Section 3. Technical sciences in general

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ADSORPTION METHODS OF PURIFYING, DRYING AND PETROLING OF NATURAL GASES

Abstract. To date, the selection and use of various adsorbents for drying natural gas is one of the main problems of the gas transportation and processing industry. The degree of dryness of natural gas during transportation determines the degree of hydrate formation of natural gas in gas pipelines. This article presents the results of the degree of gas drying under dynamic conditions by various adsorbents.

Keywords: natural gas, adsorbent, dew point, gas hydrate, water, dynamic conditions, zeolite, silica gel, aluminum oxide.

The problems of drying natural gas with various adsorbents are considered in a number of publications, in particular, in [1–2].

The feasibility of using one or another method of adsorption drying and purification of natural gas depends on many factors and is determined by the plant capacity, gas composition, concentration of $C_{5+\ hydrocarbons}$, sulfur compounds and other impurities, consumer requirements for purified gas.

When solving specific practical problems related to gas purification and drying-topping, it is necessary to take into account the main advantages of a particular adsorbent, such as [3]:

– the ability to provide cleaning from all unwanted components in one system;

– ensuring deep gas drying;

– ease of operation and the possibility of automation.

The adsorption process for drying hydrocarbon gases is widely used at gas processing plants as the first stage of low-temperature technology, the final product of which is liquefied gases such as propane, butane, liquid nitrogen, and helium [4].

There is an opinion that the adsorption process of preparing gas for processing is metal-intensive and expensive compared, for example, with absorption, which is widely used in the fields.

However, a higher degree of moisture extraction from the gas and the absence of absorbent vapors in the dried gas, which can condense in the piping and apparatus during gas cooling (not to mention entrainment), make this process reliable, stimulate

its improvement and widespread use in factory processing. gases.

As for the field preparation of gas for transportation through main gas pipelines, the main criterion for choosing a preparation method is the gas dew point for moisture and hydrocarbons, which excludes their condensation and precipitation in gas pipelines [1, 5].

The main adsorbents used for purification and drying-topping of natural gases in industry are [6]:

– active coals;
– zeolites;
– active aluminum oxide;
– silica gels.

On their basis, a number of technologies for cleaning, drying and topping natural gas have been developed and introduced into industry.

Activated carbons are porous industrial adsorbents, consisting mainly of carbon and having a number of features determined by the nature of their surface and porous structure [2]. The surface of carbon crystallites is electrically neutral, and adsorption on coals is mainly determined by the dispersion forces of interaction.

As a rule, the structure of coal is represented by a range of pores of all sizes, and the adsorption capacity and rate of adsorption of industrial gas components are determined by the content of micropores per unit mass or volume of granules.

Active carbon is the only hydrophobic type of industrial adsorbent, which determined its wide application for vapor recovery, purification of wet gases and waste water. However, at low amounts of the adsorbent (extraction of trace impurities from the gas stream), when the duration of purification is long, the humidity of the environment reduces the adsorption capacity of coal for the extracted component (absorption of carbon disulphide from ventilation emissions of viscose production).

Zeolites are widely used as adsorbents – aluminosilicates containing oxides of alkali and alkaline earth metals. Zeolites are distinguished by a strictly regular structure of pores, which are filled with water molecules under normal temperature conditions [2–3].

Zeolites are both natural and synthetic. The industry produces five types of zeolites. The classification is based on a two-digit designation: first, the cation that is predominantly included in the zeolite lattice (K, Na, Ca), then the type of the zeolite crystal lattice (A, X or Y) is indicated.

Another type of inorganic adsorbents widely used in the oil and gas processing industry for drying gases is active alumina. The advantages of aluminum oxide (thermal stability, relative ease of preparation, as well as the availability of raw materials, etc.) make it possible to widely use it along with such adsorbents as silica gels and zeolites [7].

It is also widely used in adsorption processes (for drying gases, oils, cleaning gases and liquids from chlorine- and fluorine-containing compounds).

Silica gel is one of the most common mineral adsorbents in industrial technology, which has a large developed surface.

In appearance, it is a hard grain: transparent, opaque, colorless or light brown. Silica gel is produced in the form of balls, tablets or pieces of irregular shape with a grain size of 0.1–0.7 cm.

The chemical and adsorption properties of silica gels are affected by the presence of the =Si-OH group. OH groups mainly occupy the vertices of tetrahedra, which are exposed to the silica gel surface [2, 7]. As a result of chemical modification of its surface (introduction of amino-, sulfo- and nitrile groups, fluorine atoms, alkyl and alkenyl radicals into the composition of silica gel), it is possible to achieve a change in adsorption properties.

The main advantages of silica gels are [8]:

– low regeneration temperature (110–200 °C) and, as a result, lower energy consumption than in the regeneration of other adsorbents (active alumina, zeolites);

– the possibility of synthesizing silica gels in a wide range of specified structural characteristics using simple technological methods;

– low cost in large-capacity industrial production;

– high mechanical resistance to abrasion and crushing.

Adsorption gas treatment at the fields, in which there is no removal of liquid desiccants, contributes to environmentally friendly gas transportation through main gas pipelines.

As noted earlier, the prospects for using adsorption technologies to prepare natural gas for transport are increasing. In our country, there are production facilities for all the main types of industrial adsorbents, however, additional studies of their physical and technical properties are required in order to determine the most promising ones for their possible use in gas treatment plants for transport instead of imported ones.

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