Evaluation of Energy Savings Claims of Progressive Distillation

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Executive Summary

About 2% of the energy content of a crude oil stream is used in the distillation process. The concept of progressive distillation applied to crude fractionation was proposed as a better alternative to conventional schemes that have been around for more than 50 years. There are several unconventional distillation designs that have been developed over the last century that merit evaluation as to their potential in energy savings, especially considering recent increases in energy prices. One of these designs is progressive distillation. Progressive distillation is based on an expired Technip patent claiming that reductions in energy consumption are achieved. The now expired US patent no. 4,664,785 states that, "The process consists in successively separating increasingly heavy petroleum cuts at the head of a plurality of columns in [the primary sequence] which feed individually each column of the [secondary sequence]… By carrying out a succession of progressive separations performed in a series of small volume, more efficient utilization of the recovery of heat is achieved. " We studied this concept as it is explained in the patent and compared it to atmospheric crude columns.

Our methodology was to first create a simulation that represented the concept behind the progressive crude distillation patent. Once the model provided the same products or better as compared to those in the conventional model, the heat utility was minimized. Columns can be fitted with either steam input or reboilers in the last tray to provide an impetus for separation. In our initial simulation, all of the columns were outfitted with reboilers, which caused the overall heat utility to be very high. The next step was to replace the reboilers with steam input in order to try to lower the furnace utility. This reduced furnace heat utility, however the overall heat utility increased due to high steam flow rates. The final model used a combination of steam and reboilers to optimize use of available heat in the heat demand-supply diagram.

Our results show that furnace heat utility in the progressive simulation using light crude is reduced by 9% when compared with the conventional simulation. Heavy crude progressive simulation results indicate a 9% decrease in overall heat utility and a 14% decrease in furnace heat utility compared with the similar conventional model results. In both progressive cases, more valuable products were produced.

An analysis of overall profit change was done using current prices of hydrocarbon products, utility costs, cooling water, and steam generation, an analysis was done on the product sales profit change and the utility cost change. The simulations run were which based off a crude oil flow rate of 795 m^3/hr. Without a vacuum unit, the gross profit increase using progressive distillation was over \$10 million for a light crude feed and over \$27 million for a heavy crude feed. With a vacuum unit, the gross profit increase using progressive distillation was about \$26 million for a light crude feed and about \$57 million for a heavy crude feed. Capital costs and heat exchanger networks were not included in the comparison. ***In conclusion, progressive distillation lowers the heat utility necessary for the distillation process.***