Tikrit University

College of Petroleum Processes Engineering

Department of Petroleum and Gas Refining Engineering

Gas Technology

Forth Class

Lectures 11

By

Jasim I. Humadi

ACID GAS TREATING

- Natural gas, while ostensibly being hydrocarbon in nature, contains large amounts of acid gases, such as hydrogen sulfide and carbon dioxide. Natural gas containing hydrogen sulfide or carbon dioxide is referred to as sour, and natural gas free from hydrogen sulfide is referred to as sweet.
- The corrosiveness nature of hydrogen sulfide and carbon dioxide in the presence of water (giving rise to an acidic aqueous solution) and because of the toxicity of hydrogen sulfide and the lack of heating value of carbon dioxide, natural gas being prepared for sales is required to contain no more than 5 ppm hydrogen sulfide and to have a heating value of no less than 920 to 980 Btu/scf.
- Hydrogen sulfide, carbon dioxide, mercaptans, and other contaminants are often found in natural gas streams. Gas sweetening processes remove these contaminants so that the gas is marketable and suitable for transportation. The removal of H_2S from natural gas is accompanied by the removal of CO_2 and COS if present, since these have similar acid characteristics.

Factors effect on natural gas treating

There are many variables in treating natural gas. The precise area of application of a given process is difficult to define. Several factors must be considered:

- Types and concentrations of contaminants in the gas.
- The degree of contaminant removal desired.
- The selectivity of acid gas removal required.
- The temperature, pressure, volume, and composition of the gas to be processed.
- The carbon dioxide–hydrogen sulfide ratio in the gas

- The desirability of sulfur recovery due to process economics or environmental issues.

ACID GAS REMOVAL PROCESSES

- The processes that have been developed to accomplish gas purification vary from a simple once-through wash operation to complex multistep recycling systems.
- Process complexities arise because of the need for recovery of the materials used to remove the contaminants or even recovery of the contaminants in the original.
- There are two general processes used for acid gas removal:
  1) Adsorption on a solid (dry process).
  2) Absorption into a liquid (wet process).

Adsorption Processes

- **Adsorption** is a physical–chemical phenomenon in which the gas is concentrated on the surface of a solid or liquid to remove impurities. Usually, carbon is the adsorbing medium, which can be regenerated upon desorption.
- **The quantity of material adsorbed** is proportional to the surface area of the solid and, consequently, adsorbents are usually granular solids with a large surface area per unit mass. Subsequently, the captured gas can be desorbed with hot air or steam either for recovery or for thermal destruction.

Absorption Processes

- **Absorption** differs from adsorption in that it is not a physical–chemical surface phenomenon, but an approach in which the absorbed gas is ultimately distributed throughout the absorbent (liquid).

- **The process depends** only on physical solubility and may include chemical reactions in the liquid phase (chemisorption). Common absorbing media used are water, aqueous amine solutions, caustic, sodium carbonate, and nonvolatile hydrocarbon oils, depending on the type of gas to be absorbed. Usually, the gas–liquid contactor designs that are employed are plate columns or packed beds.
- Absorption is achieved by dissolution (**a physical phenomenon**) or by reaction (**a chemical phenomenon**). Chemical adsorption processes adsorb sulfur dioxide onto a carbon surface where it is oxidized (by oxygen in the flue gas) and absorbs moisture to give sulfuric acid impregnated into and on the adsorbent.
- **As currently practiced,** acid gas removal processes involve the chemical reaction of the acid gases with a solid oxide (such as iron oxide) or selective absorption of the contaminants into a liquid (such as ethanolamine) that is passed countercurrent to the gas. Then the absorbent is stripped of the gas components (regeneration) and recycled to the absorber. The process design will vary and, in practice, may employ multiple absorption columns and multiple regeneration columns.
- **Liquid absorption processes** [which usually employ temperatures below 50◦C (120◦F)] are classified either as physical solvent processes or as chemical solvent processes. The former processes employ an organic solvent, low temperatures, or high pressure. In chemical solvent processes, absorption of the acid gases is achieved mainly by use of alkaline solutions such as amines or carbonates. Regeneration (desorption) can be brought about by the use of reduced pressures and/or high temperatures, whereby the acid gases are stripped from the solvent.
- **Amine washing of natural gas** involves chemical reaction of the amine with any acid gases with the liberation of an appreciable amount of heat and it is necessary to compensate for the absorption of heat. Amine

derivatives such as ethanolamine (monoethanolamine), diethanolamine, triethanolamine, methyldiethanolamine, diisopropanolamine, and diglycolamine have been used in commercial applications