AN ECONOMICAL/ENVIRONMENTAL PROPOSED SOLUTION FOR REUSING THE FLARE ASSOCIATED GASES IN RAS-GHARIB OIL FIELDS

By

Mostafa Mohamed Samy Mostafa

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Chemical Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Key Words:
Flared associated gas, sweetening process, Valuable products.

Summary:
The General Petroleum Company produces about 40,000 barrels of crude oil daily from Ras-Gharib concession, with this quantity of crude oil there are 22 MMSCFD of associated gases. A part of this gas flow, which is approximately 7MMSFCD, is injected directly to injection wells to maintain the reservoir pressure. The rest, i.e. 15 MMSCFD of these associated gases, is transmitted directly to the flare from El-Hamd, Gharib and Fanar fields. The current research work proposes a solution to reuse the raw associated gases produced in Ras-Gharib into a valuable material and consequently addressing the above environmental/societal implications. This study performs economic and environmental evaluations accounting for the profitability, revenues and economics of treating these raw associated gases in a sweetening unit to produce sweet gas and hydrogen sulfide that minimize carbon monoxide and carbon dioxide emissions.

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ABBREVIATION

LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MMSCFD	Million standard cubic feet per day
BBL	Barrel
GPC	The general petroleum company
COS	Carbonyl sulfide
MF	Mole fraction
PPM	Part per million
GPM	gram per minute
MM	milli-meter
CAPEX	Capital expenditure
OPEX	Operating costs
RBLR Q	Reboiler heat duty
COND Q	Condenser heat duty
USA	The united states of America
US $	United states dollar
ºR	Radian
MEA	Mono-ethanol amine
DEA	Di-ethanol amine
MDEA	Methyl di-ethanol amine
XEA	Amine solution

ABSTRACT

The General Petroleum Company "GPC" is an Egyptian company in the field of oil and gas production that owns a Petroleum Concession in Ras-Gharib City in the Eastern Desert in Egypt. GPC produces about 40,000 barrels of crude oil daily from Ras-Gharib concession, with this quantity of crude oil there are 22 MMSCFD of associated gases. A part of this gas flow, which is approximately 7MMSFCD, is injected directly to injection wells to maintain the reservoir pressure. The rest, i.e. 15 MMSCFD of these associated gases, is transmitted directly to the flare from El-Hamd, Gharib and Fanar fields.

In addition to being a waste of valuable materials, the transmitted associated gases to flares impose huge environmental problems to Ras-Gharib city as this stream of gases contains acid gas content exceeding 13 mol % (10.45% H_2S and 3.24 % CO_2). Further, there are some societal implications in the region due to the flaring, such as Nausea and vomiting, Kidney failure, Sterility, Lung Cancer, and Blindness. Also, carbon monoxide and carbon dioxide gases are emitted to the atmosphere with additional environmental impact.

The current research work proposes a solution to reuse the raw associated gases produced in Ras-Gharib into a valuable material and consequently addressing the above environmental/societal implications. This study performs economic and environmental evaluations accounting for the profitability, revenues and economics of treating these raw associated gases in a sweetening unit to produce sweet gas and hydrogen sulfide that minimize carbon monoxide and carbon dioxide emissions. Furthermore, H_2S can be processed to produce free sulfur to minimize pollution totally. The designed treatment process conforms to the international H_2S contents in the sweet natural gas as 4 ppm in the sales gas. The research study includes several tasks, such as selecting the optimum sweetening process (amine solutions), minimizing the hydrogen sulfide content, and optimizing the operating conditions. A potential economical added value of the proposed solution implies that the sweet gas produced can be pumped directly into the Egyptian National Network for Gas. Furthermore, Liquefied Petroleum Gas can be obtained from this sweet gas, while elemental sulfur can be obtained in a sulfur recovery unit.

The proposed processing unit provides sales gas into the local Egyptian network of capacity of 10 MMSCFD, equivalent to some 2000 barrels/day of petroleum crude oil. The economics of the treatment unit results in an annual net profit of 2.3 million Dollars. The capital costs of the proposed project are estimated as 10 million Dollars, including the initial costs of the amine solutions. The rate of return for the project in the first year is 100 % with a payback time of one year.

CHAPTER 1: INTRODUCTION

Natural gas is a combustible mixture of hydrocarbon gases and other impurities. The natural gas industry was started in the beginning of the twentieth century in the United States. This industry produces high quality fuel as it considered one of the cleanest fuel sources all over the world. Besides that, many valuable petroleum chemicals produced from this industry. Raw natural gas is found in deep reservoirs underground. This raw natural gas occurs either in association with crude oil as it named associated gas or dry gas without crude oil which named non-associated gases. Although, this dry gas may contain large amount of natural gas liquids (NGL) components.

The General Petroleum Company "GPC" is an Egyptian company in the field of oil and gas production that has three concessions. Ras-Gharib concession one of these. It consists of 20 petroleum fields. In this concession, about 40,000 barrels of crude oil are produced daily. With this quantity of crude oil, there are 22 MMSCFD "million standard cubic feet per day" of associated gases produced. 7 MMSFCD are injected directly to injection wells to maintain the reservoir pressure. but the reminder which is 15 MMSCF daily are transmitted directly to the flare without any benefit but also with huge environmental pollution as this stream of gases it's acid gas content exceeds 13 mol %. These flared gas streams are produced from three fields (Gharib, Al-Hamd and Fanar).

These associated gases are produced in a city occupied with huge number of people as its population numbered 100,000. There are some societal implications in the region due to the flaring, such as Nausea and vomiting, Kidney failure, Sterility, Lung Cancer, and Blindness. Also, carbon monoxide and carbon dioxide gases are emitted to the atmosphere with additional environmental impact. Beside the huge environmental impact there is an economic impact for flaring these raw gas streams without any benefit. These flared gas streams can be treated to produce many valuable products such as: liquefied natural gas (LNG), liquefied petroleum gas (LPG), condensate, pure sulfur and sweet sales gas which can be either pumped to the Egyptian National Network for Gas or injected directly to injection wells to maintain the reservoir pressure as the rest. Minimizing Environmental pollution and harmful emissions saves a huge amount of money that spent to cure the caused clinical diseases in addition to the removal of the H2S.

The current research work proposes a solution to reuse the raw associated gases produced in Ras-Gharib into a valuable material and consequently addressing the above environmental/societal implications using simulating program in order to find the optimum conditions and process. This study performs economic and environmental evaluations accounting for the profitability, revenues and economics of treating these raw associated gases in a sweetening unit to produce sweet gas and hydrogen sulfide that minimize carbon monoxide and carbon dioxide emissions. Furthermore, H_2S can be processed to produce free sulfur to minimize pollution totally. The designed

treatment process conforms to the international H_2S contents in the sweet natural gas as 4 ppm in the sales gas.

The proposed processing unit provides sales gas into the local Egyptian network of capacity instead of flare these gases. This sales gas can be further processed to produce many valuable products. Condensate, Liquefied petroleum gas, butane and propane can be produced to add an economic value to the project. This project will minimize the harmful gas emissions hence, minimize clinical diseases caused in presence of harmful gas emissions. Besides that, hydrogen sulfide produced in the sweetening unit used that can be further processed in sulfur recovery unit to produce pure sulfur. This pure sulfur can be sold directly as it used in many industries as fertilizers.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

Natural gas is defined as a composition of light hydrocarbons with a low content of heavy hydrocarbons. When the natural gas only contains these compounds it will be defined as a dry gas as it found in deep underground without crude oil or as a gas cap over crude oil. When the natural gas is found with crude oil it called associated gas. Raw natural gas stream must be processed before it can be transmitted into long-distance pipeline systems for consumers. The target of gas processing is to extract natural gas, condensate, acid gases, and water from the raw natural gas stream and condition each fluid of these for sale or disposal. The typical process operation units are summarized in figure2.1. Each unit consists of a specific group of equipment performing a specific function together. All these units will not necessarily to be in every gas plant.

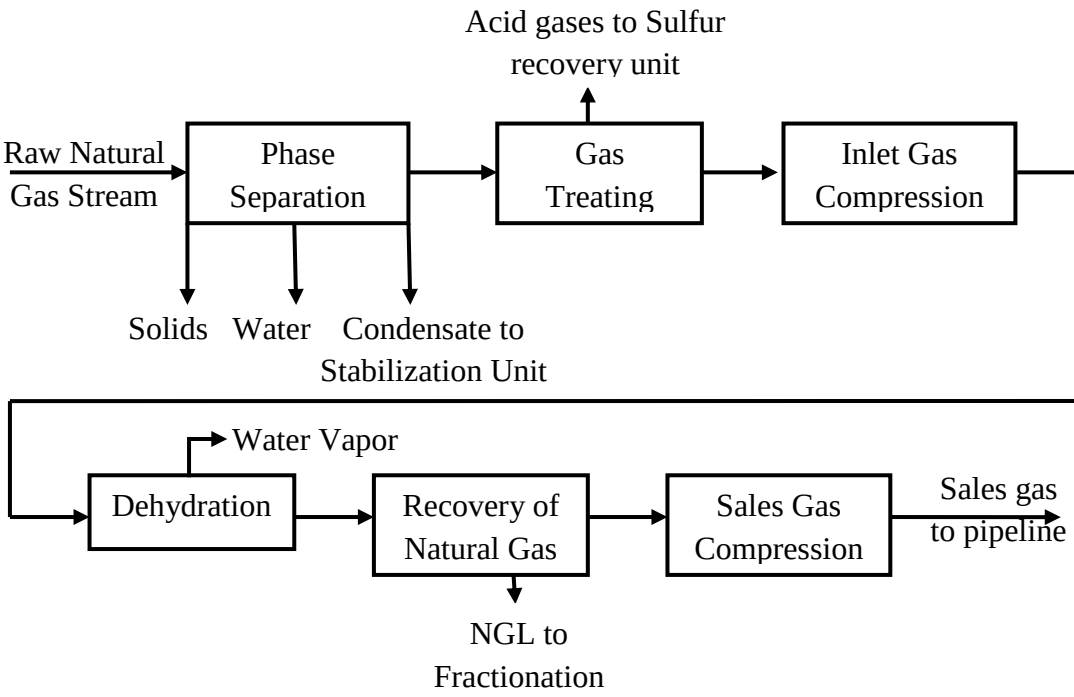

Fig 2.1: Typical process operation units in a gas plant [1]

The first unit is the phase separation of the different phases, which are gas, liquid hydrocarbons, liquid water, and/or solids. Phase separation of the production stream is mostly done in a slug catcher then in an inlet separator. The slug catcher is designed to separate gas, hydrocarbon condensate, and inlet water. Then the gas stream is sent to the inlet separator. Hydrocarbon condensate recovered from natural gas and may be shipped without further processing. Hydrocarbon condensate produced from the inlet