

# Natural Gas Sweetening by Membrane Separation

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### Abstract

The traditional approach, for sour gas processing, is to utilize solvent systems for natural gas cleanup and Claus technology for conversion of  $\text{H}_2\text{S}$  to elemental sulfur. However, this technology is difficult to operate and could be uneconomical when used on lower amount of highly sour acid gases in remote locations. Moreover, the production of sulfur is a nuisance as currently there are insufficient market resources to absorb large volumes of elemental sulfur, which is brought into the market from natural gas treating applications. Hence with the existing sour gas production areas producing large amounts of sulfur, a new technology that can envisage a more sustainable future is needed.

In the past, membranes could only be used for coremoval of  $\text{H}_2\text{S}$  and  $\text{CO}_2$  when the acid gas sulfur level is low. But some wellhead sources of natural gas may contain acid gas sulfur level as high as 80%. Upon combination with water, these gas streams are highly corrosive and can rapidly destroy pipelines and equipments unless they are partially removed. Hence, exotic and expensive materials are required for the construction of pipeline and downstream facilities. Before entering the distribution pipelines, natural gas needs to be purified from acid gasses,  $\text{CO}_2$  and  $\text{H}_2\text{S}$ , to prevent pipeline corrosion. Apart from being corrosive,  $\text{H}_2\text{S}$  is also highly toxic, hence only small traces of  $\text{H}_2\text{S}$  are allowed to be present (<4ppm). For  $\text{CO}_2$ , the pipeline specification is often set at 2% or 3%, with an additional reduction required (<50 ppm) if the gas is turned into liquefied natural gas (LNG).

Some companies have developed polymeric membranes, which can be used for bulk  $\text{H}_2\text{S}$  removal from natural gas carrying very high concentration of  $\text{H}_2\text{S}$ , at high operating pressures. This approach allows more sustainable development of new sour gas fields or retrofitting of existing applications. The membrane system can be used to either treat the gas to meet pipeline specifications or make a bulk cut of acid gases, and then final pipeline specifications can be met using the traditional amine processes or other traditional follow-on operations. Ideally, the permeate gas from the membrane system is reinjected rather than being converted to elemental sulfur. The advantages of membrane systems over conventional processes are site specific, but may include lower capital and energy costs, reduced space requirements, faster delivery time, and lower installation costs owing to smaller, lighter modular design; lower operating costs and limited manpower requirements owing to simplified operation and maintenance; increased adaptability to changing feed flow and composition; elimination of dehydration equipment; potential elimination of costly sulfur recovery units; faster, easier start-up and shutdown. In general, significant reductions in capital and operating costs can be achieved over traditional acid gas removal processes and this report compares the process designs and economics using membrane technology for a wide range of acid gas removal operations.

This report addresses treatment of natural gas in a remote location using membrane technology and utilizing PEBAX® material as membrane, and a process scheme which limits methane loss. Analysis is carried out for two flow rates 2 MMscf/d and 35 MMscf, containing varying amounts of  $\text{CO}_2$  (2% to 7%) and  $\text{H}_2\text{S}$  (1% to 6%), using PEBAX® 4011 material for membranes and treating gas to pipeline specification. A material balance table, a sized equipment list, and process flow diagrams are also

included in the report. Simulation was carried out using PROMAX® version 4. An Excel based tool, iPEP Navigator®, is also provided for easy economic analysis in different regions of the world.

The technological and economical assessment of the process is PEP's independent interpretation of a potential commercial process based on the information presented in open literature, such as patents or technical articles and it may not reflect in whole or in part the actual plant configuration. IHS Markit believes that they are sufficiently representative of the process and process economics within the range of accuracy necessary for economical evaluation of the conceptual process design.

# Contents

<b>1</b>	<b>Introduction</b>	<b>6</b>
	Background	6
	Membrane systems for acid gas removal	6
<b>2</b>	<b>Summary</b>	<b>10</b>
<b>3</b>	<b>Industry status</b>	<b>14</b>
	Natural gas reserves	14
	Global consumption	14
	Imports	16
	Historical pricing	17
	Treatment of natural gas	18
<b>4</b>	<b>Technology review</b>	<b>22</b>
	Background	22
	Membrane morphology	26
	Gas separation membrane properties	27
	Commercial membranes	28
	New membranes for natural gas treating	29
	DOE Study [2020-04-13]	29
	Engineering membrane modules	30
	Membrane modular structure	30
	Stage configuration	32
	Sealing of defects in membranes	33
	Natural gas treatment requirements	33
	Other potential solutions	38
	SmartSulf®	40
	Iron sponge process	41
	SulfaTreat™ (Iron Oxide) Scavenger process	41
	Carbon dioxide removal	43
	Dehydration	45
	Nitrogen removal	46
	Helium removal	46
	Sulfur removal	46
	Scavengers	47
	Solid scavengers	47
	Liquid scavengers	47
	Liquid redox process—LO-CAT®	48
<b>5</b>	<b>Natural gas treatment high flow</b>	<b>53</b>
	Introduction	53
	Process description	54
	Process discussion	62
	Material of construction	63
	Carbon and water footprint	63
	Waste stream summary	63
	Cost estimate	63
	Capital cost	64
	Production cost	64
	Conclusion	73
<b>6</b>	<b>Natural gas treatment low flow</b>	<b>75</b>
	Introduction	75
	Process description	76

Process discussion	79
Material of construction	80
Carbon and water footprint	80
Waste stream summary	81
Cost estimate	81
Capital cost	81
Production cost	82
Conclusion	85

## Tables

Table 2.1 Typical US national pipeline specification for natural gas	10
Table 2.2 Summary of all cases	12
Table 4.1 Major applications and manufacturers of membrane systems	25
Table 4.2 Commercial membranes for natural gas treating	28
Table 4.3 Hollow fiber module development	32
Table 4.4 Short list of reservoirs with high H <sub>2</sub> S content	34
Table 4.5 US national pipeline specification for natural gas	35
Table 4.6 Technologies for contaminant removal in natural gas	36
Table 4.7 Liquid H <sub>2</sub> S scavengers	48
Table 4.8 Sulfur removal technology selection table	51
Table 5.1 Design basis—35 MMscf/d	54
Table 5.2 Stream balance lbs/h (high sulfur low CO <sub>2</sub> —Case 1)	55
Table 5.3 Stream balance lbs/h (high sulfur low CO <sub>2</sub> —Case 2)	55
Table 5.4 Stream balance lbs/h (medium sulfur high CO <sub>2</sub> —Case 3)	56
Table 5.5 Stream balance lbs/h (high sulfur high CO <sub>2</sub> —Case 4)	56
Table 5.6 Equipment list Case 1	57
Table 5.7 Equipment list Case 2	58
Table 5.8 Equipment list Case 3	59
Table 5.9 Equipment list Case 4	60
Table 5.10 Utility summary Case 1	61
Table 5.11 Utility summary Case 2	61
Table 5.12 Utility summary Case 3	61
Table 5.13 Utility summary Case 4	62
Table 5.14 Optimizing Secondary Membrane area for Case 4	63
Table 5.15 Carbon footprint all cases	63
Table 5.16 Waste stream summary all cases	63
Table 5.17 Capital cost (Case 1)	65
Table 5.18 Capital cost (Case 2)	66
Table 5.19 Capital cost (Case 3)	67
Table 5.20 Capital cost (Case 4)	68
Table 5.21 Production cost (Case 1)	68
Table 5.22 Production cost (Case 2)	69
Table 5.23 Production cost (Case 3)	69
Table 5.24 Production cost (Case 4)	69
Table 5.25 Production cost continued (Case 1)	70
Table 5.26 Production cost continued (Case 2)	71
Table 5.27 Production cost continued (Case 3)	72
Table 5.28 Production cost continued (Case 4)	73
Table 5.29 Summary of all cases	74
Table 6.1 Design basis—2 MMscf/d	76
Table 6.2 Stream balance lbs/h (low sulfur low CO <sub>2</sub> —Case 5)	77
Table 6.3 Stream balance lbs/h (low sulfur low CO <sub>2</sub> —Case 6)	77

Table 6.4 Equipment list Case 5	78
Table 6.5 Equipment list Case 6	79
Table 6.6 Utility summary Case 5	79
Table 6.7 Utility summary Case 6	79
Table 6.8 Carbon footprint	80
Table 6.9 Waste stream summary	81
Table 6.10 Capital cost (Case 5)	82
Table 6.11 Capital cost (Case 6)	83
Table 6.12 Production cost (Case 5)	83
Table 6.13 Production cost (Case 6)	84
Table 6.14 Production cost continued (Case 5)	84
Table 6.15 Production cost continued (Case 6)	85
Table 6.16 Summary of Cases 5 and 6	86

## Figures

Figure 2.1 Two stage configuration for membrane separation	11
Figure 3.1 World production of natural gas	16
Figure 3.2 World consumption of natural gas	17
Figure 3.3 Natural gas prices, \$/MMBtu	17
Figure 3.4 Application envelopes for absorption and membrane processes to treat sour gas	19
Figure 4.1 Typical membrane separation	23
Figure 4.2 Sorption model for non-porous polymer membrane	24
Figure 4.3 Membrane Separation for gases	25
Figure 4.4 Membrane morphologies	26
Figure 4.5 Permeability vs selectivity	28
Figure 4.6 Cellulose acetate polymer structure	29
Figure 4.7 PEBAX® polymer structure	29
Figure 4.8 Hollow fiber membrane development	31
Figure 4.9 Spiral wound module construction	32
Figure 4.10 Two stage configuration for membrane separation	33
Figure 4.11 Schematic for typical processing of natural gas	37
Figure 4.12 Process flow schematic for the amine-Claus process for large land-based gas fields	39
Figure 4.13 SmartSulf® process scheme	41
Figure 4.14 Schematic diagram of the membrane/SulfaTreat® hybrid process	42
Figure 4.15 Choice of carbon dioxide removal technology	44
Figure 4.16 Two stage membrane system	45
Figure 4.17 FPSO liquid redox process block flow diagram	49
Figure 4.18 FPSO liquid redox sulfur removal system process flow schematic	50

## Appendix C Figures

Figure C1 Process flow scheme Cases 1 to 4	96
Figure C2 Process flow scheme Case 5	97
Figure C3 Process flow scheme Case 6	98

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