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Environmental Impact Assessment for Sulfur Recovery Unit in Natural Gas Liquids Plant

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Abstract - In all environmental regulations and requirements, it is important to control the industrial emissions to avoid any adverse effects. One of these requirements is the Environmental Impact Assessment (EIA) studies. This study will provide an EIA for a typical Sulfur Recovery Unit (SRU). There are three main parts in this study, (i) A brief description for the history of the EIA, importance, requirements and procedures, (ii) A brief description for the sulfur recovery processes and (iii) EIA study for a typical Sulfur Recovery Unit.

Index Terms – Aspect, Continuous Emission Monitoring System (CEMS), Environmental Impact Assessment (EIA), Impact, Periodic Emission Monitoring System (PEMS), Screening, Scoping, Sulfur recovery Unit (SRU).

1. INTRODUCTION

EIA "Environmental Impact Assessment" is simply defined as a systematic process to predict, identify, and evaluate the environmental effects of proposed actions, new developments and projects before the development is allowed to go ahead. This process is applied prior to major decisions and commitments being made. Whenever necessary, social, cultural and health effects are considered as an integral part of EIA. Particular attention is given in EIA practice to prevent, control and mitigate the significant adverse effects of proposed undertakings [2].

The purpose of EIA is to, provide information for decision-making on the environmental consequences of proposed actions and promote environmentally sound and sustainable development through the identification of appropriate enhancement and mitigation measures. Figure-1 describes the process of the EIA.

The immediate objectives of EIA are to improve the environmental design of the proposal, ensure that resources are used appropriately and efficiently, identify appropriate measures for mitigating the potential impacts of the proposal, and facilitate informed decision-making, including setting the environmental terms and conditions for implementing the proposal.

The long term objectives of EIA are to protect human health and safety, avoid irreversible changes and serious damage to the environment, safeguard valued resources, natural areas and ecosystem components, and enhance the social aspects of the proposal.

The study will also result in the following benefits:

1. Detailed aspects and impacts of the project and relevant activities.
2. Detailed management plan for the different aspects and impacts of the project.
3. Detailed monitoring plan for the different wastes and emissions from the project.
4. Proposals for the Best Available Techniques (BAT) that could be implemented for more improvement and enhanced controls.
5. Reducing financial liabilities resulting from violation of the legal requirements and acceptable limits.
6. Reducing financial liabilities resulting from pollution remediation.
7. Improve relationships with insurance companies by obtaining best possible rates and coverage.
8. Eliminate and reduce the public complaints.
9. Reduction of the pollution.
10. Reduction of waste disposal.
11. Compliance with the requirements of international markets.
12. Demonstrates to customers that the organization is meeting environmental expectations.
13. Satisfying investors and shareholders criteria.
14. Provide a competitiveness advantages in the market.
15. Customer satisfaction.
16. Provide a benchmarking tool.
17. Enhancing company image.

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STRUCTURE OF THE EIA PROCESS

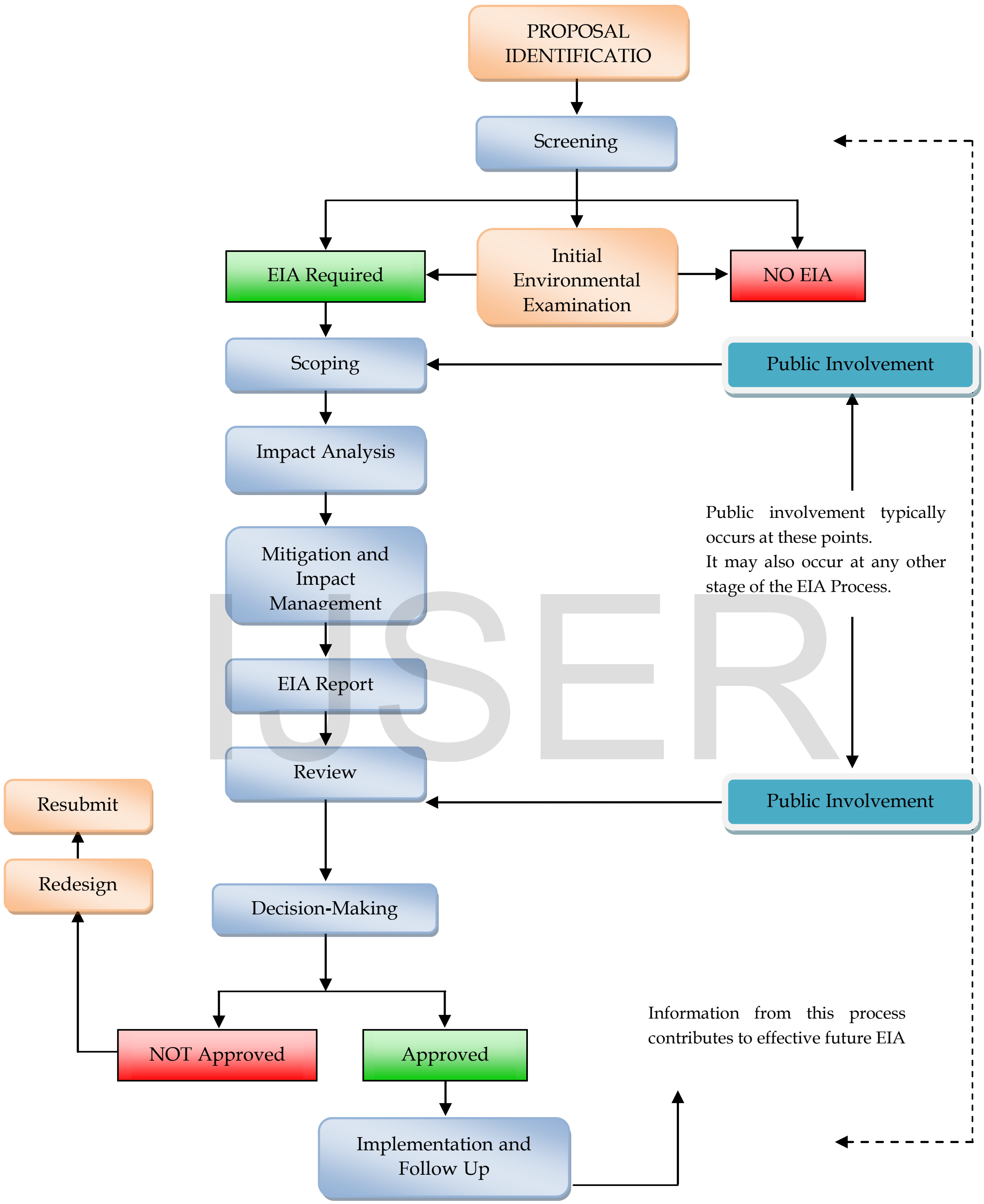

Fig. 1 - EIA Process Chart

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2. EIA PROCESS

2.1. SCREENING

Screening is the first stage of the EIA process. Screening is to identify the proposals that require an EIA and exclude those that do not. It is intended to ensure that the form or level of any EIA review is commensurate with the importance of the issues raised by a proposal.

a) PROJECT CLASSIFICATIONS

The World Bank undertakes environmental screening of each proposed project to determine the appropriate extent and type of Environmental Assessment (EA). The World Bank classifies the proposed project into one of four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts [1].

I. Category A

A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works.

For a Category A project, it will be required to prepare full EIA Report.

II. Category B

A proposed project is classified as Category-B if its potential adverse environmental impacts on human populations or environmentally important areas -including wetlands, forests, grasslands, and other natural habitats - are less adverse than those of Category-A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for Category-A projects.

The scope of EIA for a Category-B project may vary from project to project, but it is narrower than that of Category-A EIA.

III. Category C

A proposed project is classified as Category-C if it is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EIA action is required for a Category-C project.

b) OUTCOMES FROM THE SCREENING PROCESS

Usually, Screening has one of the following outcomes:

- **No further EIA requirement applies.**
- **A preliminary EIA study is required.**
- **A full or comprehensive EIA is required to complete the screening process.**

2.2. SCOPING

Scoping is a critical, early step in the preparation of an EIA. The scoping process identifies the issues that are likely to be of most importance during the EIA and eliminates those that are of little concern [2].

a) OBJECTIVES OF SCOPING

Key objectives of scoping can be summarized as follows:

- **Inform the public about the proposal.**
- **Identify the main stakeholders and their concerns and values.**
- **Define the reasonable and practical alternatives to the proposal.**
- **Focus the important issues and significant impacts to be addressed by an EIA.**
- **Define the boundaries of an EIA in time, space and subject matter.**
- **Set requirements for the collection of baseline and other information.**
- **Establish the Terms Of Reference for an EIA study.**

b) ENVIRONMENTAL BASELINE CHARACTERISTICS

Environmental Baseline Characteristics section is an essential part of the EIA study. It describes the existing features of the project area. Knowledge and understanding of the existing features of the project environment and the sensitivity of each part of the environment enables the organization, General Petroleum Authority and other legal authorities to measure the extent of changes to the baseline conditions caused by the project on one hand and to evaluate the significance of those changes on the other hand. It also constitutes an important part in the process of decision making for whether the project is approved to be undertaken in the designated area or not.

3. ASPECTS/IMPACT IDENTIFICATION AND RISK EVALUATION

Detailed ENVID worksheet is produced summarizing all likely effects on the environment (Air, water, soil …etc).

4. STUDY WORK

4.1. SCREENING AND SCOPING

The screening and scoping study for the project of Sulfur Recovery Unit in Natural Gas Liquids Plant results in the conclusion that the project is of Category-A as per the World Bank classification and needs a complete EIA study.

ENVIRONMENTAL BASELINE CHARACTERISTICS

The area consists mainly of extensive carbonate sediments principally of Pleistocene. The superficial deposits, typically ranging in depth from 6 m to 15 m, consist of sand dunes and marine sands.

The groundwater is hypersaline up to 8 times the concentration of seawater. Due to this hypersaline nature, the groundwater at the project area is unfit for using for potable, agricultural or industrial purposes. The marine flora and fauna species diversity in this area is low.

The area has an arid, almost humid, desert climate. The prevailing wind from the North-West sector for more than

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55 % of the year, light to moderate, followed by wind from SSW - SSE sector for around 20 % of the year. The wind speeds for all sectors tend to be low, and are below (8 knots) for over 65% (Fig. 2).

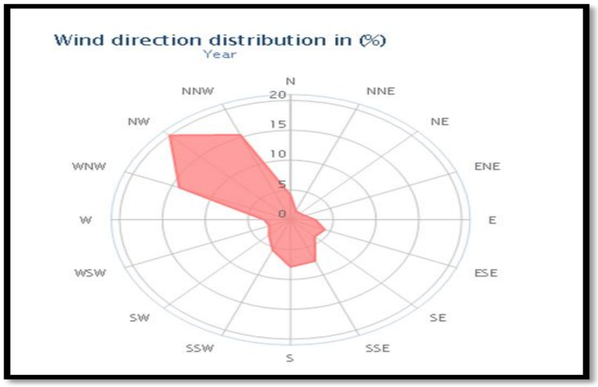

Fig. 2 - Wind Direction Destribution [3]

During summer period, average daytime temperatures can climb to ranges between 42°C - 46°C, but in extreme cases degrees up to 58 °C have been recorded. Temperatures can fall in winter night time to near freezing in rare cases but usually it does not go below 10°C (Fig. 3).

Rainfall in generally averaging around 10 mm per year, noting that some years have no rainfalls. Rarely, overflows are recorded (Fig. 4) [3, 4].

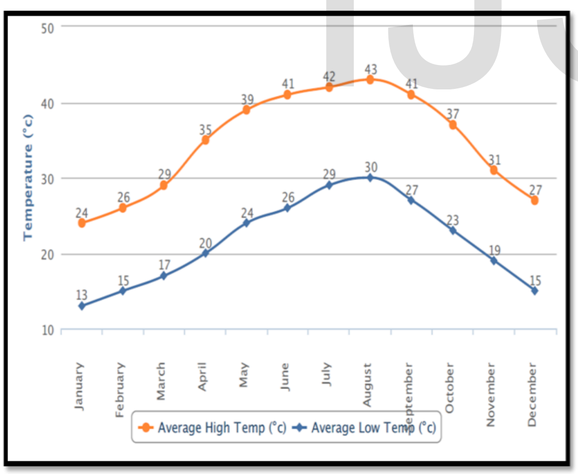

Fig. 3 - Average Temparaturs

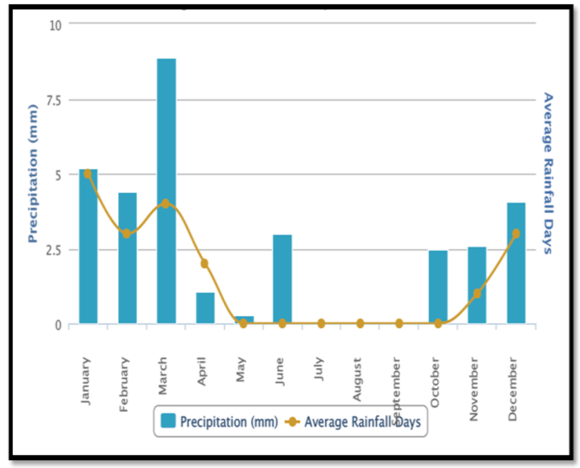

Fig. 4 - Rainfalls [3]

4.2. SULFUR RECOVERY PROCESS DESCRIPTION

a) ACID GAS ENRICHMENT (AGE) SECTION

The AGE amine treating unit is designed to remove H2S (and partially CO2) from acid gas stream from Ethane and Propane treating units.

The acid gas fed to the AGE unit is contacted counter-currently in the trayed AGE Absorber (C-01) against a cool, lean Amine. For all operating cases essentially all of the H2S and approximately 15% of the CO2 in the feed gas are absorbed into the solution; the remaining 85% of the CO2 is slipped by the solution and flows through to the top section of the absorber. The top section of the absorber is a 4-tray water wash section where the treated gas is water-washed to remove traces of amine solution which may have been entrained into the treated gas.The washed off gas then flows to the Thermal Oxidizer (EX-13) in the Tail Gas Treatment Unit (TGTU) where it is incinerated.

The rich Amine collects in the bottom of the AGE Absorber; it is joined there by a flow of rich Amine solution which comes from the TGTU Absorber (C-07) column bottoms. Both solutions are then pumped by the AGE Rich Amine Pump (P-10) through the Lean/ Rich Amine solution exchanger (EX-16) and onto the Amine Solution Regenerator (C-02).

The rich Amine solvent solution flows down the bottom trayed section of the Amine Solution Regenerator where H2S and CO2 are stripped from the solution by counter-current contacting with process steam generated in the Regenerator Reboiler (EX-11).

The regenerator overhead acid gas, which contains approximately 50% H2S and 50% CO2, flows to the Sulfur Recovery Unit (SRU) for conversion of the H2S to elemental sulfur.

The Hot Lean Amine Pump (P-20) pumps the stripped, hot lean Amine solution through the Lean/Rich Amine Solution Exchanger (EX-16), then through the Lean Amine Solution Cooler (EX-17), and on to the Lean Amine Solution Tank (TK-100).

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The Lean Amine Circulation Pump (P-30) takes suction from the solution tank and pumps the lean Amine solution back to the top of the AGE Absorber (C-01) [5,6].

b) Sulfur Recovery Section

Acid gas from the Amine solution regenerator overhead flows to the Sour Gas KO Drum (C-03) which separates out any amines/sour water which may have been entrained into the acid gas.

The acid gas (es) from the KO drum flows to the Acid Gas Preheater (EX-18) where it is heated prior to entering the Reaction Furnace Burner (EX-19); and then flows on to the combustion chamber section of the reaction furnace (EX-20) where the H2S in the acid gas is burnt to form SO2 and all other combustibles (minor amounts of hydrocarbons in the acid gas) are destroyed.

The process gas then undergoes two separate stages of catalytic conversion in order to achieve a design 94% conversion of the H2S to elemental sulfur per pass through the SRU.

Prior to each of the two stages of catalytic conversion, the process gases pass through a reheater, in order to heat the gas up to a proper temperature for initiating the Claus reaction in the catalyst bed which follows. The reheaters are electrically powered.

On leaving the second Claus reactor, the process gases enter the Final Sulfur Condenser where more liquid sulfur is condensed and removed.

The tail gas from the SRU final sulfur condenser flows to the Tail Gas Treatment Unit (TGTU) process.

c) Sulfur Degassing Section

This sulfur contains dissolved H2S in the range of 300 ppm(w). The H2S concentration must be reduced to 10 ppm(w), which will make the liquid sulfur safe for transport without the possibility of forming an explosive mixture of air and H2S above the sulfur during transportation.

d) Tail Gas Treatment Section

The process tail gas from the SRU flows to the Tail Gas Treatment Unit (TGTU). The TGTU is designed on the basis of receiving a feed based on a Claus SRU conversion of 94% and increases the overall recovery of the unit to >99.9%.

e) Thermal Oxidizer

The Thermal Oxidizer will be specified to handle the off-gases from the AGE absorber (C-01) and TGTU absorbers (C-07), the vent gas from the Sulfur Pit (TK-200).

The function of the Thermal Oxidizer is to convert by incineration any of the limited amounts of sulfur compounds in its feed gas to SO2 before discharging to the atmosphere through a stack (Fig. 5, 6).

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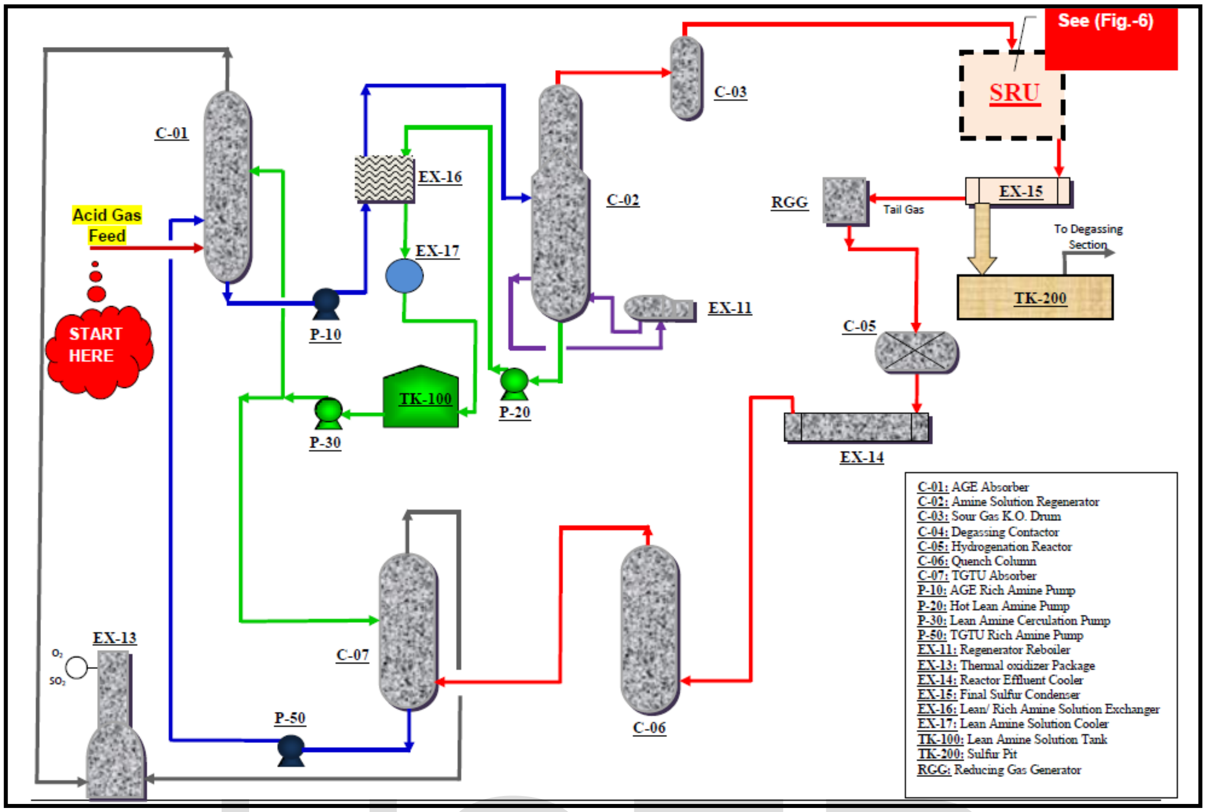

Fig. 5 - Typical Sulfur Recovery Process [7]

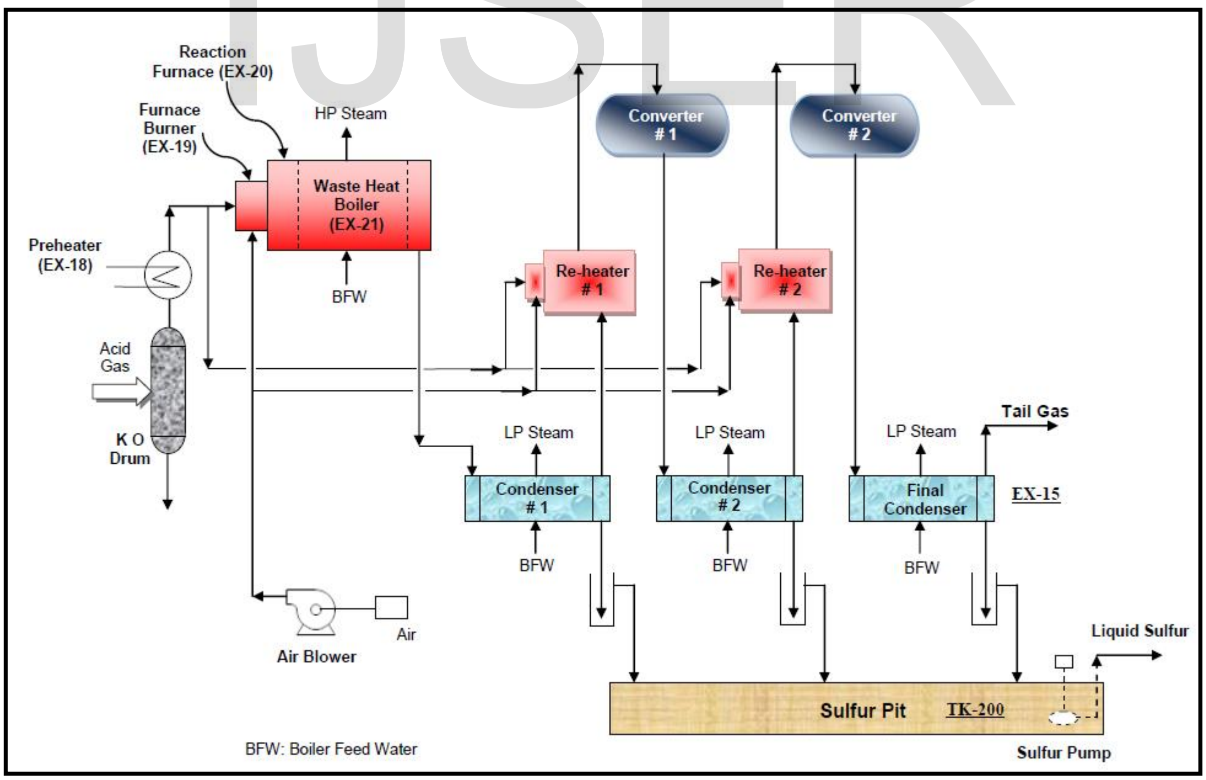

Fig. 6- Typical Claus Process [8,9]

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4.3. OVERALL SUMMARY OF ENVIRONMENTAL ASPECTS AND IMPACTS

The detailed study of the project and potential aspects and impacts with a detailed ENVID worksheet are summarized in (Table-1) for the main aspects and impacts which are ranked as medium and above. * P: (Planned activity), **A: (Accidental activity).

Table 1 - Environmental Aspects and Impacts

S.N.	Guideword	Aspect / Activity	Type of Impact	Impact / Consequences	Ranking
1.	Air Emissions (H_2S)	**Operation and maintenance of:** • AGE absorber, • Amine solution Regen. • Sour gas K.O. Drum. • Clause unit.	**A ** **	• Degradation of ambient air quality.	**Medium**
2.	Air Emissions (SO_2)	**Ignition of H_2S in abnormal cases.**	**A**	• Degradation of ambient air quality. • Acid rains.	**Medium Significant**
3.	Air Emissions (ODS - Halon 1211)	• Use of Halon fire extinguishers	**P**	• Ozone depletion. [10]	**Catastrophic Significant**
4.	Carbon oxides, NOx, HC's …etc	• Traffic, transportation, vehicles…etc.	**P**	• Degradation of ambient air quality. • Climate changes. • Ground ozone formation. • Acid rains.	**Critical Significant**
5.	Hazardous Solid Waste **"Activated Alumina"**	• Maintenance activities "Periodic replacement of spent catalyst in the clause reactors"	**P**	• Soil contamination. • Degradation of ambient air quality.	**Critical Significant**
6.	Hazardous Solid Waste **"Activated Titania"**	• Maintenance activities "Periodic replacement of spent catalyst in the clause reactors"	**P**	• Soil contamination. • Degradation of ambient air quality.	**Critical Significant**
7.	Hazardous Solid Waste **"Hydrogenation Catalyst"**	• Maintenance activities "Periodic replacement of spent catalyst in the Hydrogenation Reactor"	**P**	• Soil contamination. • Degradation of ambient air quality.	**Critical Significant**
8.	Hazardous liquid/ Solid Waste **"Sulfur"**	• Liquid sulfur loading to sulfur trucks. • Sulfur truck accident.	**A**	• Soil contamination.	**Medium Significant**
9.	Hazardous Solid Waste **"rags, containers and drums of used oils, chemicals and paints …etc."**	• Maintenance activities "Preventive maintenance, painting activities …etc."	**P**	• Soil contamination.	**Critical Significant**
10.	Trade effluent "Oily/ contaminated water"	• Drainage from closed drain amine unit. • Contaminated fire water during drills.	**P**	• Soil contamination. • Degradation of surface water quality. • Spoil of the sewage treatment works. [11]	**Critical Significant**
11.	Trade effluent "Oily/ contaminated water"	• Drainage from closed drain amine unit. • Contaminated fire water during real cases.	**A**	• Soil contamination. • Degradation of surface water quality. • Spoil of the sewage treatment works. [11]	**Critical Significant**

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4.4. DISPOSAL AND TREATMENT PROPOSALS

Table-2 identifies the main wastes and the typical disposal and/or treatment method used in the plant:

Table 2 - Waste Disposal and/or Treatment Methods

S.N.	WASTE	DISPOSAL/ TREATMENT METHOD
1.	**Hazardous Solid Wastes** "Activated alumina, activated titania, hydrogenation catalyst, solid sulfur, rags, insulation materials, chemical and oil drums…etc."	• Decontamination of equipments and drums and then disposal in the governorate hazardous waste disposal area. • Collection of hazardous wastes such as rags, activated alumina and titania …etc. in proper collection containers, labeled, properly sealed and stored separately.
2.	**Uncontaminated Solid Wastes** "Scrap metals, demolition wastes not containing asbestos, old equipment …etc."	• **Recycling of recyclable materials:** Transferred through certified carriers / transporters for further recycling for recyclable wastes. • **Land filling:** Burring of other wastes in special designated land filling areas.
3.	**Hazardous Liquid Wastes** "Oily contaminated water"	• **Oil water separator:** use of Oil water separator to separate oil from water and then send clean water to sewage treatment unit or road side water drainage.
4.	**Hazardous Liquid Wastes** "Liquid sulfur"	• Once the liquid sulfur exposed to air it cools down and solidify, then it is treated as hazardous solid wastes above.

4.5. ENVIRONMENTAL MONITORING PROGRAM

Hereafter (Table-3) is an overview of the environmental parameters required to be monitored during the operation phase of the unit i.e. Air Emissions, Water Quality, Solid Waste and Noise emissions.

Table 3 - Environmental Monitoring Program

Monitoring Component	Parameter	Monitoring Method	Location	Frequency
Stack Emission	SRU Incinerator (Exit gas velocity of flue gases)	CEMS	Stack tip.	Continuous
	Temperature monitoring	CEMS	Stack tip.	Continuous
Fugitive Emissions	HC and H2S	Gas analyzers. PEMS.	Locations have to be specified by operations.	Biweekly
Ambient Air Quality	SO2, NOX, O3 and total HC	CEMS	Sensitive areas outside the fence line.	Continuous
Noise Levels	Sound pressure level	Sound pressure level meter.	Sensitive locations outside the fence line.	Semi-annually

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Monitoring Component	Parameter	Monitoring Method	Location	Frequency
Hazardous Waste	Quantity of Hazardous waste generated and disposed at site.	Mass basis	Waste sources	
Trade effluent "Oily/ contaminated water"	Water quality	Trade effluent lab analysis	Water drainage points.	Biweekly

5. CONCLUSIONS

In the light of the study and its results, the following conclusions can be summarized:

1. The project is in compliance with local laws as well as with the international regulations to avoid any liabilities.
2. The proposed location for the project is suitable for the proposed operations and will not create significant environmental irreversible impacts due to less sensitivity of the environment and the less importance of the resources in that location (e.g. hyper-saline of ground water…etc.) as pre-described in the environmental baseline characteristics.
3. It is safe to implement the proposed project and operations in the described manners taking into considerations all the required control and mitigation measures.
4. With regard to the produced wastes, proper management plans have to be in place for proper disposal of the different types of solid and liquid wastes in safe manner depending on the types and quantities of wastes produced and described in the study as well as the controls mentioned in the monitoring plan.
5. With regard to the produced gas emissions, proper management and monitoring plans have to be in place for proper control of different types of gases and reduce of the gas emissions hazards before emitting to the atmosphere depending on the types and quantities of wastes produced and described in the study as well as the controls mentioned in the monitoring plan.
6. Last but not the least we have to say that the proposed project and its operations is not only with no significant impact on the environment, but this project is a necessity for the existing NGL plant especially when we realize that the plant was flaring all acid gases to the atmosphere depending on the less sensitivity of the local environment and the long distance between the plant and the nearest residential area.

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