Preliminary Evaluation of the Heat-Integrated Distillation Column

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Executive Summary

Crude fractionation is a high-energy demand process, requiring approximately 3% of the total energy used in the United States. Currently, there are incentives to reduce energy usage due to rising costs of energy. A recent development in distillation technology that has shown potential savings of up to 60% is the heat-integrated distillation column (HIDC). HIDC columns save energy by recovering excess heat from the rectifying section for usage in the stripping section. However, this technology has only been applied to specific hydrocarbon systems. This study investigates the application of some HIDC concepts in crude fractionation.

Two new design of a column that applies HIDC to crude fractionation were developed. One was a basis off of the conventional crude fractionators with 34 trays and a compression ratio of 2:1. In order to obtain this compression ratio, the pump-around duties were drastically reduced to allow column convergence. The second column was similar to the conventional except it included 50 trays and a compression ratio of 2:1. The pump-around duties were also reduced to converge, but not as much as in the first column design. In both columns heat was slowly added to the stripping section from the rectifying section. As this was done, the furnace for the pre-heated feed was reduced by the same amount added to the stripping section. This ideally should reduce the required heating utility for the system. In doing so, the product specifications should remain relatively unchanged.

The first column design studied was found to require an increase in heating utility. This is due to the reduction of pump-around duties, which leads to a less optimized heat exchanger network. The product specifications do not remain constant. The residue becomes a heavier product, but also increases in flowrate. So, all of the valuable products are being lost to the residue. This leads to a less economical system. The maximum gross profit was found to be -$2.1 million/year compared to the conventional method. The second column design studied was found to reduce the amount of heating utility required. This is due to the increase in number of trays and increase in pump-around duties from the first design. This leads to a more optimized heat exchanger network. The product specifications do not remain constant. The residue becomes a heavier product, but also increases in flowrate. So, the valuable gasoil product is being lost to the residue. This leads to a less economical system. The maximum gross profit was found to be -$2.6 million/year compared to the conventional method. Even though energy is being saved, even more of the products are being lost to the undesirable residue.

For the system and operating conditions, the HIDC concept does not improve crude fractionation. These results seem to display adverse affects to the system making it less economical. Further studies will be needed to substantiate these results by investigating different operating conditions and possibly a completely different column design more closely.