CHEMICAL ENGINEERING TRANSACTIONS, Volume 12, 2007
Edited by Jiri Klemeš
 ISBN 88-901915-4-6

SOx Emission & Pollution Control At Mellitah Gas Plant

M. Hasan[1], A. Gembri[2], A. Shibani Azzawiya[3], M. Abukshim[4]
[1]Western Libya Gas Project-Eni Gas B. V. Libyan branch,
P.O. Box 31004, Azzawyia Libya, MHasan@EnigasLy.com
[2]Eni Gas B. V., GEMBO375@hotmail.com
[3]Oil refining Co., asashib2001@yahoo.com
[4]Seventh of April University, PROF_MBA@yahoo.com

Due to the increase of energy consumption, natural gas energy is becoming one of the most important sources to fulfil the world energy demand. But normally the available raw natural gas is mixed with some heavy components such as C_3^+ and/or some impurities such as CO_2, N_2 & sulphur compounds (H_2S & RSH).

The raw gas should be treated in order to meet the international specifications and eliminate or at least minimize the emission of toxic and/or pollutant gases to the surrounding area. Mellitah plant applies the latest technology in order to meet the international emission standards.

In this paper we will present the different process at Mellitah site in which we produce a clean natural gas for export and recover 99.8% wt. of associated sulphur compound with the raw gas and/or acid gas. The recovered sulphur is produced in liquid phase then dried for storage in solid phase. The solid sulphur is exported to international market.

The emission control at Mellitah plant is optimized and controlled as per latest available technology. The fuel gas utilized for all the process is completely clean gas; flue gas contains always less than 10 ppm of H_2S.

As a consequence the burned gas produced mainly CO_2 & H_2O with a trace amount of SOx. If SOx emission at Mellitah is compared with any other industrial complex in Libya or any similar plant any elsewhere utilizing fuel oil and/or diesel oil then the Mellitah emissions will be the lowest.

1. Introduction

Western Libya gas project comprises three locations: Wafa field, Baher Elsalam field and Mellitah plant. Mellitah plant, which is the focus of our investigation from the emission point view, consists of the facilities for crude oil stabilization produced from Wafa desert, condensate stabilization and the main plant treating the raw gas produced from Baher Elsalam in the gas plant and sulphur recovery units.

Normally Wafa desert raw gas contains no H_2S and it is subjected to physical separation in order to control the gas composition and obtain CO_2 content within the required specification. Then the produced gas is compressed and sent to Mellitah site (to Green Stream for compression and export to Italy through sub sea pipe line).

Since the raw gas from Baher Elsalam field is containing considerable amount of H_2S hence it is subjected to normal treatment in order to obtain a clean gas completely similar to the gas produced from the gas plant at Wafa Desert and exported together through export line.

The other products from gas plant are LPG which sent to Wafa coastal plant (LPG splitter) for further separation process and the Acid gas which contain mainly CO_2 and H_2S is sent to sulphur recovery units in which these units recover the associated sulphur element up to 99.8%wt.

The recovered sulphur is solidified in past elating unit and exported as a solid phase.

2. Description of typical gas treatment and sulphur recovery plant

The worldwide pressure to reduce emissions in general led the Libyan authorities to use a suitable treatment for raw from Baher Elsalam platform.

It is subjected to complete treatment in which all the containments such as CO_2, H_2S etc (acid gas) are separated at the first stage of the process by absorption utilizing MDEA as a solvent and sent to SRU trains. The clean gas (sweet gas) is physically separated into:

- Sales gas (dry gas) which is subjected to dehydration process in order to control HC dew point specification and then sent to export gas header.
- Heavy hydrocarbons (C_3^+) sent first to de-ethanizer in order to separate at the top ethane and lighter products and then the gas is sent to fuel gas system. The bottom product is sent to De-butanizer in order to separate at the bottom C_5^+ as condensate which is sent to condensate stabilization plant and the top product from Debutanizer is mainly LPG and sent to LPG splitter at Wafa Coastal plant.

The acid gas produced from gas plant is sent to SRU plant which includes:

- Low pressure absorber to separate CO_2 from the acid gas in order to reduce the hydraulic load on upstream Claus process and maximize H_2S concentration of the main feed to thermal reactor as Amine Acid Gas.

- Claus process which contains thermal reactor and catalytic converters at SRU plant. In this process the recovery is reached to 97.5 %.

- Tail Gas Treatment unit in which the waste gas from Claus process is sent to TGT in order to increase the over all sulphur recovery up to 99.8% and reduces the emission to minimum and acceptable level environmentally.

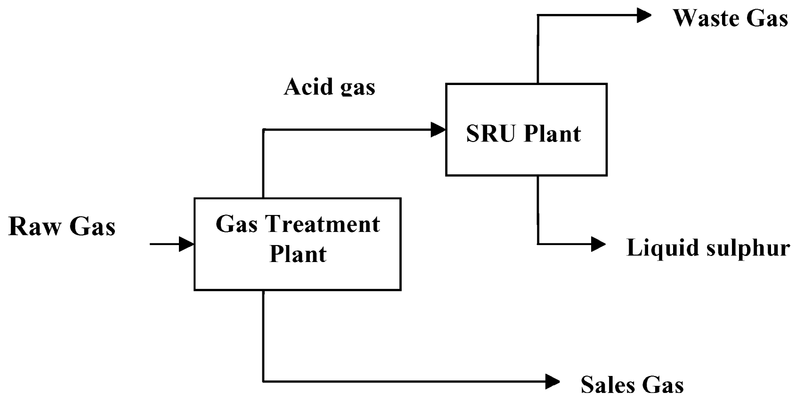

Fig. 1 Mellitah plant block Diagram

3. Description of overall material balance

Raw gas processed (on the average) at Mellitah gas plant is **906,000** Sm^3/h producing **579,000** Sm^3/h of Sales gas (export gas or clean gas) and **126,972** Sm^3/h of acid gas which is charged to sulphur recovery plant.

Table 1. Main components in Raw, Sales and Acid Gas from Mellitah plants

	CO_2 mole%	N_2 mole %	H_2S mole %	C_1^+ mole %
Raw Gas	13.120	4.140	1.320	rest
Sales Gas	1.280	3.472	nil	rest
Acid Gas	83.310	7.380	8.970	rest

Material balance done on the main components which is has an effect on the emissions from Mellitah complex plants, such as CO_2, H_2S, N_2 and SO_X (Table 1).

Volumetric mass: - $\dfrac{4{,}170 kmol}{10^6 Sm^3}$ at stand red condition - 15 °C, 100 kPa (Campall, 1998)

$\therefore$ 1 K mol = 23.95 Sm^3

By simple analysis of the above mentioned components we could confirm that the following quantities exist in the raw gas

- Average flow rate of H_2S in the raw gas is 499.3 kmol/h equivalent to 15.978 t/h of sulphur element (Ariej and Lila 2007).

- The other major component present in the raw gas is CO_2 with average flow rate of 4,963.1 kmol/h equivalent to 218.34 t/h (Ariej and Lila 2007).

- Least pollutant component is N_2 with average flow rate in the raw gas is 37,828.81 kmol/h equivalents to 43.85 t/h (Ariej and Lila 2007).

In order to remove the above mentioned pollutants components, gas treatment plant was designed to produce sales gas (clean gas) and acid gas from the raw gas as specified in above table. Export gas still containing small amount of CO_2, N_2 and trace of H_2S as bellow:

- Small amount of CO_2 (17.84 t/h) is left with the sales gas and it is within the sales gas specifications and amount will be released at the consumer area (Ariej and Lila 2007).

- N_2 quantity of 30.81 t/h, which is in the free state, will be released also at the consumer area as free N_2 and still within the sales gas specifications (Ariej and Lila 2007).

- Normally no H_2S left within the export sales gas which leads to Zero emission of SO_X at the consumer area (Ariej and Lila 2007).

The bottleneck of the plant is the acid gas stream, which is treated carefully at the sulphur recovery plant in order to convert all the associated H_2S gas to liquid sulphur then to solid sulphur taking into consideration the over all recovery of 99.8 % applying the latest technology with zero H_2S and minimum SO_X emission to the surrounding area.

The unconverted H_2S which represent normally less than 0.2% is finally sent to thermal incinerator with waste gas in order to obtain complete combustion utilizing the produced energy for upstream production.

- Quantity of H_2S in the acid gas is 475.549 kmol/h equivalents to 15.217 t/h (Ariej and Lila 2007) of sulphur element and the recovered liquid sulphur is 15.187 t/h, in which the unconverted sulphur is only 0.0303 t/h which is sent to thermal incinerator for complete combustion hence zero H_2S emission is allowed in the surrounding area, the residual H_2S is subjected to complete combustion at the thermal incinerator and only SOx emission observed and it is much lower than the allowable limit (Ariej and Lila 2007).

- Quantity of N_2 which is coming with the acid gas is emitted to atmosphere. It is about 10.96 t/h through the thermal incinerator.

- Quantity of CO_2 in the acid gas is 4416.7 kmol/h, which is equivalent to 194.3 t/h (Ariej and Lila 2007) which is completely emitted to atmosphere from the incinerator stack. In addition to this quantity there is also CO_2 emission from the consumed fuel gas at Mellitah complex which is approximately equal to 144 t/h, taking into consideration that emission of such amount of CO_2 consuming a considerable amount of O_2 which is mean that total CO_2 emission at Mellitah site is equal to 338.3 t/h. Above mentioned quantity of CO_2 is emitted to atmosphere, it is to be mentioned that till now there is no proven method to eliminate and/or minimize CO_2 emission. This part of emission could be subjected to deep investigation in order to get red off CO_2 and produce the required fuel from Mellitah complex with out CO_2 production.

4. Conclusion

Mellitah complex is one of the advanced worldwide energy supply project. The existing emissions from this plant are generally within the standards of such advanced plants.

Mellitah plant is applying the latest technology to prevent the emission of H_2S and SOx. Regarding greenhouse CO_2 emission, research is being carried out for a new technology leading to satisfy energy requirements without CO_2 production.

5. Recommendations

Due to a considerable change in the climate, the world should adapt that emission control is responsibility of everyone.

1. Strong action and proper plan must be taken by all governments because it is a global warming problem and it will have impact on everyone.

2. Everyone in this world should think, optimize and reduce energy consumption as much as possible hence the reduction of emissions is associated with the energy production.

3. Reduction of CO_2 emissions by utilizing other sources of energy such as solar energy instead of fossil energy especially in the hot climate areas.

6. Future work

Due to global warming problem it is highly recommended to seriously study the possibility of the reduction and/or elimination of CO_2 emissions especially at big energy consumers. The cost analysis of CO_2 capture processes has been presented elsewhere (Klemeš at al, 2007).

The whole carbon foot print (CFP) based on the life cycle assessment should be considered to get correct and fair results on CO_2 generated by specific industrial processes (Bulatov at al, 2007).

By taking into consideration some new technologies such as **design methods for decarbonised energy production in process plants that produces the traditional liquid and/or gas fuels with out carbon dioxide** (Lou et al, 2006) in addition to the available and well known methods of CO_2 reduction such as planting more forests, trees and increasing the green areas in general will help in reducing CO2 emission.

7. References

Ariej M and M .Lila, 2007, Sulfur Production from Natural Gas, (BSc. Chem. Eng. project), 7th April University, Tripoli, Libya

Bulatov I., Klemeš J., Perry S., 2007, The Feasibility of Micro Renewable Energies in Reducing the Carbon Footprint of Energy Use in Buildings, #1738, CLIMA2007, Helsinki, Finland

Campbell, J.M., 1992, Gas Conditioning and Processing, Vol. 1, 7th ed., Campbell Petroleum Series, Norman, OK, US

Klemeš J., I. Bulatov and T. Cockerill, Techno-economic modelling and cost functions of CO_2 capture processes, Computers & Chemical Engineering, Volume 31, Issues 5-6,May 2007, Pages 445-455

Lou Yu., R. Smith and J. Sadhukhan, 2006, Decarbonisation in energy production, Process Integration Research Consortium, The University of Manchester, UK

8. Nomenclature

CFP	Carbon Foot Print
TGT	Tail Gas Treatment
SRU	Sulphur Recovery Unit
LPG	Liquefied Petroleum Gas
NGL	Natural Gas Liquefied
C_5^+	Liquid Hydrocarbon
C_3^+	HC compounds heaver than C_3H_8
MDEA	Methyl Diethyl Amine