Tikrit University

College of Petroleum Processes Engineering

Department of Petroleum and Gas Refining Engineering

Gas Technology

Forth Class

Lectures 8

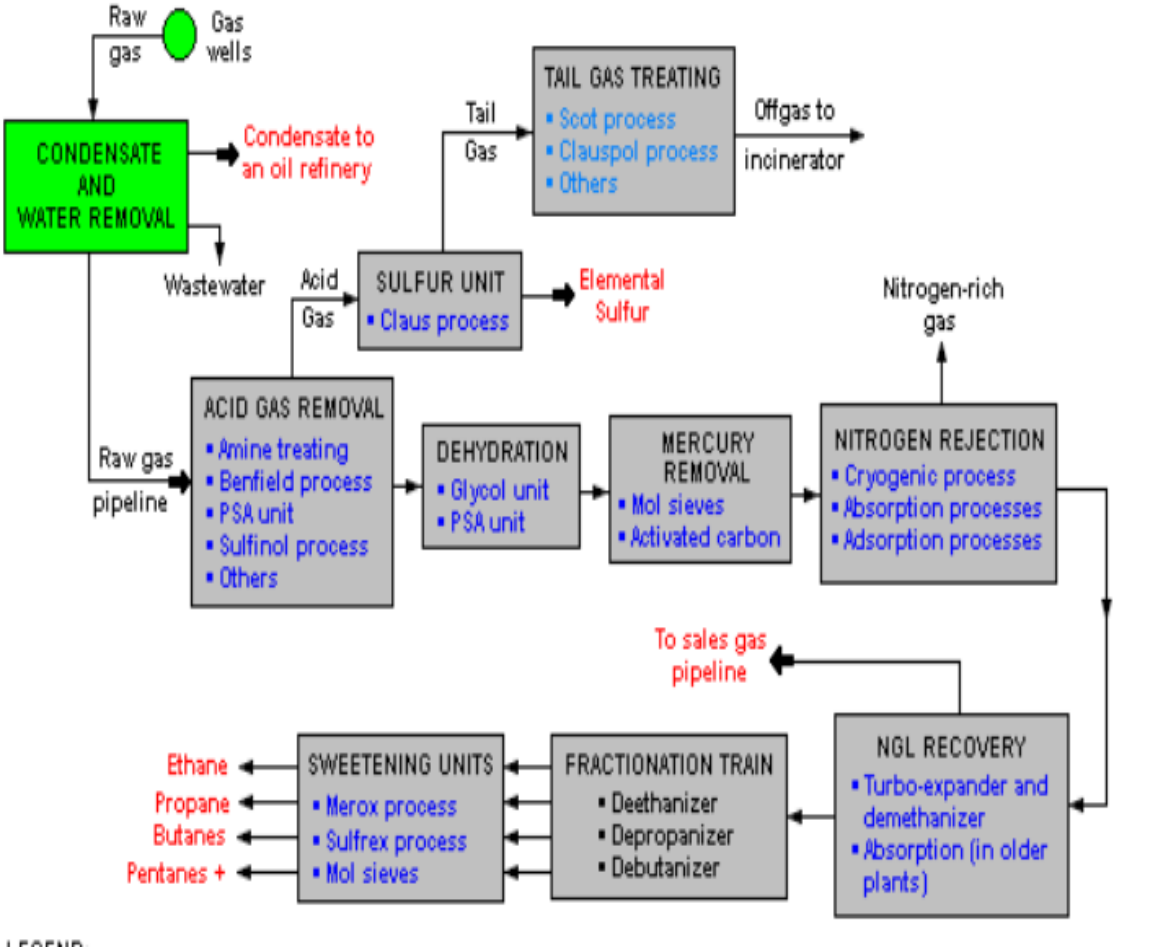
By

Jasim I. Humadi

Basic Concepts of Natural Gas Processing

Raw natural gas after transmission through the field-gathering network must be processed before it can be moved into long-distance pipeline systems for use by consumers. The block flow diagram, Figure (1), is a generalized, typical configuration for the processing of raw natural gas from **non-associated gas wells**. It shows how raw natural gas is processed into sales gas pipelined to the end user markets. It also shows how processing of the raw natural gas yields these byproducts:

- Natural gas condensate
- Sulfur
- Ethane
- Natural gas liquids ***(NGL***): propane, butanes and ***C5+*** (which is the commonly used term for pentanes plus higher molecular weight hydrocarbons)



LEGEND:

- Located at gas wells — Located in gas processing plant
  Red Indicates final sales products — Blue Indicates optional unit processes available
- Condensate is also called natural gasoline or casinghead gasoline
- Pentanes + are pentanes plus heavier hydrocarbons and also called natural gasoline
- Acid gases are hydrogen sulfide and carbon dioxide
- Sweetening processes remove mercaptans from the NGL products
- PSA is Pressure Swing Adsorption
- NGL is Natural Gas Liquids

Figure 1: Typical Gas Processing Plant

Processing Objectives

If the natural gas is transported by pipeline, the processing installation must be designed to meet either transport or final specifications. Processing of a gas stream may have one of the following three basic objectives:

- To produce a sales gas stream that meets specifications of the type shown in Table 1. These specifications are mainly intended to meet pipeline requirements and the needs of industrial and domestic consumers.
- To maximize NGLs production by producing a lean gas stripped of most of the hydrocarbons other than methane.
- To deliver a commercial gas. Such gas must be distinguished by a certain range of gross heating value lying.

Table 1: Natural Gas Specifications in the Salable Gas

Characteristic	Specification
Water content	4–7 lb/MMscf (max)
Hydrogen sulfide content	1/4 grain/100 scf (max)
Gross heating value	950 Btu/scf (min)
Hydrocarbon dew point	15°F at 800 psig (max)
Mercaptan content	0.2 grain/100 scf (max)
Total sulfur content	1–5 grain/100 scf (max)
Carbon dioxide content	1–3 mole percent (max)
Oxygen content	0–0.4 mole percent (max)
Sand, dust, gums, and free liquid	Commercially free.
Typical delivery temperature	120°F
Typical delivery pressure	714.7 psia

Effect of Gas Type in Field Processing

- The gas composition of the field is the most important issue in choosing a processing scheme.
- In other words, depending on the type of reservoir and the composition of the produced gas, the gas processing plant may contain extensive facilities for the processing of the associated liquefiable hydrocarbons.
- Typically, associated gas is very rich in liquefiable hydrocarbons and must undergo NGL and condensate recovery to meet hydrocarbon dew point or minimum heating value requirements.
- The gas processing scheme will also be dictated by the format of the sales contract and its specifications. The contract may be totally different for each customer depending on the composition and amount of gas, plant recoveries, and the contractual preferences of the customer

Phase Separation

- Raw natural gas is commonly collected from a group of adjacent wells and is first processed at that collection point for **removal of free liquid water and natural gas condensate**.
- The raw gas is pipelined to a gas processing plant.
- Hydrocarbon condensate recovered from natural gas may be shipped without further processing but is typically stabilized to

produce a safe transportable liquid. Unstabilized condensates contain a large percentage of methane and ethane, which will vaporize easily in storage tanks.

Stabilization is the full removal of light fractions from the condensate, usually achieved by distillation. Stabilized liquid will generally have a vapor pressure specification (Reid vapor pressure1 of <10 psi), as the product will be injected into a pipeline or transport pressure vessel, which has definite pressure limitations.

Acid gas treating (Sweetening)

In addition to heavy hydrocarbons and water vapor, natural gas often contains other contaminants that may have to be removed completely or partially.

- **Carbon dioxide (CO_2),**
- **Hydrogen sulfide (H_2S),**
- **Other sulfur-containing species such as mercaptans**

These compounds are collectively known as ***"acid gases."*** H_2S when combined with water forms a weak sulfuric acid, whereas CO_2 and water form carbonic acid, thus the term "acid gas." **Natural gas with H_2S or other sulfur compounds present is called "sour gas," whereas gas with only CO_2 is called "sweet."** Both H_2S and CO_2 are very undesirable, as they cause corrosion and present a major safety risk.

Dehydration

Water dew point control is required to meet specifications and to control hydrate formation. Gas hydrate formation is a major concern for engineers in pipeline and natural gas transportation industries as it causes choking/plugging of pipelines and other related problems. Methods of preventing hydrate formation in the plant include

- **Lowering the hydrate formation temperature with chemical inhibition or**
- **Dehydration to remove the water.**

Recovery and Separation of Natural Gas Liquids(NGLs)

- Hydrocarbon dew point or hydrocarbon liquid recovery involves cooling the gas and condensing out the liquids.
- The residue gas from the NGL recovery section is the final, purified sales gas which is pipelined to the end-user markets.
- The recovered NGL stream is processes through a fractionation train consisting of three distillation towers in series: a ***deethanizer***, a ***depropanizer*** and a ***debutanizer***.
- The overhead product from the deethanizer is ethane and the bottoms are fed to the depropanizer.

- The overhead product from the depropanizer is propane and the bottoms are fed to the debutanizer.
- The overhead product from the debutanizer is a mixture of normal and iso-butane, and the bottoms product is a C5+ mixture.
- The recovered streams of propane, butanes and C5+ are each **"sweetened"** in a **Merox process** unit to convert undesirable mercaptans into disulfides and, along with the recovered ethane, are the final NGL by-products from the gas processing plant
- Natural gas specifications in the salable gas stream is given in Table (1).