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ANALYSIS OF THE PROCESS OF DRYING NATURAL GAS WITH GLYCOLS USING AZEOTROPIC SOLVENTS AND MULTIFUNCTIONAL ADDITIVES

Abstract: Currently, many gas fields have entered a phase of declining production, which complicates gas preparation in fields, especially in terms of ensuring the quality indicators of natural gas. In order to comply with regulatory requirements for the quality of natural gas supplied to main gas pipelines, it is necessary to improve the calculation, technological and measurement methods for studying the efficiency of gas drying technological equipment. To clarify the thermodynamic methods for calculating the moisture content and dew point temperature for aqueous phases (liquid water, ice and gas hydrate), additional experimental studies of the phase equilibrium in the “natural gas - water - hydrate” system are required. Therefore, the development and improvement of methods for determining the technological parameters of natural gas drying devices is a topical research topic [1]

Key words: Azeotrope, solvents, glycols, absorption, contact-regenerative, desorption, degradation, diethylene glycol.

Introduction: In the gas industry, the contact-regenerative method of drying gas with an absorbent (glycol) is most often used. This process consists of the absorption of moisture by glycol, desorption and recycling of the regenerated glycol. The depth of gas drying largely depends on the residual water concentration in the glycol at the outlet of the desorber. To increase the depth of glycol regeneration, the following are used: increasing the temperature, reducing the pressure, cleaning with dried gas, and introducing a substance that forms an azeotropic mixture with water.

The main disadvantages of absorption drying

• Insufficient depth of water desorption, which reduces the absorption efficiency:

• Glycol foaming in the absorber:

• Corrosion of equipment by acids formed during glycol degradation

• Loss of glycol with water vapor during desorption:

The purpose of this work is to improve the process of deep absorption of natural gas with glycols using an azeotrope-forming agent and surfactants.[2]

In industry, diethylene glycol (DEG) is often used as an adsorbent in the process of hydrocarbon gas absorption, and triethylene glycol (TEG) is used abroad. TEG has a number of advantages compared to DEG: its total losses are 2-2.5 times lower, it causes a higher dew point depression, and its regeneration produces fewer glycol (acid) degradation products due to its higher decomposition temperature. At the same time, the conversion of glycol recovery units from DEG to TEG is complicated, since the temperature for desorption of water from the TAG must be 30-40°C higher, which requires significant capital costs. It is known that the use of azeotrope-forming agents lowers the boiling point of solutions. Thus, the addition of such agents allows the conversion of existing absorption gas drying units from DEG to TAG with minimal material investment, which in turn allows for significant savings in operating costs.[3]

Results: We calculated the boiling point of some hydrocarbon-water mixtures using the Antoine equation. Since the mutual solubility of hydrocarbons and water is less than 0.2%, a model of immiscible components was used for the calculation. [4] The results are presented in Table. 1. As shown below, the boiling point of the “hydrocarbon-water-TEG” mixture almost coincides with the experimental data on the boiling point of the “hydrocarbon-water” mixture. Therefore, TEG does not actually affect the boiling point of the “hydrocarbon-water” azeotropic mixture. From Table. 1 it can be seen that for some components the calculated temperature of the “hydrocarbon-water-TEG” mixture significantly exceeds 100°C.[5]

Comparison of calculated and experimental boiling points of hydrocarbon-water-TEG and hydrocarbon-water mixtures.			
Hydrocarbon	Boiling temperature °C		
	Calculation of the “Hydrocarbon-water-TEG” mixture	Calculation of the "hydrocarbon-water" mixture	Literature information on "Hydrocarbon-water"
Pentane	35,7	34,5	34,6
Hexane	67,0	61,6	61,6
Heptane	92,1	79,2	79,2-79,6
Octane	111,1	89,4	89,4-89-6
Dean	132,7	97,5	97,2
Isooctane	92,6	79,3	78,8
Cyclohexane	77,4	69,4	69,5
Benzene	76,9	69,2	69,3
Toluene	101,1	84,4	84,1-84,5
Ethylbenzene	117,0	92,0	89,0-92,0

For example, for decane it was 132.7°C. Our experiments showed that in fact the boiling point of the mixture “n-decane — water — TEG” is in the range of 97-100°C. Thus, the effect of glycol can be neglected when calculating the phase-equal boiling of “hydrocarbon-water” azeotropic mixtures in the presence of TEG.

Of practical interest is a comparative analysis of the amounts of azeotropic solvents required to distill the same amount of water. The results of such calculations are summarized in the table.

Conclusion: Analysis of the efficiency of glycols used in the process of drying hydrocarbon gases showed that triethylene glycol (TEG) has a number of advantages over diethylene glycol (DEG), which makes it a more promising adsorbent on an industrial scale. In particular, the low loss rate, high dew point depression, and thermal stability of TEG make it a viable choice from an energetic and economic perspective. At the same time, the higher temperature required for water desorption from TEG creates certain technological obstacles to its implementation.

Based on the calculations and experimental results, it was found that the boiling point of the “hydrocarbon-water-TEG” mixture is very close to the experimental values known for the “hydrocarbon-water” mixture. This indicates that the presence of TEG does not significantly affect the azeotropic properties of hydrocarbon-water mixtures. Also, the experimental results conducted on the example of the “n-decane-water-TEG” system confirm this theoretical conclusion in practical terms.

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