AMERICAN JOURNALS
Open Access, Peer Reviewed Journals

American Journal of Technology and Applied Sciences
ISSN (E): 2832-1766 Volume 48, May - 2026

THE METHOD OF DETERMINING THE DYNAMIC ADSORPTION CAPACITY OF ADSORBENTS ON WATER

Suyarov M. T.
Shoimov S. O.
“Air Products Netherlands Gases BV”, Karshi State Technical University
Tel: (90) 607-73-33; E-mail: suxrobshoimov675@gmail.com

ABSTRACT

In this article, the selection of adsorbents with high efficiency in gas drying and their physico-chemical parameters are discussed. Special cleaning processes in order to partially dry moisture and mechanical impurities in natural gas: adsorption in molecular systems; increasing the processing efficiency of solid adsorbent-zeolites is achieved. As a result of scientific research, the renewal of adsorbents has been scientifically based, and directions for the introduction of research have been studied.

KEYWORDS

Adsorber, desorber, adsorbent, solid mechanics, adsorbtiv, adsorbat

Introduction

Today, the quality of technological gases used in various industries, especially in the oil and gas industry, chemical industry, energy and cryogenics, is of great importance. Moisture (water vapor) contained in gases not only reduces their quality, but also has a serious negative effect on the operation of technological equipment: problems such as corrosion, alloy formation, energy losses, and a decrease in production efficiency arise. Therefore, effective drying of gases - that is, their dehumidification - is one of the urgent issues in modern industry.

In the world, scientific research is being carried out on the improvement of natural gas purification and drying processes, the development of new types of adsorbents or adsorbent compositions for adsorption drying. In this regard, the "dew point" of commodity gases is one of the main standardized indicators, and the moisture content of natural gas significantly affects the corrosion of gas pipelines in gas transportation and storage, and the smooth operation of automatic control equipment, the operation of equipment in compressor stations and technological systems. Therefore, special attention is being paid to the improvement of technologies aimed at increasing the efficiency of natural gas drying processes, in particular the adsorbents used in the adsorption drying process.

Gas humidity refers to the presence of water vapor in its content. Moisture retention in natural gas depends on pressure and temperature. The higher the temperature of the gas, the more moisture it holds per unit volume. Gas pressure is inversely proportional to temperature, and as gas pressure increases, gas humidity decreases

Water vapor can be saturated with gas up to the saturated water vapor pressure at a given temperature. If water vapor passes this limit, then it condenses, that is, it turns into a liquid state.

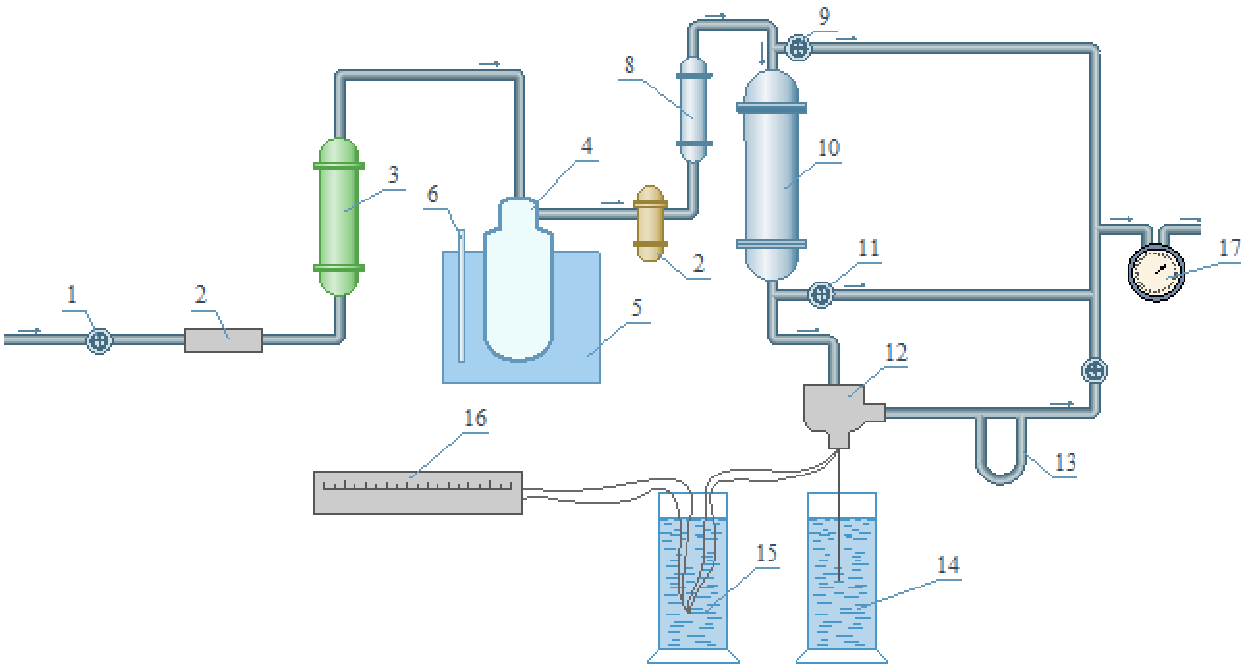
The temperature at which a gas is completely saturated with water vapor is called the dew point of this gas. The presence of moisture in the gas leads to the corrosion of gas transportation pipelines, as well as the formation of hydrates and condensate in gas pipelines. In addition, moisture reduces the heat of combustion of gas. Therefore, gases are dried from moisture using solid or liquid absorbers. However, in these drying processes, in particular, in the process of adsorption, the development of modern developments for the complete extraction of moisture from the gas composition continues to this day.

RESULT: Adsorbents of different origins and structural properties (for example, nano-sized zeolites, modified silica-gel, carbon-based composites) were tested, and their adsorption capacity and regeneration stability were studied. When investigating the effect of methanol on the rate of formation of propane hydrate, it was observed that the amount of propane in the mixture passes the highest point with an increase in the amount of methanol in the water-methanol solution. Accordingly, the time of hydrate formation increases.

The scheme of the laboratory device for determining the dynamic adsorption capacity of adsorbents on water is shown in Fig. 1.1 [1]

The sequence of research

The gas sample in the sample holder is passed through 1 valve, 2 cartridges filled with activated carbon, installed to clean the gas from mechanical particles and oily substances. Then 4 bottles half filled with water are fed to 3 rotameters to moisten the thermostat.



1.1. - a picture. Scheme of the laboratory device for determining the dynamic adsorption capacity of adsorbents on water: 1 - needle valve, 2 - activated carbon cartridge, 3 - rotameter, 4 - Ivisk container, 5 - water bath, 6 - thermometer, 7 - trap, 8 - drop absorber, 9,11 - three-way taps, 10 - adsorber, 12 - clamp, 13 - copper tube, 14 – EOI device, 15 – rheometer, 16,17 – Dewar containers.

Thermostatization of the ivisk tank is carried out using 5 water baths circulating thermostatic water at a temperature of 20 oC. The temperature of the water in the bath is measured using a thermometer[2]. Humidified gas is supplied to 8 droplet traps through 7 traps, maintaining humidity in the range of 13 to 15 mg/dm3. After that, it is sent to the adsorber filled with the studied adsorbent through a three-way tap. At the exit from the adsorber, the dried gas is separated into 2 streams using 11 three-way valves and 12 clamps. A flow rate of 0.5 to 1.0 dm3/min is supplied to the EOI device 14 to determine the dew point. After 15 rheometers, it is connected to the main gas stream using a three-way tap. The total gas flow is measured at 19 gas meters and discharged from the device.

Processing the results

The dynamic adsorption capacity of adsorbents for water (A_s) mg/sm3 is calculated by the following formula

$$A_s = \frac{(M_2 - M_1 - K)}{(M_1 - M_0)} . \boldsymbol{\rho} \qquad (1.1)$$

where: M2 is the combined mass of the adsorber with the adsorbent after the test, mg; M1 - mass of adsorber after regeneration with adsorbent, mg; M0 - mass of adsorber without adsorbent, mg; K - adsorption moisture corrector, mg; r - cumulative mass of adsorbent, mg/cm3.

Adsorption moisture corrector K, mg is determined as follows:

$$K = (M_2 - M_1) * \left(\frac{T - T_1}{T}\right) \qquad (1.2)$$

where: T is the total time of adsorption (when the dew point is up to minus 70 oC), min; T1 - time of protective effect of dew point to minus 70 oC, min.

Determining the density of adsorbents: The mechanical strength of adsorbents is based on the loss of mass of adsorbent granules during digestion as a result of the increase in gas flow (Fig. 1.2). [86] Before starting the experiment, the adsorbent is cleaned of dust and weighed on an analytical balance, and placed in a tube with a pore section of 23 mm in diameter. Air is passed through the tube, the adsorbent is taken for a certain time and measured, and the process is stopped when a constant mass is reached[3].

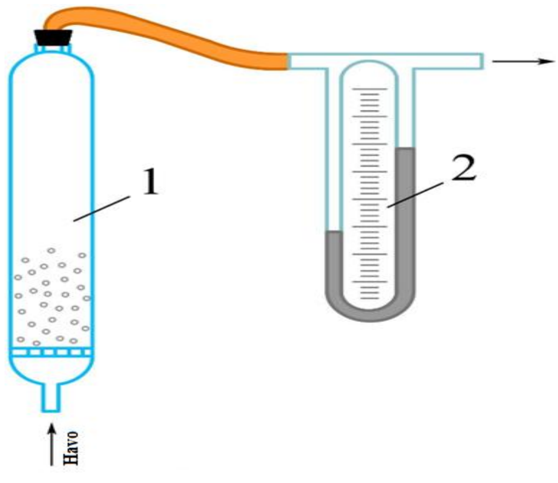


Figure 1.2. Determination of the mechanical strength of the adsorbent:

1 – tube filled with adsorbent, 2 – rheometer

After that, the speed of the air flow is set at the level of moving the adsorbent in the boiling bed. The test will be held for 15 minutes. After the test, the adsorbent is removed and cleaned of dust and measured. then the strength of the adsorbent is calculated by the following formula:

$$a = \frac{m_2}{m_1} * 100 \qquad (1.3)$$

where: m1 and m2 are the mass of the adsorbent before and after the test, g.

The test is conducted twice at two different air flow speeds: 2.2 and 2.6 m/s.

CONCLUSION:

Adsorbents of different origins and structural properties (for example, nano-sized zeolites, modified silica-gel, carbon-based composites) were tested, and their adsorption capacity and regeneration stability were studied. When investigating the effect of methanol on the rate of formation of propane hydrate, it was observed that the amount of propane in the mixture passes the highest point with an increase in the amount of methanol in the water-methanol solution. Accordingly, the time of hydrate formation increases.

REFERENCES

1. M.J.Maxmudov, X.I.Ne’matov Silikagellarni qo‘llab tabiiy gazni adsorbsiya Fan va texnologiyalar taraqqiyoti. Ilmiy – texnikaviy jurnal. Buxoro, 2022. – №1. 3-8 – b.

2. Суяров М.Т.,Якубов Ю.Й. Пути повышения экологичности бензина International Conference on Developments in Education. Hosted from Toronto, Canada February 2023, p.21-24.

3. Махмудов.М.Ж, Ахмедов У. К, Суяров М.Т Разработка технологии компаудирования автомобильных бензинов Аи-91 и Аи-80 и синергетических оксигенатных композиций // Международный научный журнал «Universum: технические науки» №9 Москва -2022, стр 30-32.

4. Опарина, Л.А. Виниловые эфиры продуктов каталитической деструкции лигнина как потенциальные добавки к топливам / Л.А. Опарина, О.В.Высоцкая, Н.А. Колыванов, В.Н. Сапрыгина, Е.В. Носова, Б.А. Трофимов // Известия вузов. Прикладная химия и биотехнология. - 2016. - Том 6, № 3. -С. 7-1.