THE WRITE PROCESS FOR PRODUCING PIPELINEABLE HEAVY OIL

PART I: OPTIMIZATION OF THE DISTILLATE RECOVERY UNIT

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Abstract

The WRI Thermal Enhancement (WRITE) process is a field deployed bitumen upgrader capable of converting non-upgraded bitumen (as produced by in-situ production processes) into a residuum free heavy oil whose density and viscosity exceed the specifications for Canadian pipelines without the need for costly diluent additions. The WRITE process proceeds in two stages. The first is a low temperature thermal separation designed to remove distillate from the incoming stream and recover it as usable product suitable for blending with virgin oil or with overhead from the second stage. The heavy material not recovered from the distillate recovery unit flows to the continuous coker from which there is produced gas, a lighter cracked oil that is recovered as an overhead product and coke.

Process optimization begins with the distillate recovery unit (DRU) where the yield and quality of the oil recovered depend upon temperature, residence time, sweep gas composition and volume, and the nature of the incoming oil. The DRU optimization program seeks to understand each of these effects and to use that understanding in order to optimize the yield and quality of oil produced in the DRU.

Introduction

In addition to converting bitumen into a residuum free heavy oil whose density and viscosity exceed the specifications for Canadian pipelines, the process also produces sufficient quantities of coke to meet both its own thermal energy needs and also those of the production process as well. The bottomless heavy oil produced by the process may be transported to any refinery accessible to Canadian crude oils for further upgrading into finished products. The producer using the WRITE process is thus freed from the constraints imposed by diluent addition, has a reduced need for natural gas, and produces a product acceptable to any refinery or upgrader accessible to Canadian crude oils. This leads to four significant advantages for the producer:

(1) Each pound of non-upgraded bitumen fed to the process produces 0.6 to 0.8 pounds of residuum-free heavy oil that meets the Canadian pipeline specifications for density and viscosity and thus may be transported without diluent. Total flow per barrel of product is reduced by 50% or more from the production area and no diluent return lines are needed.

(2) The product crude is residuum-free and may be processed further in conventional upgraders to produce 30 to 40EAPI syncrude or it may be processed in refineries to finished products. The fact that the product contains no residuum removes the restriction that it be processed at a facility with a coker.

(3) After startup, approximately 75 pounds of coke are produced per barrel of process feed. This material has a heating value of around 15,000 Btu per pound and is sufficient not only for process needs but can also be used for the generation of production steam and offsite needs. The small quantities of gas produced can be recovered and reformed to provide process hydrogen if needed.

(4) The flash and distillate recovery units are designed to accommodate feeds with up to 10% BS&W. As a result, minimal feed pretreating and conditioning is required. Similarly, the system is capable of continuously coking the bottoms from the distillate recovery unit. The large, semi-batch equipment characteristic of that used in delayed coking is unnecessary. System modularity with regard to the distillate recovery unit and the coker allow maximum flexibility for integration of the upgrading equipment with the production facility.

Experimental

Cold Lake crude received from Alberta Energy Company (now EnCana) was used as the starting feed in all of the optimization studies. This oil was processed in the one-barrel-per-day DRU located at WRI's Advanced Technology Center (1) at stage temperatures of up to 700°F. The bottoms from each of these runs were processed further in the 6-inch rotary screw coker to produce light, cracked overhead product for blending with the corresponding DRU overheads. DRU yields as a function of stage temperature are shown in Figure 1 and selected DRU overhead properties are shown in Figure 2. Storage stability of the liquid products was performed according to ASTM D4625 and the compatibility tests were carried out according to a test developed by Wiehe (2). Products from processing Athabasca bitumen in the WRITE process have been shown to be relatively stable during 4 weeks storage at 43°C, in spite of having high olefinic content. Furthermore, the distillate products are compatible with most Alberta crude oils (3).

Results and Discussion

Four levels of processing severity are being investigated in the DRU optimization study and the results of these tests are summarized in Figure 1. The first level of processing severity involves normal distillation (the NBP curve used in the NCUT economic evaluation) and produces DRU overhead yields approaching 25% as the stage temperature approaches 750°F. Increasing the processing severity slightly, as was done in the stability and compatibility study (2), enables yields of >30% to be achieved at temperatures below 700°F, while moderate increases in severity enable these results to be extended to yields exceeding 40% at temperatures below 675°F. A new series of experiments is presently being planned with the objective of achieving DRU yields in excess of 45% while maintaining temperature below 650°F.

An examination of Figure 2 shows no perceptible changes occurring in overhead product quality, at least not as measured by API gravity, as processing severity is increased. Quite the contrary situation exists with the DRU bottoms, however, as the density of this oil shows marked increases with increasing processing severity.

Conclusions

These activities have confirmed that as-produced, non-upgraded bitumen from Canadian oil sands can be converted continuously into residuum-free, synthetic heavy oil, along with associated quantities of gas and coke. The naphtha fraction of the produced oil comprises about 6% by weight of the total oil and contains olefins and di-olefins that will have to be hydrotreated before its addition to the pipeline. The remainder of the oil, comprising about 67% by weight of the total oil fed, has a density and a viscosity compatible with

specifications governing Canadian pipelines and can be admitted without the need for diluent. Stability and compatibility testing on this oil has shown it to be stable and compatible with other common Albertan crude oils. Energy for the process is available in the coke produced as a process by-product and the gases produced contain sufficient hydrogen to stabilize the naphtha fraction. Processing conditions are mild, do not involve the use of excessive temperatures or pressures and allow the presence of BS&W in the feed oil.

Acknowledgements. This project was funded by the US Department Energy (USDOE) under Cooperative Agreement No. DE-FC26-98FT40322. This support is gratefully acknowledged.)

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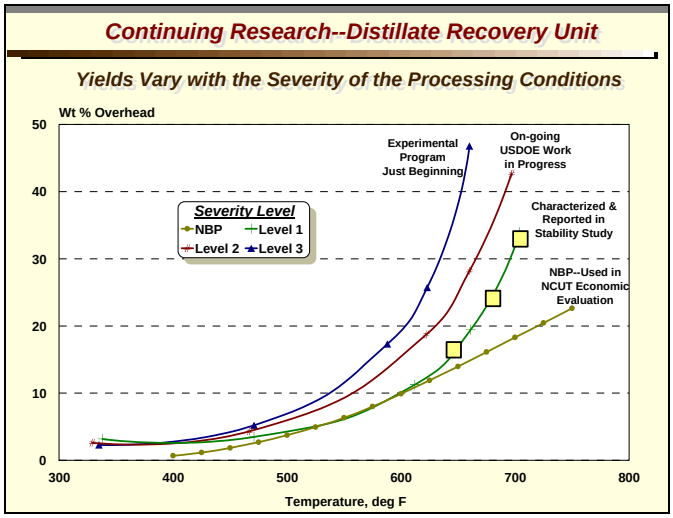

Figure 1. DRU yields as a function of stage temperature

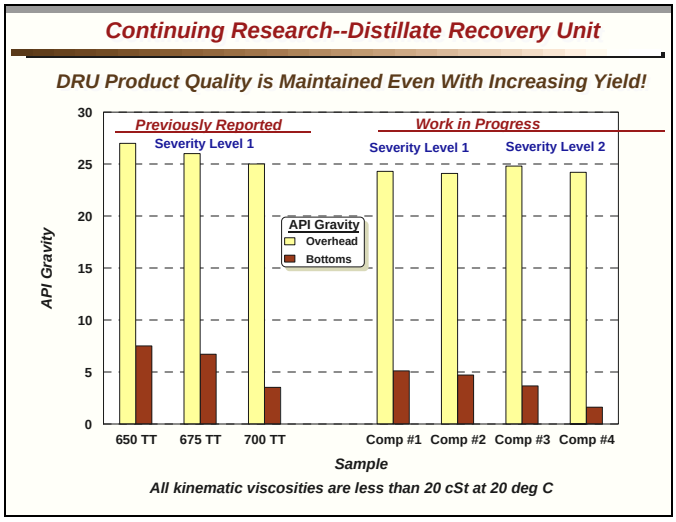

Figure 2. Selected DRU overhead properties