problem. Much of this waste oil comes from refineries. However, a large portion, about 2.5 million bbl each year, is a by-product of oil field production known as tank bottoms.

This oil field waste is a mixture of oil, brine, and solids that collect at the bottom of holding or production tanks in which oil is stored before shipment to an oil refinery. A large portion of this oil waste is disposed of in earthen pits. Many pits and ponds across the North America are filled with this discarded oil. Some pits contain as much as a million bbl of oil. In today's environmental climate, the many millions of barrels of oil accumulated in tank bottoms, pits, and ponds pose a severe waste disposal problem.

The waste oil is usually bound in an oil-chemical-water-solids emulsion. Attempts have been made to recover some of this oil using expensive thermal or chemical techniques, either alone or in combination. Unfortunately, adding heat drives off light components, leaving behind an oil-chemical-water-solid mixture that presents an even more difficult separation problem. This mixture, called dead oil, is currently unrecoverable.

Separation Difficulties

Much of the difficulty in separating these mixtures lies in the multiphase character of the mixture. Past attempts to separate such mixtures have been made using two-phase centrifuges, with the idea that multiple two-phase separations would be needed to achieve the desired three-phase separation.

Two-phase decanting centrifuges have been used in oil fields since the early 1950s. These centrifuges were originally used to control the viscosity of drilling muds. In recent years, their role in the oil field has expanded to include environmental cleanup. Little data on these efforts are available, but a two-phase centrifuge cannot separate three phases in a single pass. The product from a two-phase centrifuge is often an oil-coated solid and an oil-water emulsion needing further treatment.

A single-pass operation would obviously be more economical than a multiphase process. Therefore, this article focuses on the three-phase centrifuge process.

The Three-Phase Centrifuge

Oil field cleanup is really a three-phase problem. The problem mixture usually contains oil, solids, and water in a range of ratios. Some mixtures may contain solids and oil in such a nonfluid mix that water must be added before the mixture can be introduced into a centrifuge. In a good separation, the solid product will have a low basic sediment and water (BS&W) concentration. The required BS&W concentration for salable oil varies with location. For example, oil reclaimed in some facilities is required to have a BS&W concentration of 3% or less, while oil reclaimed in other areas are required to have a concentration of 0.5% or less. While it is always possible to reach the lower BS&W numbers a careful study must be carried out to evaluate the economic impact to reach the lower BS&W.

A three-phase centrifuge is capable of three distinct phase separations in a single pass. Three-phase centrifuges are uncommon in the petroleum industry, but have been used in other industries. The oil field separation is a far more difficult problem, because the oil field mixture is a solid-stabilized emulsion produced from a liquid-solid mixture that often contains very small particles with relatively large surface areas.

Figure 1 provides a flow diagram of the centrifuge process. The process requires pumps, a heater, and holding tanks, in addition to the centrifuge. The heater is used to reduce the viscosity of the feed mixture and to improve the flow characteristics. A feed-holding tank (desired but not required) provides a place to uniformly mix the feed for easier process control and to add water or chemicals when they must be added to the feed mixture to achieve the desired separation.

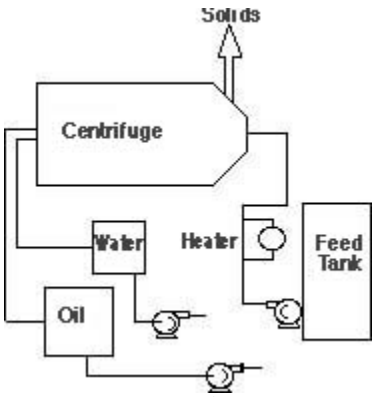

Figure 1 Flow Diagram for Three-Phase Centrifuge Process

Some Results

Quantex Technologies Inc. recently completed a technical review and evaluation of their centrifuge technology.

The Quantex three-phase centrifuge design is based on a two-phase decanter centrifuge with several technological modifications. The ability to separate a three-phase mixture into three individual phases in one pass requires, in addition to the three-phase centrifuge, an expert knowledge of the many waste mixtures to be separated and how they will behave in the machine.

The results were good in all cases, even though the waste to be cleaned was potentially troublesome in nearly all cases. Usually, the feed BS&W content was very high, which indicates that the problem mixture had been previously treated with heat and/or chemicals to remove the salable oil, leaving behind the very difficult to recover oil. In each case the product specifications varied, yet the specifications were met.

The challenge was to reduce the BS&W concentration to an acceptable level so that the oil product would be salable. Table 1 lists the results from tests at Site 1. The three-phase centrifuge produced salable oil from these runs. In fact, the average product oil BS&W content was below 1%, making the entire batch salable. (For reasons related to performance and maintenance, it does not make good business sense to produce better quality products than required.) Also, the water was clean enough to be reusable on site.

Table 1 Three-Phase Centrifuge Separation Data

Run Number	Feed BS&W, %	Product Oil BS&W, %	Product Water Oil Content, ppm
1	75	0.96	5.3
2	4	0.94	11.6
3	72	0.6	2.6
4	40	1.48	2.3
5	78	1.44	1.6
6	80	1.44	2.3
7	63	0.92	2.4

One problem with these test mixtures was that most of them had been treated very heavily, so a solid hydrocarbon phase was present. At operating temperatures, which necessarily must be below the boiling point of water, the hydrocarbon solids were recovered with the other solids, making the solid phase high in hydrocarbon content. This particular solid phase required further treatment to separate out the solid hydrocarbons.

In this trial, the three-phase centrifuge usually provided excellent separation on all three phases, even for hard-to-treat mixtures.

Project Considerations

All projects must be evaluated with a thorough sampling and analytical program. This then determines a number of factors of the project such as:

- Total volume of material
- Site requirements
- Processing times
- Composition of feedstock
- Chemical and heat requirements
- Finished product
- Costs

Generally crude projects are considered large projects as lagoons can range in size from 5,000 Barrels to 250,000 Barrels. Due to the volume of these lagoons the composition can vary greatly and sampling will not always provide an accurate measure of the material. In some cases the material will become layered over time and the production results can vary greatly.

To date Quantex has not encountered a material that could not be processed however in some cases the processing costs outweighed either the environmental or economic benefits.