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Empirical Study on Effective Groups in Treatment Process of Sour Gas by Novel Method: Introduction of New Producer

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Abstract

Adsorption of water vapour on the nano zinc oxide bed is a studied method of dehydration, in this work. The amount of mass transfer which varies with the values of temperature, pressure, dimensionless groups in length, H/D, temperature, $(T_p - T_a)/(T_i - T_a)$, dimensionless pressure, $\Delta P/P_a$, catalyst diameter, dimensionless diameter, D/d_p, and initial amount of water in the feed stream is investigated through the experiments. The results are analysed by the historical data tool of Design expert software. The energy optimization is occurred when the process do in optimum conditions. In addition, the experimental data are analysed by historical data interface on the Response Surface tab. This helps to evaluate the experiments and investigate the optimum pressure and temperature. The software suggests linear correlation between variables. The parameters of temperature, pressure, H/D, particle diameter and initial amount of water are chosen as numeric factors. The response is defined as amount of dehumidification flux, N_a.

Keywords

Energy Optimization, Bed, Dimensionless, Adsorption, Pressure, Temperature

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1. Introduction

The main reason for water elimination from natural gas is that water (which is mostly in vapor phase at natural gas) becomes liquid under low temperature and/or high pressure conditions. There are five major reasons for natural gas treating from water contents: A). Liquid water and natural gas can form hydrates which causes plug the pipelines and other equipment such as valves, collectors etc. [1]. (Gas Hydrate: are solids formed by the physical combination of water and other small molecules of hydrocarbons. They are icy hydrocarbon compounds of about 10% hydrocarbons and 90% water) [2]. B). Natural gas containing H_2S and/or CO_2 is corrosive when liquid water is present (corrosion often occurs when liquid water is present along with acidic gases, which tend to dissolved and disassociate in the water phase, forming acidic solutions) [3]. C). Water content of natural gas decreases of its heat value. D). Liquid water in natural gas pipelines potentially causes slugging flow conditions resulting in lower flow efficiency of the pipelines [4]. E). In most commercial hydrocarbon processes, the presence of water may cause side reactions, foaming or catalyst deactivation [5]. To prevent such

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problems, natural gas treating is unavoidable [6]. There are different methods for water treating of natural gas such as: adsorption, absorption, membrane process, methanol process and refrigeration. Among mentioned methods absorption, which is called dehydration and use liquid solvent as an absorbent, is mostly common technique for treating of natural gas [7]. The basis for gas dehydration using absorption is the absorbent; there are certain requirements for absorbents for gas treating: strong affinity for water to minimize the required amount of absorbent (liquid solvent), low potential for corrosion in equipment's, low volatility at the process temperature to minimize vaporization losses, low affinity for hydrocarbons to minimize their loss during the process, low solubility in hydrocarbons to minimize losses during treating, low tendency to foam and emulsify to avoid reduction in gas handling capacity and minimize losses during regeneration, good thermal stability to prevent decomposition during regeneration and low viscosity for easily pumping and good contact between gas and liquid phases [8]. Off course, the major critical property for a good absorbent is the high affinity for water. The others are used to evaluate potential absorbents practical applicability in the industry [9]. All natural gas contains water (moisture) which is measured in natural gas pipelines at production and gathering sites, custody transfer points, compression stations, storage facilities and in the distribution markets. Several methods are used for dehydration such as pressurizing, chilling, and absorption processes that use liquid and solid desiccants [10-13]. Commonly, dehydration is achieved in the field with Triethylene Glycol (TEG) contactors [14, 15]. Glycol carryover to the analyzer is more likely at closer proximities to the outlet. This process is the "traditional" Triethylene Glycol (TEG) based dehydration process and represents a unit with gas absorption and extraction solvent regeneration [16, 17]. The objective is to reduce the amount of water in the natural gas with TEG, used as the extraction solvent [18]. This process is required to prevent hydrates formation at low temperatures or corrosion problems due to the presence of carbon dioxide or hydrogen sulfide (regularly found in natural gas). The ccorrosion problem is commonly encountered in the amine system and generally occurs in the amine regenerator, heat exchanger, amine stripper and amine pumps etc. Most corrosion occurs in areas where the acid gases are actually released from the solution i.e. in the reboiler, stripper tower and its overhead systems [17, 18]. The cause of corrosion is traced to gaseous H_2S & CO_2 which comes out of the amine solution while the rich amine solution is receiving heat in the heat exchanger prior to the regenerator. These acid gases combine with water to form acids, which will attack the metal surfaces in contact with the amine solution [17]. The corrosion problems can be minimized by the following practices: 1. Keep the amine solution clean. Do not over load the inlet separator, which prevents solids entering in the system. Other solids that contribute to corrosion are removed by amine filters. So, it's very important to maintain a good amine filtration system. 2. The presence of air will cause the amine to degrade into heat stable salts, so there should be a gas blanket on all the amine storage tanks to exclude air [16, 18]. 3. Maintain acid-gas loading within the proper ranges. 4. Corrosion problems become severe at high temperatures with the rich amine solutions, so keep the amine solution concentration up to the recommended value [15, 17]. 5. Amine reboiler temperature should be kept at the recommended range to avoid any amine decomposition or any extra water losses which will affect the amine solution concentration. 6. Maintain a regular corrosion testing programmed for an early detection of any corrosion problems in the system [18].

The adsorption of water in wet gas by nano zinc oxide is investigated experimentally and the data is analyzed by the Design Expert software, in this research. The optimum values of temperature and pressure is predicted by the historical data optimization interface in the software.

2. Materials and Methods

Gas cylinder is made of stainless steel contains feed gas. The gas is saturated by water injection into the gas line after the required amount of water is measured. All the measurement instruments are from stainless steel since this material is strong in the probable corrosion in wet gas media. Pressure, temperature and flow rate of gas stream is measured and controlled in the set up. The feed gas is heated by the electrical heater which is adjusted before the reactor bed to the value of process temperature. Adsorption of water vapour on the nano zinc oxide bed is a studied method of dehydration, in this work. The amount of mass transfer which varies with the values of temperature, pressure, dimensionless groups in length, H/D, temperature, $(T_p - T_a)/(T_i - T_a)$, dimensionless pressure, Δp/pa catalyst diameter, dimensionless diameter, D/d_p and initial amount of water in the feed stream is investigated through the experiments. The T_p is temperature of process, T_i is initial temperature and the T_a is an ambient temperature.

3. Results and Discussion

Experiments are held to obtain the trend of gas adsorption in different operation conditions. Temperature, pressure, initial amount of water in the feed gas is considered as an operation conditions. Catalyst diameter, different ratios of height of bed to diameter of bed as geometrical specification of bed is evaluated. The effect of superficial velocity on the amount of N_a. Also, the normal plot of residuals and residuals versus predicted are investigated in this paper.

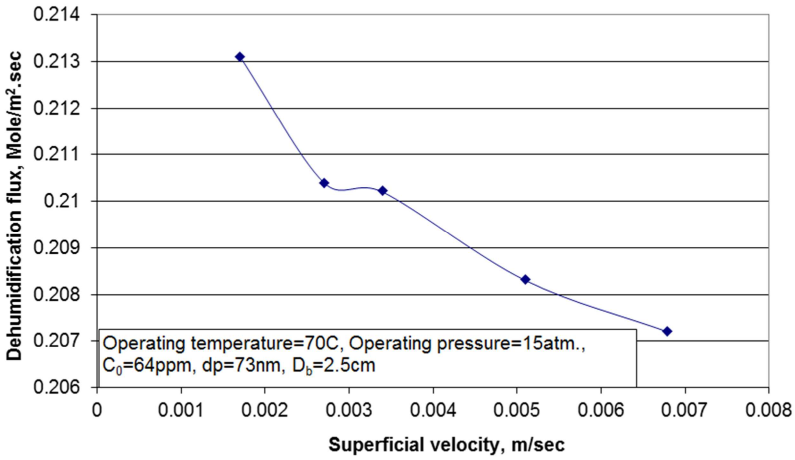

Figure 1. The effect of superficial velocity on the amount of Na.

Figure 1 shows the effect of amount of superficial velocity on the value of N_a. Changes the input flow rate changes the superficial velocity at the constant surface area. The increase in the value of superficial velocity increases the value of water also. So the driving force is increased but the mass transfer area is limited. Then the decrease in the amount of Na is obtained. The increase in the amount of superficial velocity from 0.0017 to 0.0068 m/s decreases the amount of superficial velocity from 2.8%. The experimental data are analysed by historical data interface on the Response Surface tab. This helps to evaluate the experiments and investigate the optimum pressure and temperature. The software suggests linear correlation between variables. The parameters of temperature, pressure, H/D, particle diameter and initial amount of water are chosen as numeric factors. The response is defined as amount of dehumidification flux, Na. The experimental results are defined for the interface and the suggested from of response is power form with lambda value of 1.2. So the transformed response in form of $N_a^{1.2}$ is analysed. Diagnostic curves like normal plot of residuals, Residual versus predicted, predicted versus actual help to better analysis.

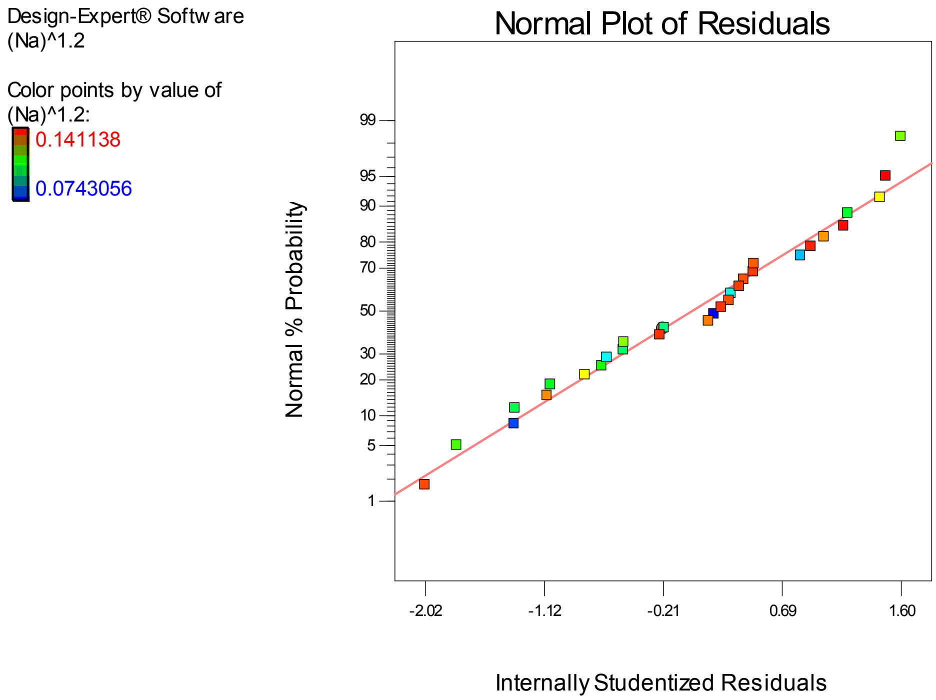

Figure 2. Normal plot of residuals.

Normal plot of the results is obtained as it is shown in Figure 2, to ensure that this power form is the most proper transformation. The residuals obey from a straight line with an s-shape pattern which indicates that this transformation may provide a better analysis.

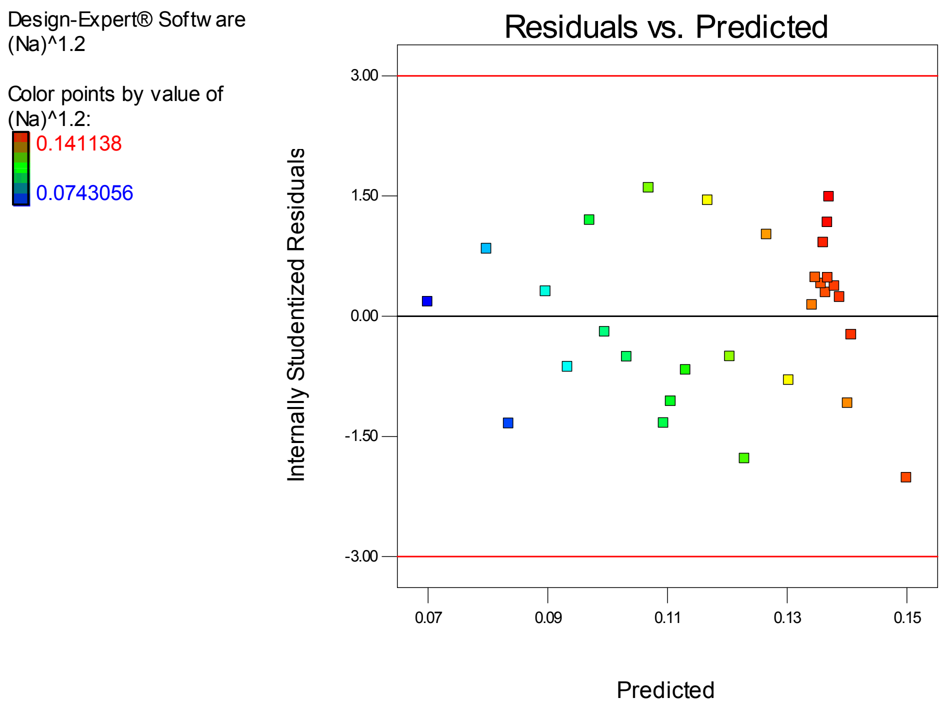

Figure 3. Residuals versus predicted.

The Figure 3 shows the values of residuals versus predicted values. The residuals show the difference between the actual and predicted values of N_a. The red lines show the limitation of the proper data. All the experimental data are ranged between two lines. The shape of the distribution is not megaphone so the experimental data with this transformation is proper for the optimization.

4. Conclusions

In this work, the adsorption of water in wet gas by nano zinc oxide is investigated experimentally and the data is analyzed by the Design Expert software. The optimum values of temperature and pressure is predicted by the historical data optimization interface in the software. The increase in the amount of superficial velocity from 0.0017 to 0.0068 m/s decreases the amount of superficial velocity from 2.8%. The experimental results show, the residuals obey from a straight line with an s-shape pattern which indicates that this transformation may provide a better analysis. The residuals show the difference between the actual and predicted values of Na. The red lines show the limitation of the proper data. In other words, experimental data are analysed by historical data interface on the Response Surface tab. This helps to evaluate the experiments and investigate the optimum pressure and temperature. The software suggests linear correlation between variables. The parameters of temperature, pressure, H/D, particle diameter and initial amount of water are chosen as numeric factors. The response is defined as amount of dehumidification flux, N_a.

References

[1] Prajapat Ganshyam, Rellegadla Sandeep, Jain Shikha, Agrawal Akhil, Reservoir souring control using benzalkonium chloride and nitrate in bioreactors simulating oil fields of western India, International Biodeterioration & Biodegradation, Volume 132, August 2018, Pages 30-39.

[2] Santosa, Sri Juari, Kunarti, Eko, Karmanto, Sri, 2013. Synthesis and utilization of Mg/Al hydrotalcite for removing dissolved humic acid, Applied Surface Science 254, 7612–7617.

[3] W. P. Cheng, Comparison of hydrolysis/coagulation behaviour of polymeric and monomeric iron coagulants in humic acid solution, Chemosphere 47 (2013) 963–969.

[4] Bian Xiao-Qiang, Zhang Lu, Du Zhi-Min, Chen Jing, Zhang Jian-Ye, Prediction of sulfur solubility in supercritical sour gases using grey wolf optimizer-based support vector machine, Journal of Molecular Liquids, Volume 261, 1 July 2018, Pages 431-438.

[5] Abrahamson, A. B. I., Brunstrom, B., Sundt, R. C., Jorgensen, E. H., 2008. Monitoring contaminants from oil production at sea by measuring gill EROD activity in Atlantic cod (Gadus morhua). Environ. Pollut. 153, 169e175.

[6] Esmaeilzadeh, F., Goodarznia, I., 2005. Supercritical extraction of phenanthrene in the crossover region, J. Chemical Engineering Data 50, 49–51.

[7] Beyer, J., Jonsson, G., Porte, C., Krahn, M. M., Ariese, F., 2010. Analytical methods for determining metabolites of polycyclic aromatic hydrocarbon (PAH) pollutants in fish bile: a review. Environ. Toxicol. Pharmacol. 30, 224e244.

[8] sima Kamari, Hidaka Kohei, Miyanaga Kazuhiko, Tanji Yasunori, The presence of nitrate- and sulfate-reducing bacteria contributes to ineffectiveness souring control by nitrate injection, International Biodeterioration & Biodegradation, Volume 129, April 2018, Pages 81-88.

[9] Xu. Zhang, Cheng-Fang Zhang, Yi Lin, Kinetics of absorption of CO_2 into aqueous solution of MDEA blended with DEA, Ind. Eng. Chem. Res. 2002, 41, 1135-1141.

[10] Habibi R., Towfighi Daryan J., Rashidi A. M., 2009, Shape and size-controlled fabrication of ZnO nanostructures using noveltemplates, J. Exp. Nanosci. 4 (1) 35-45.

[11] Alkatheri M., Betancourt-Torcat A., Almansoori A., Comparison of life cycle greenhouse gas emissions from unconventional ultra-sour and conventional gas feedstock for power: A case study of the United Arab Emirates, Journal of Cleaner Production, In press, accepted manuscript, Available online 27 June 2018.

[12] Habibi R., Rashidi A. M., Towfighi Daryan J., Alizadeh A., 2010, "study of the rod –like and spherical nano ZnO morphology on H_2S removal from natural gas". Appl. Surf. Sci., 257, pp. 434-439.

[13] Tsesmetzis Nicolas, Alsop Eric B., Vigneron Adrien, Marcelis Fons, Lomans Bart P., Microbial community analysis of three hydrocarbon reservoir cores provides valuable insights for the assessment of reservoir souring potential, International Biodeterioration & Biodegradation, Volume 126, January 2018, Pages 177-188.

[14] Balouria Vishal, Kumar Arvind, Samanta S., Singh A., Debnath A. K., Mahajan Aman, Bedi R. K., Aswal D. K., Gupta S. K., 2013, ‘’Nano-crystalline Fe_2O_3 thin films for ppm level detection of H_2S,’’Sensors Actuators B: Chemical, 181, pp. 471-478.

[15] Xomeritakis. G, Tasi. C. Y, Brinker. C. J, “Microporous sol-gel derived aminosolicate membrane for enhanced carbon dioxide separation”, Separation and Purification Technology 42, 2005.

[16] Nejat Tahereh, Movasati Azam, Wood David A., Ghanbarabadi Hassan, Simulated exergy and energy performance comparison of physical–chemical and chemical solvents in a sour gas treatment plant, Chemical Engineering Research and Design, Volume 133, May 2018, Pages 40-54.

[17] Mandal. B. P, Biswas. A. K., Bandyopadhyay. S. S, “Selective absorption of H_2S from gas strems containing H_2S and CO_2 into aqueous solutions of N-methyldiethanolamine and 2-amino-2- methyl-1- propanol”, Separation and Purification Technology 35, 2004.

[18] Han Yehua, Zhang Yanfen, Xu Chunming, Hsu Chang Samuel, Molecular characterization of sulfur-containing compounds in petroleum, Fuel, Volume 221, 1 June 2018, Pages 144-158.