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Reducing the operating costs when applying the optimal amine ratio at the purification unit of the Gazli gas refining plant

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ABSTRACT: In accordance with the Presidential Decree of the Republic of Uzbekistan № PP -4388 dated 09.07.2019 "On measures to provide the economy and the population with energy resources, financial recovery and improvement of the oil and gas industry management system" their debt burden with the involvement of independent international experts. The use of an absorbent for purification from acidic components of natural gas with a concentration (mass.) of 28% MDEA and 2% DEA at all lines of the desulfurization unit (DSU) of the Gazli gas processing plant instead of 30% MDEA, makes it possible to save operating costs up to 1,0 million USD per year by reducing the consumption of energy resources (steam, electricity, cold water, etc.). Also, the use of the above concentration of amine solutions makes it possible to bring the amount of carbon dioxide in the commercial gas to the requirements of the state standard O'zDSt 948, which will be introduced from 01.01.2023, thereby avoiding penalties from companies providing gas transportation services to gas processing plant.

KEYWORDS: gas, composition, hydrogen sulfide, absorbent, economic, processing, quality, unit, optimization.

I. INTRODUCTION

In the Republic of Uzbekistan, measures are being taken to consistently modernize and technologically re-equip the system of electricity and gas supply, improve the fundamentals of energy conservation and mechanisms for mutual settlements for the supplied electricity and natural gas.

The ongoing activities are aimed at developing the energy industry, which is one of the most important factors for sustainable socio-economic growth, increasing business activity and investment attractiveness of the country, living standards and welfare of the population.

At the same time, the existing capacities of the fuel and energy industry do not fully cover the growing demand for energy resources, the energy intensity of the domestic economy significantly exceeds the average for developed countries.
The lack of a differentiated approach to determining the cost of supplied energy resources, taking into account the categories of consumers, leads to their irrational use, does not stimulate the invest of energy-saving technologies and alternative energy sources.

In order to further improve the system of electricity and gas supply, ensure the rational use of energy resources through the widespread introduction of market mechanisms, as well as improve the quality of services provided in this area, a number of Presidential Decrees of the Republic of Uzbekistan were adopted:

- No. PP-3379 dated 08.11.2017 “On measures to ensure the rational use of energy resources”;
- No. PP-4422 dated August 22, 2019 “On accelerated measures to improve the energy efficiency of economic and social sectors, the invest of energy-saving technologies and the development of renewable energy sources”;
- No. PP-4388 dated July 9, 2019 “On measures to provide the economy and the population with energy resources, financial recovery and improvement of the oil and gas industry management system”,

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aimed at the implementation of long-term strategies for the development of the oil and gas, electric power, coal, chemical, construction industries, providing for dynamic economic growth and improving the welfare of the population, uninterrupted satisfaction of demand for fuel and energy resources.

II. REFERENCE INFORMATION

In this regard, one of the topical areas of state policy at the present stage should be to increase the energy efficiency of economic and social sectors, the widespread introduction of energy-saving technologies and renewable energy sources [1].

Taking into account that the enterprises that are part of the country's fuel and energy complex play a significant role in economic development, and the production and pricing of marketable products are based on the pricing of energy resources, the implementation of measures aimed at optimizing the operating costs of production enterprises for the production of hydrocarbons which a positive effect on the financial condition of operating companies.

III. METHODOLOGY

The scientific work under consideration is aimed to solving the issue of reducing the operating costs of existing plants and improving the quality of natural gas purification from acidic components (H_2S and CO_2) via subsequent selection of the type of sorbent and optimal process parameters without large-scale changes in the technological chain.
Purification in the technological lines of the desulfurization unit (DSU) at the Gazli Gas Processing Plant (GPP) is achieved by chemical absorption of H_2S and CO_2 in a column-type unit with a 30% aqueous solution of methyldiethanolamine (MDEA), which ensures selective absorption of hydrogen sulfide in the presence of carbon dioxide (Figure 1).

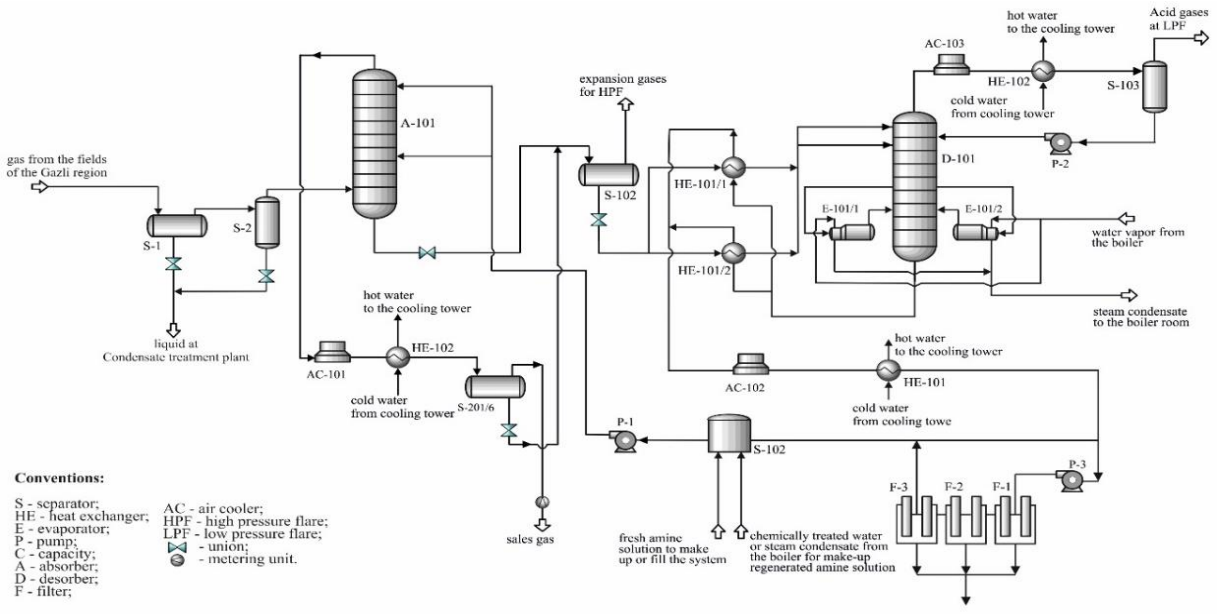

Fig. 1 - Schematic diagram of the desulphurization plant

In this case, the total volume of acidic components in the composition of the gas reaches 3.59 % mol. (including H_2S - 0.86% and CO_2 - 2.73%). As a result, hydrogen sulfide is almost completely removed from the feed gas, and carbon dioxide is partially removed. For the cleaning of sour natural gas in the amount of 180000-185000 st.m^3 per hour (for one line), the required amount of regenerated MDEA, according to calculations, is 155-160 tonn per hour (the inlet pressure is assumed to be 55 atm.) [2].

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Numerous studies performed on the basis of a special software product dedicated to the choice of the optimal ratio of methyldiethanolamine (MDEA) - selectively absorbing hydrogen sulfide and diethanolamine (DEA) - selectively absorbing carbon dioxide component from the composition of natural gas, the results of which show that at a concentration (ratio) of 28% - MDEA and 2% DEA (combined), the required amount of the mixture of the regenerated amine solution is 145-150 t/h (the inlet pressure is chosen at 55 atm.) (Figure 2).

IV. RESEARCH RESULTS

Nowadays, the amine desulfurization plant of the Gazli GPP, the volume of regenerated 30% aqueous solution of methyldiethanolamine (MDEA) is 140-145 t/h (for one line), which ensures the quality of commercial products with a hydrogen sulfide content of 4.9 ppm and carbon dioxide of 1.58 -1.63% and will not provide the requirements of the state standard (O'zDSt 948) in the future [3].

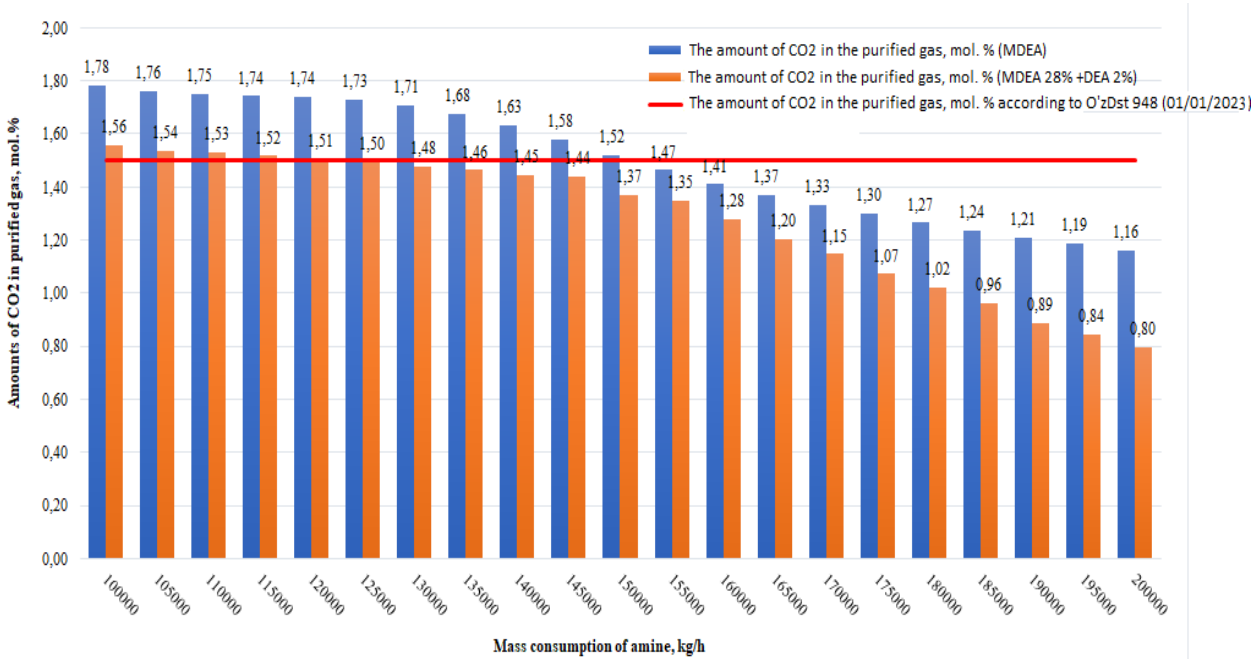

Fig.2 - Graph of the required amount of amines and the amount of CO_2 (mol.) in the commercial gas.

In order to achieve the parameters of commercial gas to the requirements of the state standard, calculation results show the necessity to increase the volume of the solution (30% aqueous solution of MDEA) to 155-160 t/h, which is 8-10% more than present actual indicator (operation conditions).

Replacing the existing amine solution (30% MDEA aqueous solution) with a concentration (ratio) of 28% MDEA and 2% DEA at a volume of 145-150 t/h makes it possible to clean natural gas to the requirements of the state standard (quality of commercial products with a hydrogen sulfide content of up to 2.48 ppm and carbon dioxide of 1.44%).

Reducing the volume of the solution by 8-10% will positively affect the consumption of energy resources (steam, refrigerant, electricity, etc.) during operation. Thus, the use of a combined amine solution, instead of the existing one, makes it possible to save up to 257.2 thousand USA dollars per year for one line, and for three lines this figure is up to 771.6 thousand USA dollars (Table 1).

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Table 1
Comparative analysis of the actual (basic) and proposed (combined) options

№	The name of indicators	Unit of measure-ment	Option-1 (basic)	Option-2 (combined)	Difference +/-	Profit, USA dollars
1	Description of options		Gas cleaning with 30% aqueous MDEA solution	Gas cleaning with a mixture of 28% MDEA and 2% DEA aqueous solution	Savings compared to option-1	
2	Incoming raw materials	m^3/h	185098	185098	-	
3	Purified gas	m^3/h	180801	180835	34	1,1
4	Regenerated solution - supply to the adsorber	kg/h	160000	145000	15000	
5	Saturated solution - supply to the desorber	kg/h	166551	151441	15110	
6	System make-up:					
6.1	Chemically treated water	kg/h	1151	1528	-377	-0,049
6.2	MDEA	kg/h	0,3768	0,4701	-0,09	-0,182
6.3	DEA	kg/h	-	0,0027	-0,0027	-0,005
7	Circulating water consumption:					
7.1	Purified gas cooling	kg/h	258135	258417	-282	-0,0004
7.2	Acid gas cooling	kg/h	157972	140224	17748	0,0231
7.3	Cooling of the regenerated solution	kg/h	273839	247824	26015	0,0338
8	The amount of energy sent to operate the main pump					
8.1	Supply of solution to the absorber	kWh	322,50	292,00	30,5	1,22
8.2	Acidic water circulation	kWh	1,25	1,01	0,24	0,01
9	The amount of steam (medium pressure) sent to heat the desorber	kg/h	58208	48606	9602	29,96
10	Final economic efficiency (per 1 line)	**USA dollars per hours**				32,1
11	**Final economic efficiency (for 1 line)**	**USA dollars per year**				257 200
12	**Final economic efficiency (for 3 line)**	**USA dollars per year**				771 600

When performing economic calculations, the energy resource tariffs valid as of 06/01/2021 were adopted, with its conversion into foreign currency (Table 2).

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Table 2

Cost indicators of energy resources as of 06/01/2021

№	Cost indicators for economic calculations	Unit	Cost in USA dollars
1	Commercial gas	1000 m^3	34
2	Electricity	1000 kW	40
3	Water	m^3	0,13
4	MDEA	tons	1950
5	DEA	tons	1780
6	Medium pressure steam	tons	3,12

V. CONCLUSION

It should also be noted that the use of a combined amine at a concentration (ratio) of 28% MDEA and 2% DEA, the amount of carbon dioxide component is below 1.5% mole, and the amount of hydrogen sulfide is below 3.5 ppm, which corresponds to the parameters of the state standard, which will be introduced from 01/01/2023.
Ensuring the requirements of the state standard for the quality of natural gas by GPP makes it possible to avoid penalties for transporting companies in the amount of 5% of the goods sold for each violated parameter.

VI. RECOMMENDATION

Reducing the volume of the circulating amine solution by 8-10% makes it possible to reduce the consumption of water vapor by 16.5% and electrical energy by 9.4%, which will ultimately lead to a reduction in the cost of products.

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