Environmental issues:

Refiners on the other hand are faced with various environmental issues related to the changing specifications of refined products. In many locations, refinery configuration has changed substantially mainly due to the declining quality of crude oil supply and environmental regulations. Refiners are faced with huge investments to meet new stringent specifications for sulfur, aromatics, and olefins content. Gasoline sulfur reduction is centered around the FCC unit employing feed pretreatment or gasoline post-treatment. For diesel fuel, a sulfur content of less than 30 ppm or maybe 15 ppm is needed, as well as an increase in the cetane number and reduction in polyaromatics content. To fulfill all these requirements, refiners have either to revamp existing units or invest in new hydroprocessing and hydrogen production units. However, the need for more hydrogen may itself contribute to an increase of $CO2$ emissions which could stand at about 20% of total refineries emission by 2035 (14% in 2005), as natural gas steam reforming should be the dominant technology. In addition the upgrading of extra heavy crude will account for more than 15% of the refineries' emissions in 2035 (4% in 2005).

Most environmental concerns in waste gas are around the emissions of SO_x, NO_x, CO, hydrocarbons, and particulates. The oxides are present in flue gases from furnaces, boilers, and FCC regenerators. Tail gas treatment and selective catalytic reduction (SCR) units are being added to limit $SO2$ and NO_x emissions. Water pollutants include oil, phenol, sulfur, ammonia, chlorides, and heavy metals. New biological processes can be used to convert H_2S or SO_x from gaseous and aqueous streams. Spent catalysts and sludges are also of concern to refineries in reducing pollution.

Gas Treatment and Conditioning:

Natural gas is valuable both as a clean source of energy and as a chemical feedstock. Before reaching the customer, it has to go through several processing steps. These steps are necessary partly to be able to transport the gas over long distances and partly for the recovery of valuable components contained in the gas.

Natural gas associated with oil production or produced from gas fields generally contains undesirable components such as H2S, CO2, N2, and water vapor. In this chapter, natural gas conditioning is detailed. This includes the removal of undesirable components before the gas can be sold in the market. Specifically, the gas contents of H2S, CO2, and water vapor must be removed or reduced to acceptable concentrations. N2, on the other hand, may be removed if it is justifiable. Gas compression is usually needed after these treatment processes.

Sweetening of natural gas almost always precedes dehydration and other gas plant processes carried out for the separation of natural gas liquid (NGL). Dehydration is usually required before the gas can be sold for pipeline marketing and is a necessary step in the recovery of NGL from natural gas.

Gas processing is made up of two operations: NGL recovery, and

separation from the bulk of gas and its subsequent fractionation into desired products.

Overview of Gas Field Processing

In its broad scope, gas field processing (G.F.P.) includes dehydration, acidic gas removal (H_2S and CO_2), and the separation and fractionation of liquid hydrocarbons (NGL). Sweetening of natural gas almost always precedes dehydration and other gas plant processes carried out for the separation of NGL. Dehydration, on the other hand, is usually required before the gas can be sold for pipeline marketing, and it is a necessary step in the recovery of NGL from natural gas.

A system involving G.F.P. can be divided into two main stages:

1. Stage I, known as gas treatment.

2. Stage II, known as gas processing.

The gas treatment operations carried out in stage I involve the removal of gas contaminants (acidic gases), followed by the separation of water vapor (dehydration). Gas processing, stage II, comprises two operations: NGL recovery and separation from the bulk of gas and its subsequent fractionation into desired product.

Gas field processing in general is carried out for two main objectives:

1. The need to remove impurities from natural gas

2. The desirability of increasing liquid recovery above that obtained by conventional gas processing

Natural gas field processing and the removal of various components from it tend to involve the most complex and expensive processes. A sour gas leaving a gas-oil separation plant (GOSP) might require first the use of an amine unit (MEA) to remove the acidic gases, a glycol unit (TEG) to dehydrate it, and a gas compressor to compress it before it can be sold.

Effect of Impurities (Water Vapor, H_2S/CO_2) and Liquid Hydrocarbons Found in Natural Gas

The effect that each of these components has on the gas industry, as the end user, is briefly outlined:

1. Water vapor: This is a common impurity. It is not objectionable as such. If it condenses to liquid, it accelerates corrosion in the presence of H_2S gas. If it leads to the formation of solid hydrates (made up of water and hydrocarbons), it will plug valves and fittings in the pipe.

2. H_2S/CO_2: Both gases are harmful, especially H_2S, which is toxic if burned to give SO_2 and SO_3, which are nuisances to consumers. Both gases are corrosive in the presence of water. In addition, CO_2 contributes a lower heating value to the gas.
3. Liquid hydrocarbons: The presence of liquid hydrocarbons is undesirable in gas that is used as a fuel. The liquid form is objectionable for burners designed for gas fuels. In the case of pipelines, handling two-phase flow (gas and liquid) is undesirable.

Sour Gas Treating

Selection of Gas-Sweetening Process

The key parameters to be considered in the selection of a given sweetening process include the following:

1. Type of impurities to be removed (H_2S and mercaptans)

2. Inlet and outlet acid gas concentrations

3. Gas flow rate, temperature, and pressure

4. Feasibility of sulfur recovery

5. Acid gas selectivity required

6. Presence of heavy aromatic in the gas

7. Well location

8. Environmental consideration

9. Relative economics

Generic and specialty solvents are divided into three different categories to achieve sales gas specifications: 1. Chemical solvents

2. Physical solvents. 3. Physical-chemical (hybrid) solvents

The selection of the proper gas-sweetening process depends on the sulfur content in the feed and the desired product as illustrated in Figure 16.1. Several commercial processes are available, as shown in Figure.

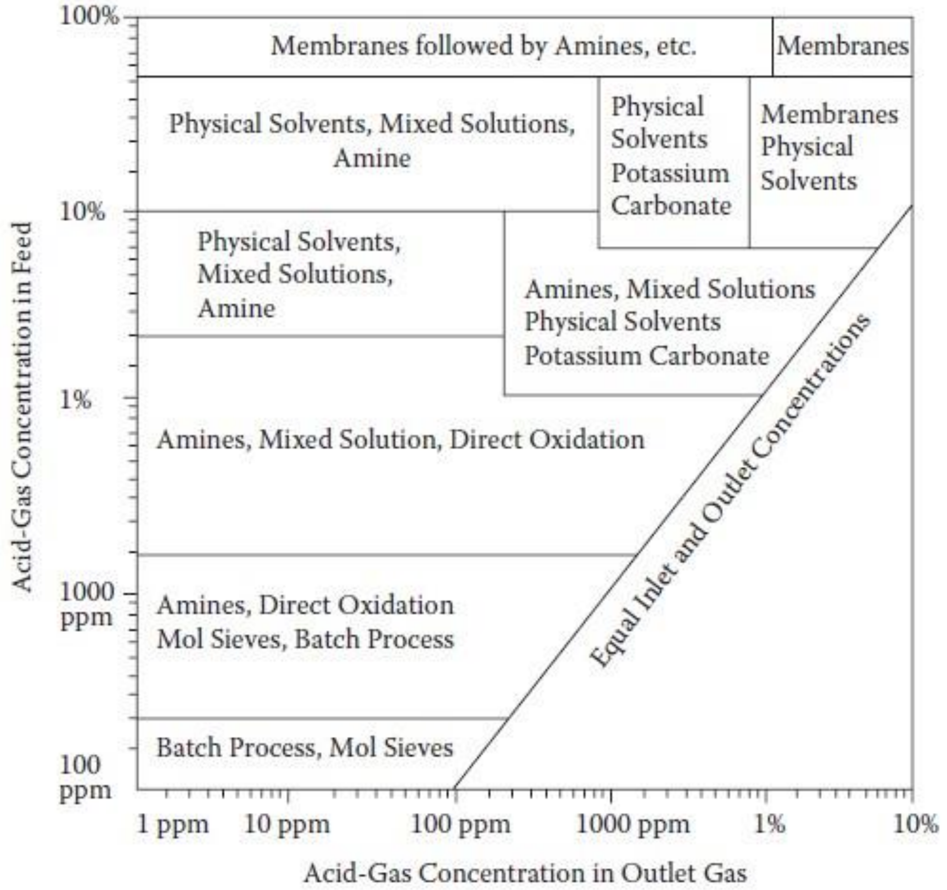

Fig 7 Selection of gas-sweetening processes

Amine Processes

Amine gas sweetening is a proven technology that removes H2S and CO2 from natural gas and liquid hydrocarbon streams through absorption and chemical reaction. Aqueous solutions of alkanolamines are the most widely used for sweetening natural gas. Each of the amines offers distinct

advantages to specific treating problems:

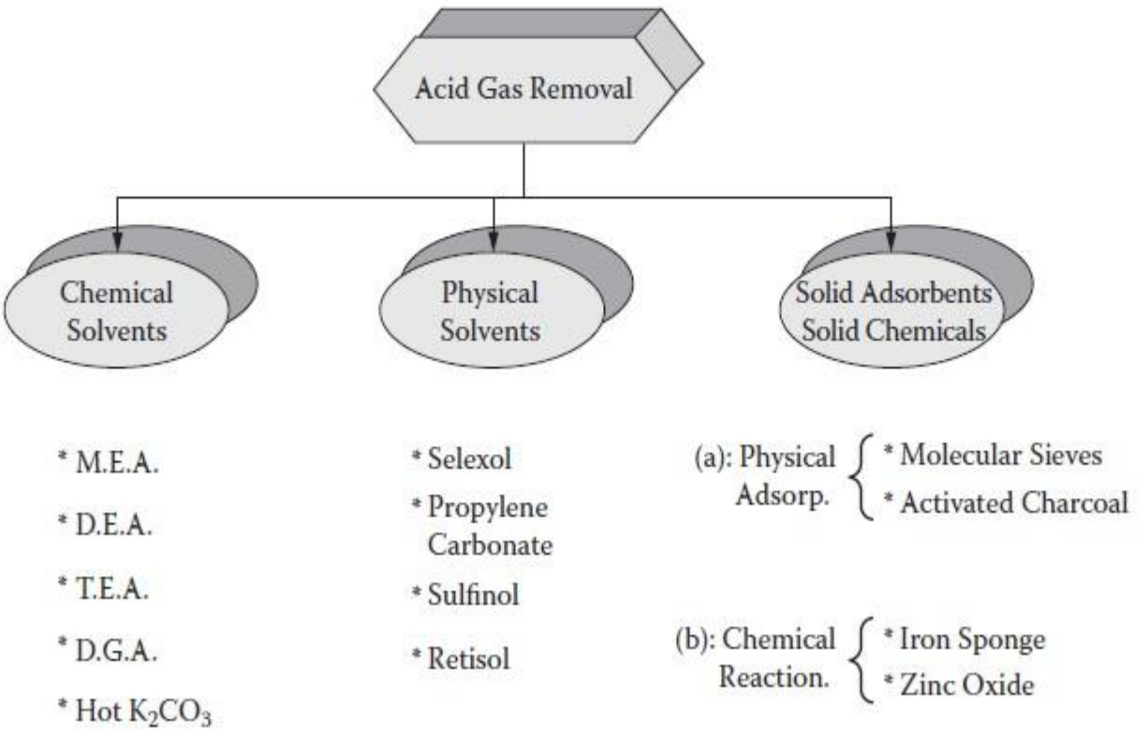

Fig 8 Classification of gas-sweetening processes

Gas Dehydration

Natural gas usually contains significant quantities of water vapor. Changes in temperature and pressure condense this vapor altering the physical state from gas to liquid to solid. This water must be removed in order to protect the system from corrosion and hydrate formation. The wet inlet gas temperature and supply pressures are the most important factors in the accurate design of a gas dehydration system. Without this basic information the sizing of an adequate dehydrator is impossible. The most common dehydration methods used for natural gas processing are the following:

1. Absorption, using the liquid desiccants (e.g., glycols and methanol)

2. Adsorption, using solid desiccants (e.g., alumina and silica

gel)

3. Cooling/condensation below the dew point, by expansion or refrigeration.