Systematic in-Process Modification Approach for Enhanced Waste Energy Recovery in Gas Plants

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1. Introduction

The growth of the oil and gas industry has been steady with strong growth over the past few years. Demand for hydrocarbons is has been increasing to meet the growth requirements around the globe which mainly come from growing Asia. Consequently, the oil and gas sector is expected to maintain its growth and expansion in infrastructure and facilities is mandated. Recent escalated energy prices have prompted researchers and scientists in both academia and industry to improve productivity and energy efficiencies within threir process plants. In addition to cost-effectiveness and product quality, sustainability, reduction in greenhouse gas emissions and other environmental aspects need to also be addressed. During the last few decades, a number of methods and tools have been developed for conservation and optimum utilization of energy. Primarily these methods were based on mathematical programming techniques and pinch technology to synthesize and operate processes optimally from an efficient use of energy point of view. The application of these methods has been limited due to several unresolved issues. Hence, these approaches could not achieve global optimal energy-consuming conditions. This study was undertaken to determine systematically (i) global minimum energy consumption for both heating and cooling utilities under all possible combination of allowed process operating and design modifications and (ii) the set of process conditions that render global minimum heating utility consumption without exhaustive enumeration in an industrial gas plant that consists of several processing units. This poster describes the energy savings and benefits obtained by using systematic in-process modification in a gas plant. It presents a new methodology for systematic targeting of energy consumption under all possible combination of in-process modifications and the automatic selection of the optimal process operating conditions that achieve desired targets. The application of this approach is not only beneficial in maximizing profitability but also in reducing the energy-based air pollution in gas processing plants.

2. Key Features

Demand and growth across the globe has driven energy prices up substantially. Therefore, industries needs to conserve on energy requirements from heating utility to increase profitability by better integration techniques (by decreasing heating utility costs) and become more environmentally friendly (by emitting less pollutants in creating heating utility). The objective of the study was to demonstrate a process solution that results in significant hot utility savings through the optimal selection of simple-to moderate process design and operational modifications in a gas plant. A three step approach was undertaken to achieve the desired goals. An energy path model for the gas plant with all possible combinations of process modifications in a constraint logic propagation environment with interval solver was first developed (i.e. put intervals over the entire possible plant variable, in the current study-temperature intervals). Secondly, global target was defined for minimum and maximum energy consumptions under interval-based process conditions. Finally the process solution that achieves the desired energy consumption target was calculated. Interval constraint satisfaction technology-based software called TEM_icons™ was used for study.

The hot and cold utility requirements in the plant were 153.75 kW and 397.40 kW respectively without any heat integration. While, hot and cold utility requirements significantly reduced to 34.13 kW and 277.08 kW respectively with heat integration between hot and cold streams at ΔT_{min}= 20°C. This indicates the importance of the step of heat integration, as a first step. Now, by using a set of possible process modifications in the range of ±5 °C for each sensible heat stream's supply and target temperature, a 37% savings in heat utility and 19.3% savings in cold utility were obtained as hot and cold utility requirements further reduced to 21.41 kW and 223.62 kW. It is important to note here that generally cooling and heating global minima can not be achieved simultaneously, because they may result from different stream conditions. In case that cooling utility costs are more important, 10.4% heating and 19.3% cold utility savings were obtained by processes modification. However, if heating utility costs are more important than cooling utility costs, then processes modification yields 37.1% heating and 9.6% cold utility savings. Since in-process modification yield significant energy savings, it can be concluded that reducing the ΔT_{min} is not the only solution to save energy.

3. Conclusions

As described above, for a gas plant, significant energy saving can be achieved by process modification. Following are the important conclusion of this study.

By simple in-process modifications through process operating temperature/pressure manipulations can render more than 37% savings in heating utility and 19% in cooling utility consumption.

Interval constraint satisfaction technology-based software called TEM_icons™ can be systematically used to define new interesting opportunities for energy saving through the all-at-once-changes in gas plant process design and operating parameters without enumeration. It can also be used to systematically search for the optimal process conditions that render desired energy consumption targets.

4. References

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