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Analysis of Modern Methods of Gas Cleaning From Hydrogen Sulfide

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ABSTRACT: The current state of the problems associated with the production, preparation and transportation of hydrocarbon gases, puts in a number of the most important tasks their purification from acidic impurities, (in particular from hydrogen sulfide) that cause corrosion of process equipment and destruction of building structures. Purification of hydrocarbon gases from hydrogen sulfide must be carried out primarily for environmental reasons due to the toxicity and aggressiveness of hydrogen sulfide and its derivatives for humans and the environment. In addition, the presence of hydrogen sulfide does not allow the use of hydrocarbon gases in everyday life, as well as in industry due to the poisoning of catalysts used in various chemical processes. Currently, in the development, construction and operation of fuel and energy complexes, problems (environmental, technological) associated with the presence of hydrogen sulfide in hydrocarbon raw materials and products are becoming more and more acute.

KEYWORD: purification, hydrogen sulfide, absorption methods, field technologies, cavitation-vortex regime, mass transfer.

Relevance of the topic: The relevance of the work is due to the daily consumption around the world of fuel for cars, aviation, the ship industry, agricultural needs, chemical industries, as well as for household items, and therefore gas desulphurization is one of the most important and promising areas of research. There are many impurities in the field gas, one of which is sulfur-containing compounds that are unacceptable in the commercial product; these impurities also affect the environmental friendliness class of the fuel. At the moment, for the existing neutralizers of sulfur compounds, and in particular mercaptans and hydrogen sulfide, specific reagents are used that must be synthesized, purchased and certain technical conditions must be observed under which these reagents will work effectively.

Thus, it is possible to form a research problem: the development of a neutralizer is more efficient, cheaper, and also easier to use and obtain.

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Purpose of the study: Research and development of the fundamentals of technology for selective purification of gases from hydrogen sulfide in order to reduce the level of environmental pollution with sulfur compounds at industrial facilities.

To achieve this goal, the following **tasks** were solved in the work:

- Development of the composition of the oxidizing solution for the conversion of hydrogen sulfide to elemental sulfur in a wide temperature range, with the ability to regenerate.
- Development of the technological foundations of the oxidative method of gas purification from hydrogen sulfide using the direct-flow method of mixing the interacting phases.

Methods for solving the tasks:

- systematization and analysis of modern technological processes of gas purification;
- experimental study of the neutralizing ability of sorbents to hydrogen sulfide and the development of an effective combination of the composition of the absorption solution;
- experimental research and testing of gas purification technology from hydrogen sulfide in field conditions;
- Summarizing the results of laboratory and field tests of the new technology.

The object of research is the development of a technology for chemical gas purification from hydrogen sulfide.

The theoretical and methodological basis of the study are the works of researchers on the removal of hydrogen sulfide from oil. An extensive and great contribution was made by several prominent scientists and well-known researchers: Afanasiev S.V., Volkov V.L., Bazhmakmetov M.K., Vildanov A.F., Garifallin R.M., Grigoryan G.L., Leshin S.P. , Nizamov K. R. Mavlyutova M. Z., Mazgarov A. M., Merzejildin Z. G., Mukhemechin M. M., Petrov A. A., Pozdnishev G. N., Sakhabutdinov R. Z., Sokolov A G., Tronov V. P., I Fakhriev A. M., Shaidullin D. F., Shakirov F. G., Shatalov A. N., Shiraev A. I.

The scientific novelty of the research lies in the development of a technology for the production of a neutralizer of sulfur compounds that excludes free formaldehyde.

The practical significance of the work. As a result of theoretical, experimental and derivative tests, high efficiency and operability of new technological and technical solutions in the environmental field have been obtained.

One of the urgent problems in the production of hydrogen sulfide-containing oils is the problem of increasing the efficiency of operation and environmental safety of oilfield systems, including productive formations, wells and surface equipment.

In the current conditions of the development of market relations, there is a tendency to use small-sized automated units in a block-aggregate design, which is dictated by the saving of energy potential. The use of the vortex effect in the improvement of existing systems for oil gathering and field treatment of petroleum gas, the development of new, energy-saving technologies is becoming an increasingly urgent problem.

Expansion of the scope and efficiency of vortex devices is one of the problems of energy and resource saving technologies and protection of the environment from harmful industrial gas emissions.

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The intensification of production in the oil and gas industry is characterized by an increase in the output of the final product, which is achieved both due to an increase in the rates of chemical reactions, temperature and pressure (process parameters), and through the development and application of fundamentally new devices, technologies and influences on the course of technological processes. Therefore, modern technological processes must be continuous and proceed at high speeds, provided that efficiency and the integrated use of raw materials and energy are ensured.

Relevant from the point of view of eliminating the possibility of environmental pollution is the need to increase the efficiency of processes for cleaning well products from hydrogen sulfide by reducing the working time for obtaining a unit of production and reducing material and energy costs while improving product quality.

All processes of gas purification from hydrogen sulfide can be classified into absorption, adsorption and oxidative (Fig. 1).

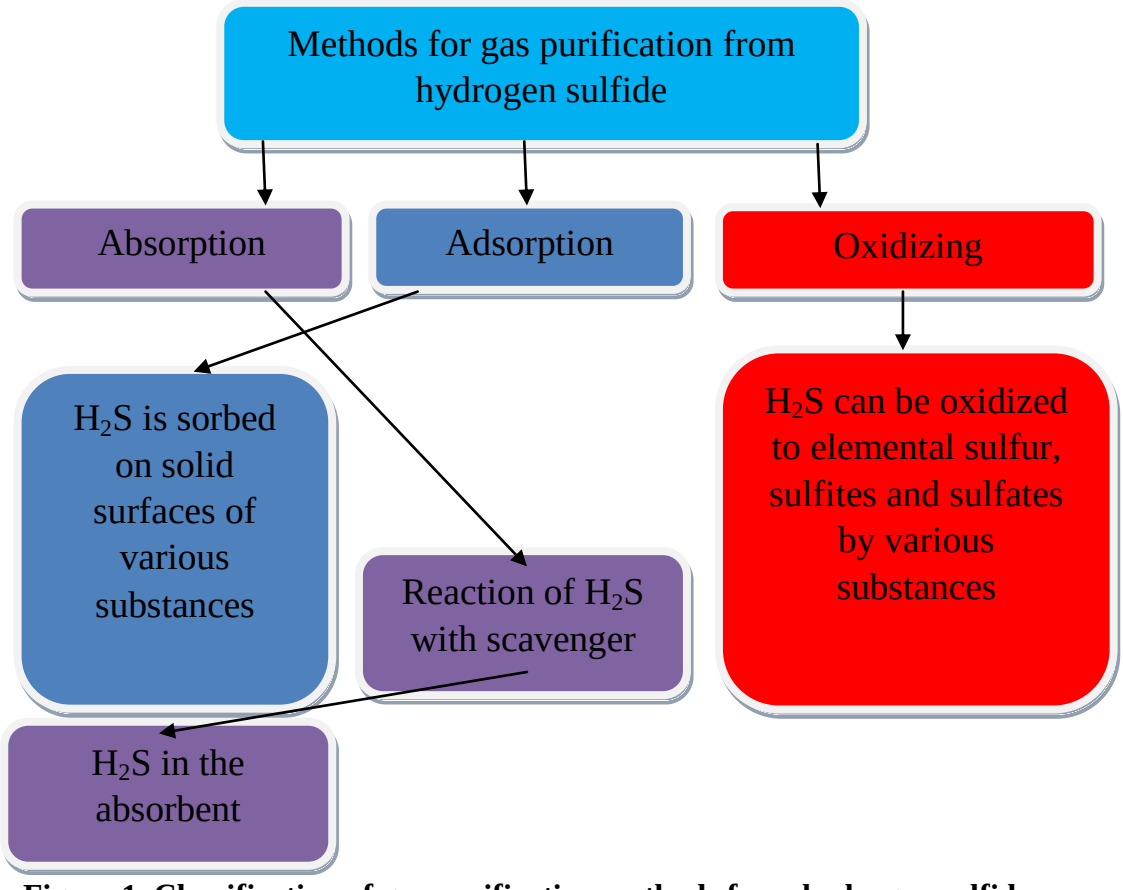

Figure 1. Classification of gas purification methods from hydrogen sulfide.

Absorption methods are based on mass transfer through the gas-liquid interface. Chemisorption processes are based on the chemical interaction of H_2S and CO_2 with the active part of the absorbent. Physical absorption processes are based on the extraction of acidic components and occur due to their solubility in organic absorbents. Combined processes in the base use both chemical and physical scavengers.

In adsorption gas purification processes, the removal of harmful impurities from the gas stream occurs as a result of their concentration on the surface of a solid material with a large specific surface area.

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Oxidative methods are based on chemical reactions in which sulfur changes its valency. Oxidative processes take place in the irreversible conversion of absorbed hydrogen sulfide into sulfur.

An analysis of the world practice accumulated in the field of natural gas purification shows that the main processes for processing large gas flows are absorption processes using chemical and physical absorbents and their combinations.

Gas purification processes with physical absorbents have a number of advantages over processes based on the use of ethanolamine solutions. They consist in the fact that physical absorbents make it possible to extract from the gas simultaneously with H_2S and CO_2 organosulfur impurities - mercaptans, carbon sulphide, carbon disulfide, and in some cases dry the gas. In addition, the energy costs for the regeneration of absorbents are much lower due to the fragility of the absorbent/impurity compounds. A limitation of their wide application (apart from cost) is the increased solubility of the hydrocarbon components of the gas in the absorbent, which is especially critical in the treatment of wet gas. Various classes of compounds are used as physical absorbents for gas purification: aliphatic alcohols, glycol ethers, heterocyclic compounds, and others.

Given the shortcomings of the absorption equipment used for the purification of natural petroleum gas from H_2S and CO_2, it seems promising to use cocurrent-vortex devices with small dimensions to create the required interfacial surface (mainly due to high throughput and gas velocity reaching 30 m/s), and low hydraulic resistance. There is experience in the use of vortex devices in the chemical industry.

The use of wave effects makes it possible to increase the efficiency of mass transfer in chemical-technological processes and to create compact devices based on them. Moreover, the energy of the flow, for these devices, is sufficient to create an effective cavitation-vortex regime (Fig. 2).

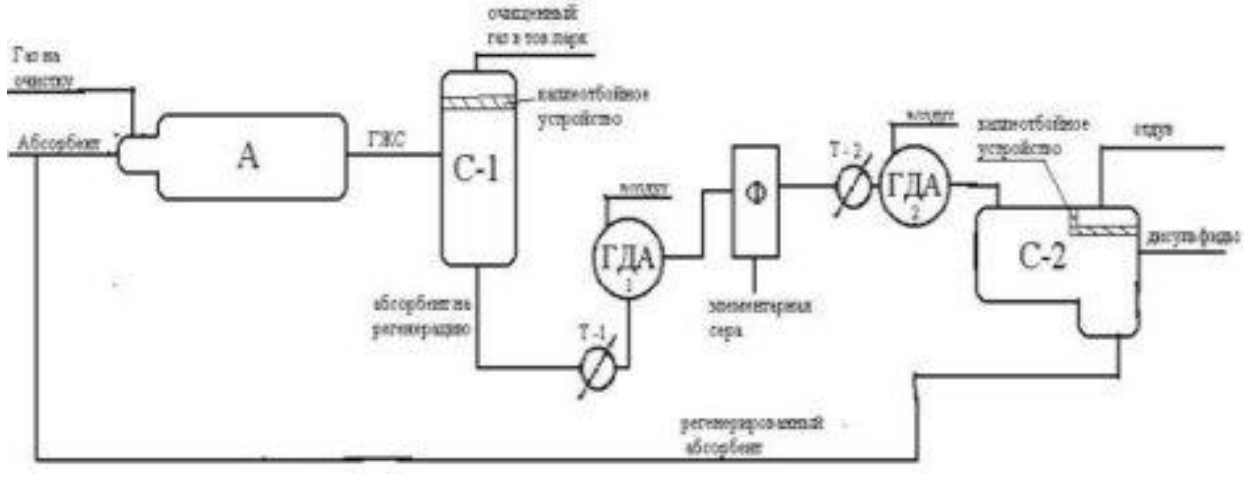

Figure 2. Scheme of gas purification with a block for regeneration of the spent absorption solution using cavitation-vortex devices:

A - absorber; C-1 - separator; HDA - hydrodynamic apparatus; C-2 gravity separator; F - filter; T-1, T-2 - heat exchangers.

Conclusion

Based on the developed designs, a process for the absorption purification of hydrocarbon gases from sulfur compounds with a two-stage unit for the regeneration of waste water-alkaline effluents has been proposed:

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- reduce the metal consumption of technological equipment;
- use an absorbent solution with a low concentration of alkali (2–4 wt. %), the smallest size of absorbent droplets (2–4 mm) is achieved at a liquid outflow rate through the nozzle of the cavitation-vortex absorber (CVA) equal to 10–15 m/s.

optimize the temperature regimes of oxidation, hydrogen sulfide to elemental sulfur and mercaptans to disulfides, -40–50^{o}C and 80–95^{o}C, respectively.

Analyzing field technologies for cleaning oil and gas from hydrogen sulfide, we can conclude that in recent years there has been some progress in the development and implementation of such technologies. One of the effective methods for removing hydrogen sulfide from petroleum gas is the method of cleaning it from hydrogen sulfide in a field preparation system using vortex devices as absorbers.

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