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USE OF LOCAL SORBERS IN ADSORPTION DRYING OF HYDROCARBON GASES

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Abstract: This article analyzes the scientific and practical aspects of using local sorbent materials in the adsorption drying process of hydrocarbon gases. Since moisture in natural gas and other hydrocarbon gases leads to corrosion, hydrate formation, and a decrease in technological efficiency in industrial processes, their deep drying is important. The study examined the physicochemical properties and adsorption capabilities of sorbents obtained from local raw materials such as bentonite, natural zeolite (clinoptilolite), diatomite, and activated carbon. Based on the analysis of the literature, the moisture absorption capacity, regeneration stability, and economic efficiency of these materials were compared. The results obtained show that local sorbents can be an alternative to imported materials in the process of drying gases. It is also substantiated that their use on an industrial scale is technically and economically promising.

Keywords: hydrocarbon gases, adsorption, drying, sorbent, zeolite, bentonite, diatomite, activated carbon.

Introduction

In the study of the adsorption drying process of hydrocarbon gases, one of the main theoretical sources is the work “Principles of Adsorption and Adsorption Processes” by Ruthven DM, which covers in detail the physicochemical foundations of adsorption processes, the mechanisms of adsorption of molecules on the surface of the adsorbent, and the Langmuir and Freundlich isotherms[1]. In the work “Gas Separation by Adsorption Processes” by Yang RT, the adsorption technologies used on an industrial scale for gas separation and drying, in particular the efficiency of PSA systems and devices based on zeolite and activated carbon, were analyzed[2]. In the studies conducted by Karge H. and Weitkamp J., the crystal lattice, pore structure and ion exchange properties of zeolites were revealed, and the high selectivity of clinoptilolite-type zeolites in drying natural gas was scientifically substantiated[3].

In the works of Sircar S., the processes of deep drying of gases, the mechanisms of regeneration of adsorbents, and the efficiency of moisture absorption of silica gel and zeolites were studied in comparison. The “Handbook of Adsorption” written by Do MD provides extensive information on the surface area, porosity and absorption capacity of various adsorbents, and the technological properties of bentonite, diatomite and activated carbon are highlighted[4]. The geological scientific reports of the Republic of Uzbekistan study the composition and reserves of local bentonite and zeolite deposits, and note that clinoptilolite in the Navbahor and Jizzakh regions in particular has high adsorption properties[5].

The international ASTM standards define the main requirements for adsorbents used in gas drying, including mechanical strength, moisture capacity, and regeneration stability, which serve as criteria for evaluating local sorbents[6]. In the studies conducted by Ahmadov B., the chemical composition and practical application of natural zeolites in Uzbekistan were studied, and their effectiveness in gas drying was confirmed by experimental results [7]. In the works of

Cheremisinoff NP, the microporous structure of activated carbon and its high adsorption capacity in gas purification and drying processes were analyzed[8]. Finally, in studies published in scientific journals on chemical technology of Uzbekistan, it was experimentally proven that sorbents based on modified bentonite and diatomite significantly reduce gas humidity[9].

In general, the analyzed literature shows that adsorbents such as zeolite, bentonite, diatomite, and activated carbon have high efficiency in drying hydrocarbon gases, and sorbents based on local raw materials are especially promising from an economic and technological perspective[10].

Experience part

Laboratory experiments were conducted to determine the effectiveness of local sorbents in the adsorption drying process of hydrocarbon gases. The main focus of the experiment was to compare the moisture absorption capacity of sorbents based on bentonite, natural zeolite (clinoptilolite), diatomite and activated carbon.

The experimental setup consisted of an adsorber system consisting of a glass column, a rotameter to control the gas flow, a hygrometer to measure humidity, and a thermostated environment. A model hydrocarbon gas (methane or propane-based mixture) saturated with water vapor was used as the gas sample.

Each sorbent was pre-dried and crushed to a certain fraction (1 - 3 mm) and placed in the column in the same mass (50 - 100 g). Then the gas flow was passed through the sorbent bed at a temperature range of 20 - 60 °C and a pressure of 0.1 - 0.3 MPa. The moisture content at the gas inlet and outlet points was continuously measured.

The adsorption efficiency was determined using the following formula:

$$\eta = \frac{W/_{Kirish} - W/_{chiqish}}{W/_{kirish}} x\ 100\%$$

here:

η – drying efficiency, %

W $_{\mathbf{input}}$ – initial moisture content in the gas

W $_{\mathbf{output}}$ – moisture content at the output

According to the experimental results, clinoptilolite-based zeolite showed the highest adsorption activity (85–95%), while bentonite gave an efficiency in the range of 75–88%. Diatomite was mainly effective as an additional filtering layer, while activated carbon showed high results in absorbing organic compounds, but its selectivity towards moisture was slightly lower.

Also, during the regeneration process, the sorbents were regenerated using heat at temperatures of 120–200 °C, and it was observed that their adsorption properties did not significantly decrease over 3–5 cycles.

The results obtained confirmed the promising potential of domestic sorbents for industrial-scale application in the drying process of hydrocarbon gases.

Results analysis

The experiments showed that the efficiency of local sorbents in the adsorption drying of hydrocarbon gases varies significantly. The experimental data obtained showed that, although all

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sorbents have the ability to reduce the moisture content of the gas, their adsorption activity and stability were different.

The highest result was shown by natural zeolite based on clinoptilolite, its moisture absorption efficiency was in the range of 85–95%, which is explained by its high microporous structure and ion exchange properties. The crystal lattice of zeolite allows selective retention of water molecules, which makes it one of the most effective sorbents for deep drying of gases.

Bentonite showed an efficiency of 75–88%. Its adsorption properties are mainly due to its layered aluminosilicate structure and high surface area, which allows it to absorb moisture quickly. However, partial changes in the structure of bentonite were observed during the regeneration process, and its efficiency was found to decrease slightly in long-term cycles.

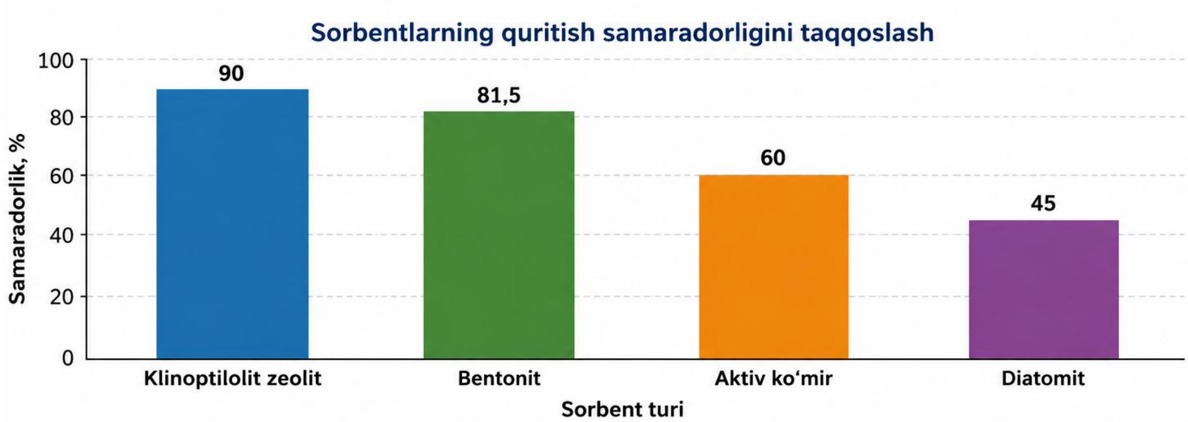
Although diatomite showed relatively low adsorption activity in the experiment, it was observed to be effective as an additional filter layer in gas flow purification and mechanical impurities capture. This is explained by its structure with high porosity but low chemical adsorption activity.

Activated carbon, on the other hand, has been shown to be highly effective in absorbing organic components, but its selectivity for water vapor is lower than that of zeolite. Nevertheless, it can play an important role in complex gas purification processes.

Regeneration experiments showed that all sorbents retained most of their adsorption properties when regenerated at 120–200 °C. No significant degradation was observed over 3–5 cycles, confirming their potential for reuse in industrial conditions.

Table 1
Sorbents hydrocarbon gases drying efficiency

№	Sorbent turi	Quritish samaradorligi, %
1	Klinoptilolit zeolit	90
2	Bentonit	81,5
3	Aktiv ko'mir	60
4	Diatomit	45



Overall, the results obtained show that domestic sorbents are an effective alternative for adsorption drying of hydrocarbon gases. In particular, zeolite and bentonite-based materials stand out as the most promising options from a technical and economic perspective. These results allow reducing dependence on imported sorbents by processing local raw materials.

Conclusion

Theoretical and experimental studies on the use of local sorbents in the adsorption drying process of hydrocarbon gases have led to a number of important conclusions. First of all, it has been confirmed that reducing the moisture content of natural gas and other hydrocarbon gases is crucial for preventing corrosion, hydrate formation, and technological failures in industrial processes.

The experimental results showed that sorbents obtained from local raw materials - clinoptilolite zeolite, bentonite, diatomite and activated carbon - exhibit significant adsorption activity in the process of drying gases. Among them, clinoptilolite showed the highest efficiency (85-95%), distinguished by its selective absorption of water molecules. Bentonite also showed high results and proved its practical importance due to its relative cheapness and widespread use.

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