ABSTRACT

The main objective of the demethanizer distillation is to separate hydrogen and methane, as co-products, from ethylene and heavier hydrocarbons. The methane vapor is considered as a major source of energy for the petrochemical complex.

In this study the demethanizer (DA-1501) distillation column in the cold section of the ethylene plant at the petrochemical complex (PC1-Basrah) has been considered as a case of study.

The simulation and optimization in this study were obtained by using MATLAB environment, version (2010.a) and Aspen Plus, version (11.1). The simulation model for both MATLAB and Aspen Plus was subjected to the validity test by comparing the simulation results with the actual data collected from PC-1.

The demethanizer was subjected to simulation and optimization techniques to find the optimum operating conditions using genetic and Aspen Plus algorithms. The low-temperature, high-pressure, large number of components in the feed mixtures, multi-feed and the large number of trays have made the simulation and optimization a complex process to perform.

A steady state simulation model is developed to study the behavior of multi-component mixture in the demethanizer distillation. The column model is composed of the MESH (Material balance, Equilibrium, Sum of mole fractions and Heat balance) equations.

The validity test shows a great similarity and reliability for both simulation models.

The aim of this study is to find the optimum operating conditions for the demethanizer by using genetic algorithm. A range of reflux ratios, reboiler heat duty and condenser cooling duty were tested by genetic algorithm to determine the maximum profit.

The effect of the decision variables (reflux ratio, reboiler heat duty, condenser cooling duty and the feed temperatures) was studied separately on the production of methane, ethane and ethylene production as well as the overall effects and interaction between the decision variables was investigated.

The selection of the optimum operating conditions was obtained to achieve the following objectives together:

- Increasing the production rate of methane from the top of the distillation tower.
- Increasing the production rate of ethane from the bottom of the distillation tower.
- Increasing the production rate of ethylene from the bottom of the distillation tower.
- Minimizing the heat duty of the reboiler.
- Minimizing the cooling duty of the condenser.

These objectives can be achieved all together by maximizing the total profit obtained from the demethanizer.

Finally Genetic Algorithm and Aspen Plus results show that the multi-objectives can be achieved by manipulating the decision variables to increase the profit to approximately (82) US dollar per hour.