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TECHNOLOGY OF AN ENVIRONMENTALLY SAFE GAS CHEMICAL COMPLEX FOR UTILIZATION OF SULFUR-CONTAINING AND FLARE GASES DISCHARGED FROM TECHNOLOGICAL INSTALLATIONS

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A B S T R A C T	K E Y W O R D S
A schematic diagram of an environmentally safe HCG is presented, which provides practically waste-free processing of sulfur-containing natural gas.	

Introduction

The Republic of Uzbekistan belongs to the gas-bearing regions and has working oil and gas processing plants. With limited reserves of gas in the subsurface, the problem is to satisfy the need for gas not by increasing the volume of gas production, but by deepening its processing, involving high-octane polymer benzines, sulfur and nitrogen-containing compounds in the production. Currently, the restructuring of the production structure of refineries and gas processing plants is directed towards the development of waste-free environmental technologies, priority in financing is given to projects in accordance with which the amount of gas waste is minimized, or they are reused and profitably used. Since there are oxygen-, nitrogen -, sulfur-containing components and additional, unsaturated hydrocarbon gases in the composition of the gas burned on flares. Combustion products of mixtures of these gases are more toxic to the environment. Therefore, only complex processing and the use of waste as secondary raw materials ensure the preservation of natural resources. At the same time, the level of environmental pollution is sharply reduced.

Intensive development of large gas, gas condensate and oil fields, whose products contain hydrogen sulfide and organic sulfur compounds, has led to the creation of a number of powerful gas chemical complexes (GCCs) for its processing [1]. Mining and processing enterprises of these complexes are the main sources of environmental pollution by emissions of sulfur compounds (hydrogen sulfide, thiols, sulfur oxides, sulfur-alkaline effluents). The main areas of their reduction can be recycling and conditioning processes, which reduce the amount, toxicity of emissions and the cost of their disposal. For the sustainable development of the gas industry, it is necessary to develop production and investment programs that take into account the requirements of reducing environmental hazards and reducing production costs associated with the extraction, processing of sulfur raw materials and the use of the resulting products [2].

This article discusses the schematic diagram of an environmentally safe HCG, which provides practically waste-free processing of sulfur-containing natural gas. The main purpose of HCG is the purification of hydrocarbon raw materials from sulfur compounds and the production of high-quality products of its processing.

The block diagram of an environmentally safe GC (Fig. 1) provides for deep purification of zeolite regeneration gases in two stages by using, at the first stage (7) - extraction of hydrogen sulfide – spent alkaline solutions from liquefied gas desulfurization units and obtaining a mixture of natural mercaptans (SPM) (5,6), and at the second stage – absorption extraction of thiols (8) with their subsequent desorption from the absorption solution and separation into individual compounds by rectification (9). A variant of the scheme is to use the process of their direct oxidation to dialkyl disulfides and sulfur (11) to extract thiols and hydrogen sulfide from zeolite regeneration gases, eventually forming dialkyl polysulfides, separating the latter and their reductive cleavage in the presence of halide alkyls to obtain dialkyl sulfides (12), which can be used as an odorant of natural gas or valuable chemical reagents and intermediates. Equipping the tanks of the goods fleet with floating pontoons reduces the volume of emissions by about two orders of magnitude, which, however, are still quite large in this case. To solve this problem, it is necessary to equip commodity tanks with an emission collection system (installations for capturing light fractions of ULF) (26), which allows to bring the content of hydrogen sulfide, thiols, light hydrocarbons in the atmosphere of commodity parks to the required level. An effective method of reducing emissions is the removal of the lowest molecular weight thiols from commercial HCG products (propane butane fraction (PBF), broad fraction of light hydrocarbons (SHFLU), stable gas condensate) by alkaline extraction (5) followed by desorption of thiols from an aqueous alkali solution (6) and separation into individual compounds (9). After separation a mixture of the obtained thiols is used as a natural gas odorant (SPM). The spent alkali solution is used to purify zeolite regeneration gases (7), and then sent to the sulfur-alkali waste carbonation unit (23) to obtain an additional amount of hydrogen sulfide. Next, the SLC is purified from dissolved thiolates by conducting a reaction with halide alkyl in the reactor (24). Purified from sulfur compounds, an aqueous solution of carbonates and alkali metal chlorides is subjected to electrolysis (25) to obtain an aqueous solution of NaOH, which is returned to the cycle. Acid gases from crude gas amine purification plants (H2S,CO2) are supplied to a direct oxidation plant (13), the exhaust gases of which go to the second stage of the direct oxidation process (14) for post-treatment on special catalysts of a honeycomb structure [3]. The purified exhaust gases of the direct oxidation plant are a mixture of nitrogen, carbon dioxide and water vapor. The water is separated by cooling the gas mixture and passing it through horizontal membrane apparatuses (15). A mixture of nitrogen and carbon dioxide is used as an inert gas in the system of increasing productive formations at the field, and water is used for technical needs. If there are productions in the composition of HCCs that require the use of hydrogen, then a variant of the scheme is advisable, according to which part of the acid gases are sent to a plasma chemical reactor (16) to produce elemental sulfur and hydrogen [4]. The gases leaving the reactor are cooled, liquid sulfur is separated and sent to the catalytic reduction reactor

(17) in order to convert the sulfur compounds remaining in them (sulfur oxides, carbon disulfide, carbon disulfide) into hydrogen sulfide, which is used to produce valuable sulfur-containing products by interacting with dioxazine (20) and formaldehyde (21). Hydrogen formed during the plasma chemical reaction is used as a reducing agent. The resulting mixture of hydrogen sulfide, hydrogen and carbon dioxide is sent to the reactor (18) to produce sulfur [5], part of which is sent to the condenser (22) to produce colloidal sulfur. Depending on the demand for the installation, the production of liquid and polymer sulfur can also be organized. The gases leaving the reactor (18) (a mixture of nitrogen, carbon dioxide and hydrogen) are sent to the amine purification adsorber (19) to extract carbon dioxide, part of which is fed to the unit carbonation of the SSCO (23). Methanethiol from blocks (8) and (24), which cannot be used as an odorant, is disproportionated in the reactor (10) to dialkyl sulfides. The latter are used as an odorant of natural gas. Part of the hydrogen from block (19) is used as a reducing agent on block (12), and the remainder (a mixture of nitrogen and hydrogen) is used as a component of raw materials for the synthesis of ammonia. The nitrogen-hydrogen mixture and carbon dioxide are dried in membrane separation devices before being supplied to the consumer. The proposed scheme of an environmentally safe industrial complex for processing sulfur-containing natural gas has been developed on the basis of generalization of data obtained during the operation of pilot and pilot-industrial installations at the facilities of the gas, oil and gas processing industries. Processing of sulfur-containing gases according to the developed scheme allows, unlike the existing ones [6-11]: to ensure 99.99% utilization of hydrogen sulfide; to achieve 98-99% extraction of thiols from zeolite regeneration gases; to achieve complete utilization of sulfur-alkaline waste; to carry out full utilization of low-molecular-weight organosulfur compounds; to efficiently dispose of non-hydrocarbon products of natural gas processing; to ensure a high degree of environmental protection during the processing of sulfur and high-sulfur gases.

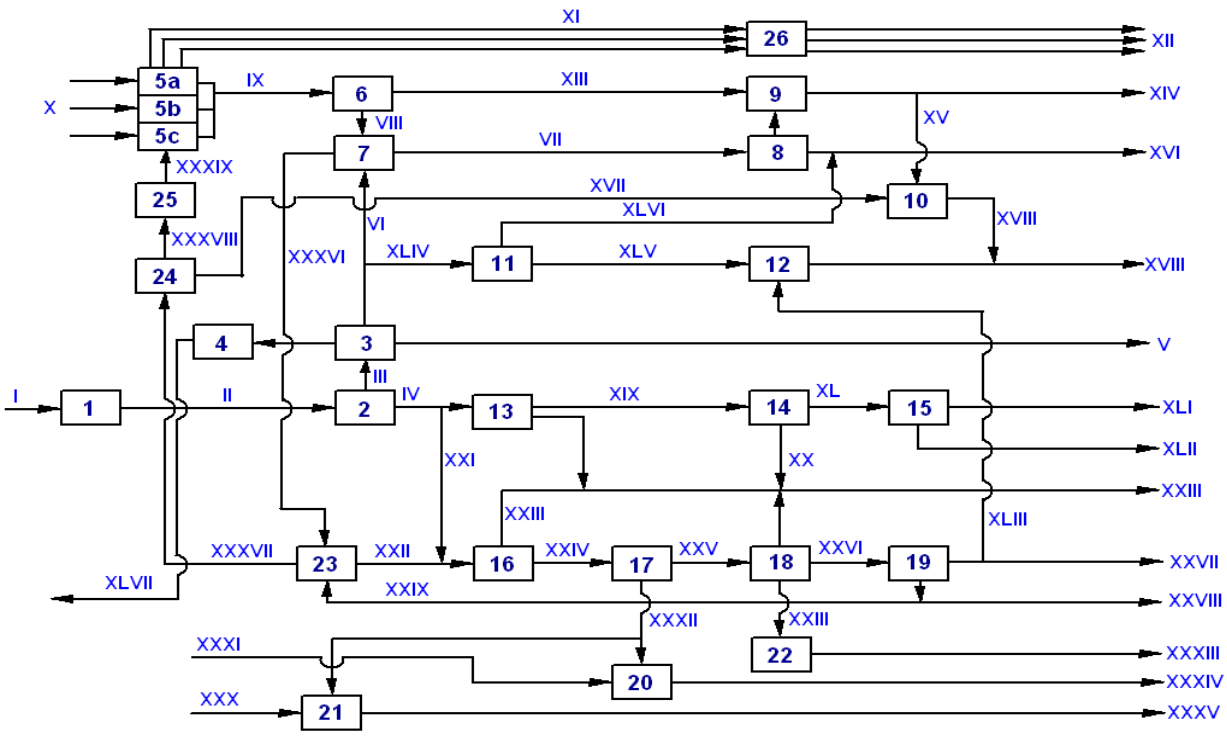

Figure 1. Block diagram of an environmentally safe HCG.

Blocks:

1 – measurement, separation and heating of sulfur dioxide from the integrated gas treatment plant (CCP); 2 – purification of gas from H2S and CO2 with alkanolamines; 3 – purification of gas on zeolites from organosulfur compounds; 4 – disposal of spent zeolite; 5 – extraction of thiols and H2S from PBF and SHFLU with an aqueous solution of alkali; 6 – regeneration of thiols from an alkaline solution; 7 – extraction of H2S with liquid SLS from the zeolite regeneration gas; 8 – alkaline extraction of thiols from the zeolite regeneration gas and their isolation from the extract solution; 9 – separation of a mixture of thiols into individual compounds by rectification; 10 – reactor for the disproportionation of thiols into dialkyl sulfides; 11 – oxidation of thiols to dialkyl sulfides; 12 – reactor for the reductive cleavage of dialkyl disulfides into dialkyl sulfides; 13 – H2S direct oxidation plant; 14 – the second stage of the direct oxidation process; 15 – cooling and membrane separation of waste products of the direct oxidation plant; 16 – plasma chemical decomposition reactor H2S; 17 – reactor for the reduction of unreacted sulfur compounds to H2S; 18 – reactor for the addition of H2S to produce elemental sulfur; 19 – alkanolamine purification of CO2 exhaust gases of a plasma chemical reactor; 20 – interaction of hydrogen sulfide with dioxazine; 21 – interaction of hydrogen sulfide with formaldehyde; 22 – production of colloidal sulfur; 23 – carbonation unit of SSW; 24 – purification of SSW from thiolates in the presence of halide alkyl; 25 – electrolyzer; 26 – commodity park with ULF unit.

Streams:

I – sulfur dioxide with UCP; II – sulfur dioxide for purification with alkanolamines from H2S and CO2; III – gas for purification from organosulfur compounds on zeolites; IV – acidic gas; V – commercial natural gas to consumers; VI – zeolite regeneration gas for purification from H2S by liquid SLC; VII – zeolite regeneration gas for purification from thiols; VIII – SLC for H2S extraction and regeneration; IX – extraction solution for regeneration thiols; X – stable condensate, CFLU, PBF for thiol extraction; XI – stable condensate, SHFLU, PBF to the commodity fleet; XII – stable condensate, SHFLU, PBF to consumers; XIII – a mixture of natural thiols for separation; XIV – individual thiols to consumers; XV – methanethiol for disproportionation; XVI – purified gas for own needs; XVII – a mixture of thiols for disproportionation; XVIII – a mixture dialkyl sulfides to consumers; XIX – waste gases of the direct oxidation plant for post–treatment; XX – liquid sulfur; XXI – acid gas into the plasma chemical reactor; XXII - acid gas from the carbonation column of the CSF into the plasma chemical reactor; XXIII – elemental sulfur; XXIV – gases from a plasma chemical reactor for post-treatment; XXV – waste gases from the reduction reactor for oxidation; XXVI – waste gases of the plasma chemical reactor for separation; XXVII – a mixture of hydrogen and nitrogen to the consumer; XXVIII – carbon dioxide to the consumer; XXIX – carbon dioxide into the carbonation column of the CSR; XXX – formaldehyde; XXXI – dioxazine; XXXII – hydrogen sulfide; XXXIII – colloidal sulfur to the consumer; XXXIV – polyaminosulfide to the consumer; XXXV –polymethylene sulfide to the consumer; XXXVI – liquid SLC for carbonation; XXXVII – SLC for purification from thiols; XXXVIII – SLC for electrolysis; XXXIX – alkaline solution for extraction of H2S and thiols; XL – waste gases for separation; XLI – a mixture of nitrogen and carbon dioxide; XLII – water for technological needs; XLIII – a mixture of hydrogen and nitrogen reducing splitting of dialkyl disulfides; XLIV – sulfur dioxide regeneration of zeolites for the oxidation of thiols into dialkyl disulfides; XLV – a mixture of dialkyl disulfides for reducing splitting; XLVI – purified gas regeneration of zeolites for their own needs; XLVII – spent zeolite for disposal.

Literatures

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