دانشگاه بین‌المللی امام خمینی
IMAM KHOMEINI INTERNATIONAL UNIVERSITY
Imam Khomeini International University
Vol. 4, No. 1, Spring 2019, pp. 10-13

Mineral Resources Engineering
نشریه مهندسی منابع معدنی
Journal of Mineral Resources Engineering (JMRE)

DOI: 10.30479/jmre.2019.9018.1144

Economical Investigation And Optimization Of Rich Amine Inlet Temperature Of Regeneration Column And Its Effect On Amine Solvent Gas Sweetening Plant

Koolivand Salooki M.[1], Keshavarz Bahadori M.[2], Esfandyari M.[3*], Mohammadbeygi Kh.[4], Sadeghzadeh Ahari J.[5]

1- PhD Student, Gas Research Division, Research Institute of Petroleum Industry, Tehran, Iran
Koolivandm@ripi.ir
2- M.Sc, Gas Research Division, Research Institute of Petroleum Industry, Tehran, Iran
keshavarzmo@ripi.ir
3- Assistant Professor, Dept. of Chemical Engineering, Faculty of Engineering, University Of Bojnord, Bojnord, Iran
m.esfandyari@ub.ac.ir
4- PhD Student, Gas Research Division, Research Institute of Petroleum Industry, Tehran, Iran
Mohamadbeigy@ripi.ir
5- Assistant Professor, Gas Research Division, Research Institute of Petroleum Industry, Tehran, Iran
sadeghzadehj@ripi.ir

(Received: 06 Jul. 2018, Accepted: 01 Jan. 2019)

Abstract: The sweetening process with amine is widely used to remove acidic gases. However, this process requirement is cooling and heating energies. In addition, the reduction of energy requirements is limited by optimizing operational parameters. Therefore, changing the process parameters can lead to a significant reduction in energy consumption, resulting in lower operating costs. In this study, parameters such as the amine temperature in the entrance of the regeneration tower, the condenser heat load, the reboiler heat exchanger and the heat load of the rich/lean amine gas sweetening unit were investigated and the optimum temperature value to reduce operating costs and increase profitability achieved. Simulation analysis was performed using PRO II software. The comparison between the main process and the optimized process showed that the optimal temperature selection of the rich amine to the recovery tower has the ability to reduce operating costs to over $ 97704 per year, while also leading to the highest recovery of hydrogen sulfide.

Keywords: Gas sweetening, Optimization, Operating cost, Optimum temperature.

INTRODUCTION

Natural gas is a main source of energy that is widely used as a domestic and industrial fuel. In order to use natural gas appropriately and environmentally friendly, it is very important to remove all the contaminations from gas [1]. Hydrogen sulfide and carbon dioxide are the main important impurities in natural gas. A gas with a H_2S content of more than 4 ppm is considered to be a sour gas and it should be removed before using because of corrosion, hazardous and environmental problems [2]. The main method used to remove acid gases is sweetening with alkanoamines, which is capable of separating more than 50% of acid gases [3]. Because this type of sweetening process consumes a huge amount of energy during the regeneration process [4], optimizing the process parameters of the regeneration column can be result in significant economic benefits for existing sweetening units. In the present article, the rule of thumb of the entry temperature of the regeneration column was studied. By changing the feed temperature to the column, the optimization of the sweetening unit has been made to reduce operational and investment costs.

METHODS

For this study, the PRO II v9.3 software simulator is used to simulate the sweetening unit which has been used repeatedly in the design of industrial units [5-7]. After selecting the software, the simulation of the sweetening unit was performed by the MDEA solvent at different temperatures of the regeneration column (the range of 80 to 120 ^{0}C). The lean amine quality was kept constant and its effect on the reboiler, condenser heat load and the amine output temperature from the lean/rich heat exchanger were investigated. In addition, special attention has been paid to the amount of steam consumed in the rich amine reboiler, as well as the composition of produced gases in the vapor phase.

FINDINGS AND ARGUMENT

A process diagram for an amine sweetening unit is illustrated with the PRO II commercial simulation software in Fig. 1. The rich amine after heating up to 100 ° C with a mass flow of 82023 kg/h and with pressure of 1.5 bar is routed to the second tray of regeneration column. Regeneration column has 20 trays. After removing acid gas from rich amine in the regenerator, the lean amine is sent back to absorption column for sweetening of entering gas. It should be noted that the data source used for this study come from one of the oil refineries $_{\text{designed}}$ in the research institute of petroleum industry.

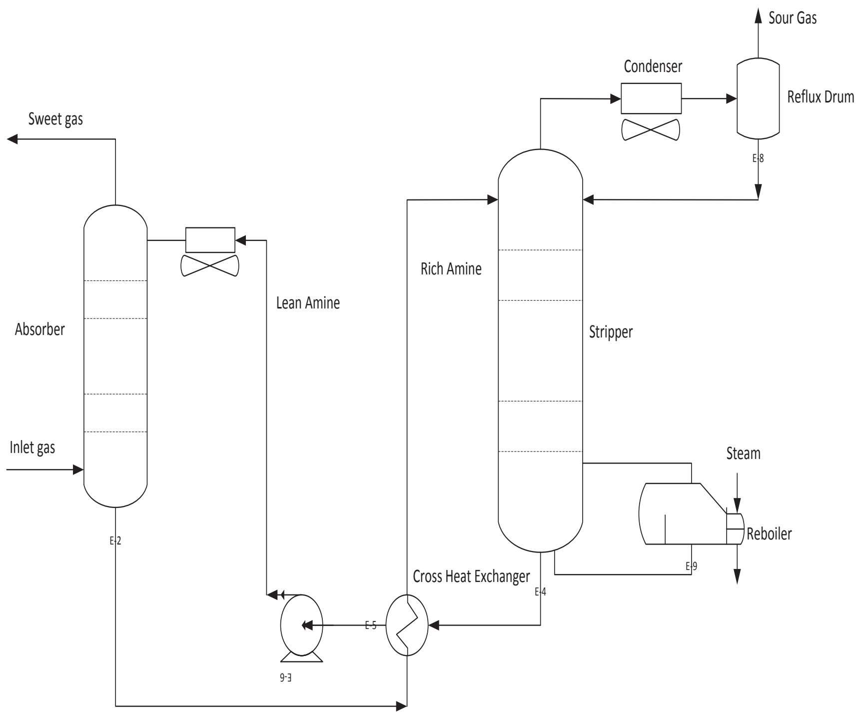

Figure 1. Schematic diagram of sweetening unit

For simulation verification based on South Pars phases, using the PROII software and ASPEN software, version 10 is shown in Table 1. As it is known, the amount of circulation rate of amine, the heat load of the reboiler and the air cooler in the simulation mode of PROII are closer to the actual results of the working phases.

Table 1. Simulation verification of PROII results with Aspen 10 and design case of SOUTH PARS GAS FIELD-Phase 4, 5

	SOUTH PARS GAS FIELD- Phase 4, 5	PROII Software	ASPEN HYSYS V 10
Parameters	MDEA	MDEA	MDEA
Feed Flow Rate [MMSCFD]	487	487	487
Solvent Circulation Rate [kmol/hr]	10705	10680	11350
Rich Loading	0.37	0.37	0.37
Lean Loading	0.002	0.002	0.002
Feed CO2 Content [ppm]	18270	18270	18270
Feed H2S Content [ppm]	6900	6900	6900
Sweet Gas CO2 Content [ppm]	10000	10000	10000
Sweet Gas H2S Content [ppm]	3 ppm	3 ppm	3 ppm
Reboiler Duty [Mega WATT]	22.8	22.4	24.1
Acid gas condenser kW	88.3	84.1	98.3

In order to observe the effect of rich amine temperature change effect, an economic comparison was made on the main heat transfer and amine transfer equipment with a loading of 28%. The calculations were performed on the basis of the JCG procedure for a temperature range of 80 ° C to 120 ° C.

Figure 2 shows the trend of changing overall costs versus changes in rich amine temperature. this figure confirms that the temperature of 100 ˚C is an optimal temperature for the regeneration column of the amine unit.

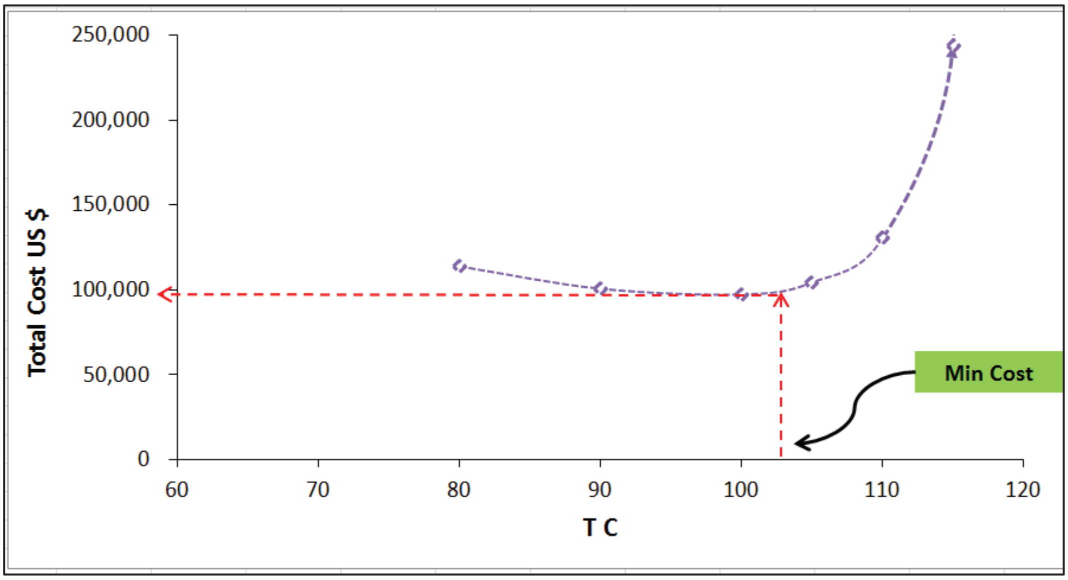

Figure 2. Total cost against the rich amine temperature change

CONCLUSIONS

In this study, due to the importance of the gas sweetening unit for the removal of contaminants such as carbon dioxide and hydrogen sulphide, the effect of the rich amine temperature entering to the regeneration column on the total energy consumption has been investigated. The heat load of reboiler, the condenser, and the heat transfer rate of the lean/rich amine heat exchanger were studied and the temperature of 100˚C was obtained as an optimal temperature to reduce operating costs and lead to the highest amount of hydrogen sulphide recovery. At this temperature, the total cost of the main heat transfer equipment is minimized.

REFERENCES

[1] Ghanbarabadi, H., and Khoshandam, B. (2015). *"Simulation and comparison of Sulfinol solvent performance with Amine solvents in removing sulfur compounds and acid gases from natural sour gas"*. Journal of Natural Gas Science and Engineering, 22: 415-420.

[2] Rezakazemi, M., Niazi, Z., Mirfendereski, M., Shirazian, S., Mohammadi, T., and Pak, A. (2011). *"CFD simulation of natural gas sweetening in a gas–liquid hollow-fiber membrane contactor"*. Chemical Engineering Journal, 168(3): 1217-1226.

[3] Lunsford, K. M., and Jerry, A. B. (1996). *"Optimization of amine sweetening units"*. American Institute of Chemical Engineers, 12-150.

[4] Wang, T., Hovland, J., and Klaus J. J. (2015). *"Amine reclaiming technologies in post-combustion carbon dioxide capture"*. Journal of Environmental Sciences, 27: 276-289.

[5] Addington, L., and Ness, C. (2009). *"An evaluation of general "Rules of Thumb" in amine sweetening unit design and operation"*. Bryan Research and Engineering, 140-250.

[6] Al-Lagtah, N. M. A., Al-Habsi, S., and Sagheer A. O. (2015). *"Optimization and performance improvement of Lekhwair natural gas sweetening plant using Aspen HYSYS"*. Journal of Natural Gas Science and Engineering, 26: 367-381.

[7] Berrouk, A. S., and Ochieng, R. (2014). *"Improved performance of the natural-gas-sweetening Benfield-HiPure process using process simulation"*. Fuel Processing Technology, 127: 20-25.