A STUDY ON TECHNOLOGIES USED FOR REMOVAL OF H_2S & CO_2 FROM NATURAL GAS

Er. Ravi Baliyan[1], Ameen Nasher Yahya Kozman[2]

[1]*Assistant Professor, HOD, Dept. of Petroleum Technology, Bhagwant University, Ajmer*
[2]*M.Tech Scholar, Petrochemical Engineering, Bhagwant University, Ajmer*

ABSTRACT

In this paper we are studding on Technologies used for Removal of H_2S & CO_2 from Natural Gas. There are mainly two types of acid gas removal processes: adsorption and absorption. Adsorption is a physico-chemical phenomenon in which the gas is concentrated on the surface of a solid to remove impurities. The acid gas removal unit is designed to remove acid sulfur to meet sales gas sulfur and CO_2 specifications. The H_2S must be removed to meet the sales gas specification of 4 ppmv, or a grain of 100 grams per gas. In addition, COS, mercaptans and other organic sulfur species should be removed.

Keyword: - *Gas, CO_2, H_2S, COS, Remove, Acid etc.*

1. INTRODUCTION

At the same time, it is worth exploring potential energy options to deal with the increasing global demand for energy and environmental impacts such as global greenhouse gas (GHG) emissions. As a baseline for most approaches, issues of producing sufficient quantities of energy with high quality, economical feasibility and environmental sustainability are current concerns. One of the important components of the world's energy supply, which meets the above requirement, is natural gas. In addition to its primary importance as a fuel, natural gas is also a source of hydrocarbons for petrochemical feedstocks. Many types of research have been done on the natural gas field because the presence of a high component of methane in natural gas contributes to the production of other potential products such as syrup and high purity hydrogen. Although natural gas is mostly regarded as a "clean" fuel, as compared to other fossil fuels, the natural gas found in reservoir deposits is not necessarily "clean" and free of impurities. Natural gas mainly contains methane as a prevalent element but contains a significant amount of light and heavy hydrocarbons as well as contaminated compounds of CO_2, N_2, Hg, He, H_2S and etc. Thus, impurities must be removed to complete the pipe. -Quality standard specifications as a consumer fuel, increase the calorific value of natural gas, avoid degradation of pipelines and equipment and remove associated process bottlenecks. This paper discusses major advances, process benefits, and limitations of absorption, adsorption, cryogenic, and membrane processes of existing technologies in natural gas refining. In addition, special emphasis is placed on the removal of CO_2 from natural gas as CO_2 is the largest contaminant found in natural gas and a major contributor to global GHG emissions. A comparison between these technologies is also described in terms of advantages and disadvantages. Emerging concepts have been exposed to new approaches in natural gas separation. Finally, future research and development directions of natural gas processing technologies are also presented. The risks posed by CO_2, H_2S and other impurities in natural gas (NG) are increasingly dangerous due to their negative consequences in humans, equipment, and the environment. Natural gas can be classified as sweet or sour. It contains methane, ethane, propane, isobutene, n-butane, nitrogen, CO_2, O_2, isopentane, n-pentane, hexane, and H_2 [1]. Other gases include helium, hydrogen sulfide, and mercaptans that give the gas its distinctive smell. CO_2 and H_2S are major pollutants in NG. For easy / safe transport, <50 ppm CO_2 is desired [2]. CO_2 and H_2S can be trapped using amine solvents, absorption devices, and membranes [3]. Other contaminants, such as carbonyl sulfide, mercaptan, ethane, pentane, etc., are usually removed through distillation and absorption. Gas purification depends on the target – solute solubility, partial vapor pressure of the components and the heat spent during solvent recovery [4], [5]. Absorption of CO_2 from flue gas using several alcohol – amine solvents has been reported [6]. According to Fang and Zhu [7],

the use of amines, carbonates, aqueous ammonia, polymer membranes, ionic liquids and enzymes in the conduction of gas treatment has been recent.

2. COMPARISON OF NATURAL GAS PURIFICATION TECHNOLOGIES FOR ACID GAS REMOVAL

Absorption by physical solvents is mostly not recommended at low partial pressures because compression of the gas is relatively no economical for physical absorption. In general, the economics of CO2 separation are greatly influenced by the partial pressure of CO2 in feed natural gas. However, if gas is available at high pressures, physical solvents may be a better alternative than chemical solvents. While physical solvents can often be stripped of impurities by reducing pressure without the application of heat, the uptake of chemical solvents is achieved by the application of heat. When the concentrations of acidic gases or other impurities are very high, physical solvents favor chemical solvents. Unlike chemical solvents, physical solvents are non-corrosive, requiring only carbon steel manufacturing. The concentration of heavy hydrocarbons in the feed gas also affects gas treatment options. If the concentration of heavy hydrocarbons is high, a physical solvent may not be the best option due to the high co-absorption of hydrocarbons, especially pentane plus. Unlike synthesis gases, where hydrocarbons do not contain appreciable amounts, natural gas can be a problem for physical solvents as a result of hydrocarbon co-absorption. This is particularly applicable to physical solvents for synthesis gas treatment (Burr and Liddon 2008). Although the adsorption technique is limited to small gas streams and medium pressures due to the complexity of the design, the PSA technique is mostly used in shut-in natural gas wells that typically contain very high N2. As a typical example, titanosilicate adsorption (Engelhard Corporation) is used in a vacuum swing adsorption combined with a PSA process to remove N2 and / or CO2 from natural gas feed streams (Ritter and Eibner 2007) . When natural gas wells contain high CO2 and H2S, the membrane process is best used at high pressures. CO_2 dissociation is accomplished by pressure-driven mass transfer through a permeable membrane, where separation occurs due to differences in the transit rate of different antennas. Although acid gas is usually recovered at low pressures, high purity products containing approximately 95% CO_2 can be obtained with one or two steps, depending on the pressure and percentage recovery of the feed gas . Economic considerations may direct additional pressure and incremental energy requirements to use two-phase separation with increasing feed pressure and / or recombination of gas from the first stage. The cryogenic process, as compared to other methods of separating CO2, has the advantage that CO2 can be obtained at relatively high pressures. However, this advantage can be offset by the need for larger refrigeration.

3. SELECTIVE REMOVAL OF H2S FROM WATER USING NON-CONDENSED GAS

Carbon dioxide, NCG injection, carbon capture, geothermal. In this study, reinforcement of NCGs (non-condensed gases) released from geothermal plants was investigated. These goals will be achieved with water by injecting CO_2 into the geological reservoir. Both H_2S and CO_2, often referred to as "acid gases", are only solubilized in water at atmospheric pressure. Even at elevated pressures, the solubility of these gases in water is not very high; Thus, it is unusual to use water to absorb these gases in commercial-scale gas treatment systems. Alkanolamines and some physical solvents are commonly used for the absorption of acid gases. The stream of vapor from the flash or reboiler, which will be rich in CO_2, will be returned to the bottom of the absorption column. This process regime allows a substantial improvement in the water's ability to absorb H_2S from feed NCG, at least (but not eliminate CO_2 absorption). This concept is described in more detail in the rest of this section, and provides the results of the process simulations that were used to characterize it. Water filled with CO_2 and H_2S from the bottom of the absorption column is subjected to either a low pressure flash or an elevated temperature partial evaporator (reboiler) to remove a large fraction of the CO_2 absorbed by the water. Can go in the absorption column. (**Source:** Mamrosh, McIntush, Douglas, Fisher, Júlíusson, Gunnarsson, Markússon, Matthíasdóttir, & Arnarson)

Table 1.1 Case Study for Selective Absorption of H_2S Using an Absorber Column with Bottoms Flash 35 theoretical stages, 5 bar operating pressure Water feed at 40 kg/s and 30°C (Darryl L. Mamrosh P.E. etal.)

Stream Description	**Feed Gas (NCG)**	**Treated Gas from Absorption Column**			
		No Flash	Case 1	Case 2	Case 3
No. Flash Stages		0	2	3	4
Last Stage Pressure, bar		NA	3	2	0.8
Compressor Power, kW		0	21	50	84
Total kg/s	0.500	0.145	0.230	0.288	0.344
H_2S mole %	25.9	0.031	0.13	1.4	14
CO_2 mole %	51.3	46.2	60	65	58
H_2S removal %		99.99	99.8	97.4	54.4
CO_2 removal %		57	25	2.8	0.006

Source: Mamrosh, McIntush, Douglas, Fisher, Júlíusson, Gunnarsson, Markússon, Matthíasdóttir, & Arnarson

4. CHARACTERISTICS OF NON-CONDENSED GAS FOR EACH GEOTHERMAL FACILITY

There are many technologies available for the removal of H_2S from NCG. The six geothermal power plants - Tattapani in Chhattisgarh., Puga in Jammu & Kashmir, Cambay Graben in Gujarat, Manikaran in Himachal Pradesh, Surajkund in Jharkhand, Chhumathang in Jammu & Kashmir - have been operated and / or planned in Iceland by member companies of the Solfix team. These facilities do not currently have H_2S abatement systems. The summary of NCG characteristics in these features is given in Table 1.2.

Table 1.1: Characteristics of NCG for Each Geothermal Facility

Characteristic	Units	Tattapani	Puga	Cambay Graben	Manikaran	Surajkund	Chhumathang
Gas Flow Rate	kg/s	1.582	1.314	0.63	1.5	0.28	1.20
H_2S Content	mass%	27.06	33.46	4.62	2.62	48.00	6.90
CO_2 Content	mass%	45.70	63.58	94.82	98.88	48.78	73.19
H_2 Content	mass%	1.14	0.49	0.05	0.06	4.66	0.42
N_2 Content	mass%	25.09	2.01	0.68	0.58	0	16.16
O_2 Content	mass%	6.18	0.48	0	0	0	6.27
CH_4 Content	mass%	0.08	0.126	0.02	0.02	0.31	0.05
Ar Content	mass%	0	0	0	0.04	0.19	0.26
H_2S Flow Rate	ton/day	32.11	34.02	1.66	1.44	7.18	6.57

Source: Mamrosh, McIntush, Douglas, Fisher, Júlíusson, Gunnarsson, Markússon, Matthíasdóttir, & Arnarson

5. MEMBRANE TECHNOLOGY

Membrane technologies compete with traditional technologies, such as pressure swing adsorption, temperature swing adsorption, or amine scrubbing in terms of commercial issues [2, 3]. In addition, the uptake of biogas through a membrane usually involves a polymer membrane. A previous study used a thin membrane from a thin hydrophilic composite (TFC) as a different method. Separation of H_2S by TFC offers future economical possibilities compared to the traditional method [40]. The traditional method decreases in efficiency because of other additional splash steps required to remove water vapor from the biogas stream; However, this step was not required when TFC is used [1]. As a core of separation through the membrane, some components of the raw gases are transported through a thin membrane, while others are retained. Under the membranes studied, several types of membranes have been used as was done in the improvement of the technology. Based on the H_2S removal results, several parameters need to be investigated. These parameters are the pressure, temperature, permittivity concentration and solubility of gases in the selective water swelling polyamide layer [4]. Methane is an issue in upgrading end product efficiency. The increase of feed pressure and concentration was exaggerated in retaliation. This result was interpreted in a set of data by Dolges et al. (2014) which showed that methane is in concentration increases to 68% per second at 500 kPa, and the lowest number The loss of methane in the permit stream is only 3 vol%. The high Pressure RO membrane is better than low pressure RO membrane. In addition, more H_2S is removed at lower pressures. The loss of methane in permeate must be considered (References Nurul Noramelya Zulkeflia et al. 2016).

Table 1.3: H_2S efficiency through membrane technique References Nurul Noramelya Zulkeflia et al. (2016)

Technique	*Efficiency*	*References*
• High pressure RO (500 kpa)	57 vol.%	Dolejs et al. (2014)
• Low pressure RO (400 kpa)	43 vol.%	
• Micro-porous hydrophobic gas-liquid absorption membrane -High pressure -Low temperature (25 °C)	98%	Wellinger et al. (2005)
• Hollow fibers membrane gas adsorber (HFMGA) -Pressure: 10 atm	100%	Mahdavian et al. (2012)

References

1. Júlíusson, B.M.; *Reducing H_2S Emissions from Geothermal Power Plants*. Collaboration of Icelandic Energy Companies; GEORG (Geothermal Research Group), From Waste to Value Seminars; April 2013; Reykjavík, Iceland.
2. Mamrosh, D.L., McIntush, K.E., Beitler, C., Markússon, S.H., Einarsson, K.; *Screening of H_2S Abatement Options for Geothermal power Noncondensable Gas at Bjarnarflag*; paper presented at the GRC Annual Meeting; October 2012; Reno, NV.
3. Fisher, K.S., Lundeen, J.E., Leppin, D.; *Fundamentals of H2S Scavenging for Treatment of Natural Gas*; paper presented at The Ninth GRI Sulfur Recovery Conference, October 1999, San Antonio, TX.
4. Dunstall, M.G., Graeber, G.; Geothermal Carbon Dioxide for Use in Greenhouses; GHC Bulletin, January 1997.
5. Anhuradha, S., Vijayagopal, V., Radha, P., & Ramanujam. (2007). Kinetic Studies and Anaerobic Co-digestion of Vegetation Market and Sewage Slugde. Clean-Soil, Air, Water, Vol. 35 pp 197-199.
6. Pellerin, R. L. (1987). Operation and Performance of Biogas-Fueled Cogeneration Systems. Energy in Agriculture,Vol. 6, , 295-310.
7. Osorio, F. & Torres, J.C. (2009). Biogas Purification from Anaerobic Digestion in a Wastewater Treatment Plant for Biofuel Production. Renewable Energy,, 34, 2164-2171.

8. Wheeler, P. J.-N. (2000). Biogas Upgrading and Utilisation. IEA Bioenergy Task 24. International Energy Association. Paris, France.
9. McCarthy, T. M. (1998). Nutzung von Biogas: Probleme und Lösungen für Spurenbestandteile gwf Wasser - - Abwasser 139 . No. 4, p. 204 - 207.
10. Schomaker AHHM, B. A. (2000 August). Anaerobic Digestion of Agro-Industrial Wastes: Information Netwroks- Technical Summary on Gas Treatment. Nijmegen, Nederland: AD-NETT: report no: fair-ct 96-2083 (dg12-ssmi)31.
11. Kim, S., H. T. Kim, et al. (2004). "Optimization of CO2 absorption process with MEA solution." Carbon Dioxide Utilization for Global Sustainability 153: 429-434.