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Improving Technology for Gas Purification from Acidic Components

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Abstract: In the article a comprehensive rational technology for purification of diethanolamine working solutions has been studied , which makes it possible to improve the quality of the absorbent, increase the productivity of amine gas purification plants, and also ensure a waste-free closed production cycle due to the recycling of the generated waste. Classified methods for purifying gas emissions from sulfur compounds.

Keywords: Gas chemical industry, natural gas, hydrogen sulfide, gas pipeline, air purification.

The continuously growing demand for natural gas as an efficient and environmentally safer type of boiler and energy fuel and raw material for the gas chemical and petrochemical industries makes it necessary to intensively develop the volume of its commercial production.

Currently, the production of hydrogen sulfide-containing natural gas makes up a significant part of the total volume of produced gas.

At the same time, the content of hydrogen sulfide in gases varies widely from several fractions to several tens of percent. Before being supplied to the main gas pipeline, such gas must be cleaned of sulfur compounds in order to protect pipelines and equipment from corrosion, protect the population from their toxic effects, protect many industrial catalysts from poisoning, and also in connection with environmental protection requirements. At the same time, hydrogen sulfide obtained during gas purification is processed into sulfur and provides valuable raw materials for the chemical industry and the national economy.

The choice of a gas purification process from sulfur compounds is determined by economics and depends on many factors, the main of which are: the composition and parameters of the raw gas, the required degree of purification and the area of use of commercial gas, the availability and parameters of energy resources, production waste, etc.

The formation of various types of industrial waste occurs at all stages of the technological process of natural gas processing and is one of the main problems in the processing of hydrogen sulfide-containing gases, the solution of which is necessary for the normal, economically profitable functioning of the enterprise.

The transition to low-waste and waste-free production requires a set of measures, including the development and implementation of fundamentally new and improvement of existing technological processes in order to significantly reduce production waste; use of waste in production itself or in other industries; development and implementation of the most advanced methods for cleaning, processing and neutralizing waste that is not used for technical or economic reasons.

Only on the basis of an objective assessment of the advantages and disadvantages of various waste disposal methods can a decision be made on the choice of options for their further use.

In foreign and domestic practice, technology using alkanolamines is used to purify gas from hydrogen sulfide and carbon dioxide . The main advantages of this technology are: a high and reliable degree of gas purification, regardless of the partial pressure of hydrogen sulfide and carbon dioxide, low viscosity of aqueous absorption solutions, low absorption of hydrocarbons, which guarantees high quality of acid gases, which are raw materials for the production of sulfur.

Acid gases are gaseous chemical elements and molecular compounds that are highly corrosive. Acidic *components* of gaseous media in industrial gas purification can also be understood as liquid ones, which have a strong destructive effect on metal structures, motors, flues, and other auxiliary metal components and assemblies.

The use of amine solutions in gas purification processes has a number of disadvantages, the main of which are foaming of the absorbent, and in some cases a decrease in its absorption capacity over time. The main reason for the difficulties that arise during operation is the thermochemical decomposition of absorbent solutions when interacting with carbon dioxide contained in the gas being purified, which produces destruction products - nitrogen-containing organic compounds.

Their presence in amine solutions worsens the performance properties of the absorbent, i.e. increases the viscosity of the solution, reduces absorption properties, and significantly increases the foaming of the solution.

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Acid gases include gas environments with chemical impurities that can cause significant corrosive changes. In the field of industrial gas cleaning, such gases also mean vapors and aerosols that have a destructive effect on various metal components and assemblies.

Today, there are three methods that ensure high-quality air purification from acids: absorption, adsorption and catalytic. The first two are based on physical and chemical cleaning. Absorption also involves a complex filtration technique. As for the chemical cleaning method, it involves contact of acid gas with sorbents. Gas purification from acidic components is in most cases carried out using alkanolamines . They are a highly hygroscopic liquid with a viscous structure.

The reaction takes place with the participation of low molecular weight alcohols or water. The choice of component is determined by the corrosion resistance of the installation. In addition to alkanolamines , monoethanolamines , triethanolamines , diethanolamines , and diglycolamines can be used.

If there is sulfur oxide in the gas, you should stop using primary alkanolamines .

Otherwise, the purification process will produce large amounts of difficult-to-recover by-products. In this case, it is better to use diethanolamine . The physical cleaning method involves dissolving acidic inclusions in an absorbent. The latter can be used methanol, propylene carbonate , N- methylpyrrolidone , polyethylene glycol alkyl ethers.

There are several methods for cleaning gas emissions from sulfur compounds. Methods (processes) can be classified as follows:

- adsorption;
- absorption;
- catalytic;
- oxidative;
- membrane technologies.

Adsorption processes based on the absorption of acidic components by solid cleaning absorbers are divided into chemical and physical. The main difference between the two types of adsorption is determined by the energy characteristics of the bonds.

Chemical adsorption, or chemisorption, is due to the chemical bonds that arise between the adsorbate and the adsorbent, during which surface chemical compounds are formed. The chemisorption process is of an activation nature; the heat of chemisorption is ~100-400 kJ/mol. Adsorbate and adsorbent molecules must have energy that exceeds the threshold activation energy. Chemical adsorption has not found wide industrial application in gas purification due to the difficulties that arise at the stage of regeneration of the spent adsorbent.

During physical adsorption (physisorption), no change in the electronic structure of atoms or molecules is observed. Physical adsorption is caused by van der Waals interaction forces between adsorbate and adsorbent molecules. These forces are small, since there is no activation barrier, and therefore the heat of physical adsorption is ~10-30 kJ/mol. Physisorption is characterized by reversibility (regeneration of the adsorbent) and multilayer adsorption. In addition, the process occurs only at relatively low temperatures.

Adsorbed molecules are desorbed without changing the chemical composition, and the regenerated adsorbent can be reused. The process can be carried out cyclically, alternating the stages of absorption and release of the extracted component.

The use of activated carbon has significant advantages over purification with iron oxides: the gas speed is 10-15 times higher, and the volume of equipment is correspondingly reduced; coal can be regenerated many times without unloading from the apparatus; The recovered sulfur is a commercial product of high purity.

The disadvantage of cleaning processes using activated carbon is its rapid decontamination due to the deposition of resin and polymeric materials on the surface of the particles; Before adsorbers, the gas must be completely cleared of these components.

All acidic components, by definition, are highly reactive substances. In the context of wet absorption gas purification, it is the property of high chemical activity that is the "Achilles heel" of acid components. It is known that acids actively react with alkalis, therefore, the absorption - technically more correctly, **chemisorption** - method of gas purification involves the mutual neutralization of acids with alkalis (or other liquids exhibiting basic properties).

Devices that carry out physical and/or chemical sorption processes - absorption filters and chemical scrubbers (as well as auxiliary units involved in the process of gas purification from aggressive compounds) - are made of inert materials that meet the requirements, which allows loading the required absorbents into the circulation circuit, including including, highly active.

In general, chemisorption processes using alkanolamine solutions are characterized by the following features: the ability to purify gas mixtures with low partial pressure of CO 2 due to the high reaction rate and absorption capacity of absorbents, high selectivity of removal and achievement of very fine purification. The process of regeneration of saturated solutions of alkanolamines in industry is usually carried out by heating (or in combination with pressure relief).

Despite the fact that gas purification with various amine solutions is currently one of the most common processes for removing CO2 from gas mixtures, this process has a number of disadvantages. The most important among them are equipment corrosion and environmental problems associated with the disposal of waste absorption liquids and their degradation products.

Currently, due to stricter environmental requirements, a search is underway for new biodegradable absorption liquids. Such absorbents may include ionic liquids. Ionic liquids are organic salts that are in a liquid state at operating temperature. They are characterized by relatively low toxicity, low saturated vapor pressure values, which avoids losses of absorbent during the absorption process, as well as high thermal stability.

At high CO2 concentrations, they occupy an intermediate position between chemical and physical absorbents. The most important disadvantages of ionic liquids are high viscosity and high cost.

Currently, methods have been developed for purifying gases using combined absorption liquids - mixtures of alkanolamines with physical absorbents. These absorbents do not have the disadvantages of physical absorbers, which allow the purification of gases only with a high partial pressure of carbon dioxide and solve the problem of increased equipment corrosion, which often occurs when using alkanolamines . In the case of combined absorption, the main amount of carbon dioxide is absorbed by a physical absorbent, and fine purification is achieved using a chemical absorbent.

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