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ОБЩИЙ АНАЛИЗ ТЕХНОЛОГИИ АБСОРБЦИОННОЙ ОЧИСТКИ ПРИРОДНОГО ГАЗА ОТ КИСЛЫХ ГАЗОВ С ИСПОЛЬЗОВАНИЕМ КОМПОЗИЦИОННЫХ АБСОРБЕНТОВ

GENERAL ANALYSIS OF ABSORPTION CLEANING TECHNOLOGY OF NATURAL GAS FROM ACID GASES USING COMPOSITE ABSORBENTS

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Аннотация. В статье рассмотрены технология очистки природного газа от кислых компонентов и вопросы по обеспечению чистоты продуктов нефтегазового производства в соответствии с требованиями государственного стандарта; повышение их уровня очистки от H_2S, SO_2, меркаптанов, тиосульфидов и дисульфидов. Создание новых композиционных сорбентов, полученных на основе местного сырья и обладающих высокой сорбционной производительностью.

Ключевые слова: композиционный абсорбент, этаноламин (ЭА), метилэтаноламин (МЭА), диэтаноламин (ДЭА), метилдиэтаноламин (МДЭА).

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Annotation. The article discusses the technology of purification of natural gas from acidic components and the issues of ensuring the purity of oil and gas products according to the requirements of the state standard; increasing their purification from H2S, SO2, mercaptans, thiosulfide and disulfide. Creation of new composite sorbents obtained on the basis of local materials and with high sorption output.

Keywords: composite absorbent, ethanolamine (EA), methylethanolamine (MEA), diethanolamine (DEA), methyldiethanolamine (MDEA).

Modern innovative technologies, while saving energy consumption, have a great impact on the improvement of the technology of oil and gas extraction and processing, including the deep absorption cleaning of natural gas with alkanolamines.

Globally, the volume of gas production and processing has increased over the next three years, and now, in Uzbekistan, these figures have approached the annual volume of 50.0 billion m^3. At the same time, the amount of hydrogen sulphide in natural gas is also increasing, and in this case high-sulfur gases make up a large part of this index [1]. In addition to hydrogen sulfide, which is harmful for environmental protection and corrosively active, carbon dioxide, thiols, mercaptans and alkyl sulfides are preserved in the composition of natural gases and it is required to separate them at the initial stages of processing. Gaseous compounds of sulfur are toxic and cause a number of problems in the processes of gas extraction, storage and processing, cause corrosion of equipment metals, and affect their physical-mechanical and operational properties. At the same instant, the composite forms of natural gas is an important raw material for the production of isolated sulfur compounds (ethyl mercaptans, odorants for household gases, ethyl and butyl mercaptans), insecticides and various detergents.

Currently, at the world level, methyldiethanolamine (MDEA) solution, diethanolamine (DEA) solution are used in gas purification devices using amine solutions. The presence of sulfur compounds (COS, R-SH, R-S-R', etc.) and chlorine ions in the gas (which is sent to the devices for cleaning natural and secondary gases using amines, from the devices for drying gases using zeolites) causes the formation of heat-resistant salts in the MDEA and DEA solutions used in the device. It should be noted that the accumulation of difficult-to-dissolve various salts and organic acids in the absorbent solution has a negative effect on the process of cleaning gases from toxic compounds, causing great problems for environmental protection. Also, such technological problems accelerate the corrosion of devices and equipment, causing them to fail.

Alkanolamines used as absorbents are colorless, viscous, hygroscopic liquids, miscible with water and alcohols of lower molecular weight in any ratio, practically insoluble in non-polar solvents. Anhydrous alkanolamines are usually used as an aqueous solution. The indicator of the concentration of amine in the solution can vary in wide ranges, it is chosen based on the reasons for conducting experiments and corrosion of technological devices [2].

The technological parameters of the cleaning process are obtained taking into account the concentration of the absorbent, its degree of saturation with H_2S and CO_2, that is, practical recommendations that al-low to eliminate negative phenomena such as corrosion, degradation and loss of the absorbent. Table 1 shows the recommended concentration of alkanolamines in the absorbent and their saturation level with H_2S, CO_2 [3].

Table 1 – The recommended concentration of alkanolamines and their saturation level with H_2S and CO_2 [3]

Alkanolamines	Concentration of alkanolamines in the solution, % mass.	The percentage of H_2S and CO_2, mole/mole of amine	
		in saturated absorbent	in regeneration
MEA-monoethanolamine $H_2N–CH_2–CH_2–OH$	15–20	0,30–0,35	0,10–0,15
DEA- diethanolamine $HN(CH_2–CH_2–OH)_2$	25–35	0,35–0,40	0,05–0,07
MDEA-methyldiethanolamine $CH_3N(CH_2–CH_2–OH)_2$	30–50	0,45–0,50	0,004–0,01
DGA-diglycolamine $HOCH_2CH_2OCH_2CH_2NH_2$	40–60	0,35–0,40	0,02–0,10

As a result of subsequent studies, it became clear that the use of MDEA was of great value in the removal of acidic components of gases, including hydrogen sulfide. MDEA differs from DEA in several parameters. In particular, since MDEA is a selective absorber, it absorbs more H_2S and less CO_2; provides additional sulfur as a result of increasing the concentration of hydrogen sulfide in high-sulfur acid gases; as a result of reducing the emission of CO_2 into the atmosphere, the environmental situation in the areas where the plant located can be improved. MDEA solution saturated with sour gases is less corrosive to metals than DEA.

The reaction rate of CO_2 and MDEA is slower than that of MEA and DEA, reducing the selectivity of H_2S extraction from natural gas. It is necessary to take into account that the rate of reactions of alkanolamine and gases with acidic components decreases when the pH of the medium decreases, depending on the saturation of the absorbent and the depletion of free ethanolamine (EA).

In the process of saturation of gases with acidic components of an aqueous solution of alkanolamine, not only the rate of mutual chemical reaction slows down, but also the partial pressure of the same components in the vapor phase decreases; physical solubility, concentration in the liquid phase increases under the influence of temperature, and the general quantitative description of the process becomes complicated.

The efficiency of the gas cleaning technology depends on the correct selection of the absorbent. The higher the absorbency of the absorbent to H_2S, CO_2 and other components, the less amount of ethanolamine is used for absorption at the level of demand for the gas being cleaned. The selection of absorbent for gas cleaning processes requires a feasibility study based on alternative indicators in each specific situation. Table 2 shows that the absorbent composition is effective in cleaning gases with amine absorbents and preventing foaming [4].

Table 2 – The effective absorbent composition in amine cleaning of gases and in foaming prevention [4]

Component	Percentage, %
methyldiethanolamine (MDEA) – absorbent	30–40 %
polimal – surface activator	10–15 %
ethylene glycol – solvent	10–15 %
water – solvent in creating a dissociative condition	30–35 %

The concentration of amines in aqueous solution used in production conditions is up to 20 % for MEA, and up to 30 % for DEA [5]. Chemically purified or distilled water is used to prepare solutions of amines. In some cases, steam condensates are used.

In summary, composite absorbents used in cleaning processes have these following properties, so they have:

– a high absorption capacity for aggressive components of natural gas;
– high selectivity to acidic components;
– low saturated vapor pressure for minimal loss in the absorption process;
– low solubility of hydrocarbons;
– reactive inertness according to the properties of the gas to be cleaned;
– ensure purification at the standard level (no more than 20 mg/m^3 of gas);
– lack of corrosive activity on metal;
– and that it is required to be stable to foaming.

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