UDK 54.056/547.269

STUDY OF FOAMING AND CORROSION BASED ON THE USE OF COMPOSITIONS OF AMINES AND ETHERS IN THE PURIFICATION OF NATURAL GASES FROM ACIDIC COMPONENTS

https://doi.org/10.5281/zenodo.15594417

T.R.Yuldashev, N.T.Yuldashev, S.X.Uralov
Karshi State Technical University

Annotatsiya

Bu maqolada tabiiy gazni nordon komponentlardan tozalashda amin va efirlarning kompozitsiyalarini qoʻllash asosida gazlarni koʻpiklanish va korroziyalanish holatlari tadqiq etilgan hamda koʻpikning barqarorligini baholashda "Kvatramin 1001" korroziya ingibitorining konsentratsiyasidan foydalanib absorbentlarning koʻpiklanish va korroziyalanish xossasiga taʼsirini aniqlashning tadqiqot natijalari keltirilgan.

Аннотация

В данной статье исследованы ситуации газопенообразования и коррозии на основе использования композиций аминов и эфиров при очистке природного газа от кислых компонентов, а также представлены результаты исследований по определению влияния абсорбентов на пенообразование и коррозионные свойства с использованием концентраций ингибитора коррозии «Кутрамин 1001» при оценке устойчивости пены.

Annotation

This article examines situations of gas foaming and corrosion based on the use of compositions of amines and ethers when purifying natural gas from acidic components, and also presents the results of studies to determine the effect of absorbents on foaming and corrosion properties using the concentration of the corrosion inhibitor “Cutramine 1001” when assessing the stability of foam.

Kalit soʻzlar

komponentlar, absorbentlar, kislotali komponentlar, absorbent kompozitsiyalar, ko'piklash, korroziya, texnologiya, aminlar, efirlar.

Ключевые слова

компоненты, абсорбенты, кислые компоненты, композиции абсорбентов, вспенование, коррозии, технологии, амины, эфиры.

Keywords

components, absorbents, acidic components, absorbent compositions, foaming, corrosion, technology, amines, esters.

Introduction. In world practice, the most widely used ethanolamines as absorbents in the purification of gases from sour components (H_2S and CO_2, ethylene mercaptan (RSH), carbon sulfur oxide (COS), CS_2) are: monoethanolamine (MEA), diethanolamine (DEA) and N- methyldiethanolamine (MDEA). The limitation is the presence of COS and CS_2 in the gas, which irreversibly reacts with MEA and causes significant loss of solution. Therefore, it is urgent to develop the technology of obtaining absorbent compositions of a new type with high selectivity in the purification of natural gases from sour components.

DEA is used in non-selective removal (discharge) of sour components and is a project absorbent in large gas processing plants (GQZ) OAO Gazprom - Orenburg and Astrakhan. Currently, a 40% DEA solution is used in the process of gas purification at the Astrakhan GKIZ. In the process, it provides the necessary processes of gas purification from H_2S and CO_2, but the disadvantage of DEA increases the heat costs for the regeneration process of the absorbent [1].

Compared to MEA, the solution of MDEA has a low corrosion activity, is less damaged by destructive thermal expansion, requires less energy during regeneration, and allows its use when strongly saturated with acidic components [1, 2].

Using MDEA instead of MEA is promising for oil refineries. The main advantage of MDEA is its low corrosion activity, which means that it can be highly enriched (30-50% by mass) compared to MEA (10-20% by mass). In this case, the degree of saturation of MEA with sour gases is limited to 0.2-0.3 mol/mol, while for MDEA it is 0.5-0.6 mol/mol. This situation provides an opportunity to reduce the energy costs spent on the circulation and regeneration of the absorbent [2, 3, 4].

Based on corrosion studies, this evidence is accompanied by the transition of the sulphide surface structure of the metal surface from crystalline to amorphous, with the loss of mechanical strength, and in some places with the washing of the surface at an increase in the flow rate [3]. Later, the cleaning concentration of all facilities of the Astrakhan NPP was transferred to the design absorbent of DEA, which was 40% by mass [1, 4, 5].

1999-2000 at Orenburg GQIZ. Experimental and industrial testing of "Novamin" absorbent was carried out by adding methyl ether polyethylene glycol (MEPEG) to the mixture of MDEA/DEA [1, 2]. An absorbent composition was

AMERICAN JOURNAL OF EDUCATION AND LEARNING
ISSN: 2996-5128 (online) | ResearchBib (IF) = 9.918 IMPACT FACTOR
Volume-3| Issue-5| 2025 Published: |30-05-2025|

prepared by adding MEPEG to the working solution of the mixture of MDEA/DEA. The composition of MEPEG was 7-13% by mass, and the ratio of MDEA/DEA was 70-55%. Research tests show the result that "Novamin" absorbent has a fast regeneration feature compared to absorbents without MEPEG [4].

DEA is one of the industrial enablers of the first MDEA. It has been more than 30 years since foreign countries used a mixture of MDEA/DEA in gas treatment practice, but now this mixed absorbent is gradually being replaced by improved ones, which have good energy efficiency, thermal stability and corrosion activity [4 ,5].

The use of such "activated" amines instead of DEA, which is selective for CO_2 without an activator, provides an opportunity to reduce energy costs in amine regeneration.

When researching the corrosion behavior of various absorbents (Table 2), the data obtained separately for DEA and MDEA in the amount of 5-20% MEPEG St. It reduced the corrosion rate of 10-carbon steel by 10-12%. Piperazine (PP) has a much stronger effect: PP added to DEA and MDEA at 2% reduces the corrosion rate in such a way that the MDEA/DEA mixture has the same effect [5, 6, 7].

Table 1

Solubility equilibrium of CO_2 in aqueous solution of MDEA/DEA + MEPEG absorbents [4].

The composition of the absorbent	temperature,	CO_2 partial pressure of, kPa	Amine saturation, mol CO_2 /mol amine
	40	5,07	0,43
	70	4,82	0,15
	40	11 97	0 57
40 % (50 % MDEA	70	11,42	0,24
	40	97,84	0,72
	70	97,84	0,50
	40	4,73	0,37
	70	5,30	0,13
40 % (50 % MDEA	40	10,65	0,48
+ 20 % MEPEG	70	10,86	0,20
	40	98,90	0,66
	70	98,90	0,41

Properties of absorbents were carried out in a glass absorption column on the wall of the laboratory under the following conditions: gas transfer - 8 l/h (sour gases added to nitrogen), absorbent - 60 cm^3/h, temperature - 40°C. Nitrogen was used as a model gas, which included the following compounds - H_2S, CO_2, COS, RSH.

The results of the corrosion studies, i.e. Table 2, show that, in contrast to other activations, PP actually reduced the corrosion properties of the absorbents without increasing the absorption indicators.

Table 2

St. in various absorbents. Corrosion rate of grade 10 carbon steel [5].

Absorbent	Corrosion rate, mm/year
30 % DEA	0,0868
30 % DEA + 10 % EMS	0,0813
30 % DEA + 2 % PP	0,0064
40 % MDEA	0,08559
40 % MDEA + 10 % EMS	0,0773
40 % MDEA + 2 % PP	0,0080
40 % (MDEA/DEA – 50/50 %)	0,0948
40 % (MDEA/DEA – 50/50 %) + 2 % PP	0,0121

The experimental results are presented in Table 2. When PP was added to MDEA and DEA in the amount of 2-10%, it practically did not affect the extraction rate of RSH.

Our scientific research is aimed at bringing the quality of domestic raw natural gas to the requirements set for the above commodity gases. The main goal of scientific research is to remove sour components of gas, i.e. hydrogen sulfide and carbon dioxide, and for this purpose, the development of new generation absorbents in the absorption process and its practical implementation are set as a goal.

MEA and DEA were used as amines, and dimethyl and monomethyl ethers of polyethylene glycol were used for gas purification. At the first stage of our research, aqueous solutions of amines and ethers of different concentrations were obtained, and the obtained results are presented in Figure 1 [8;9].

In order to determine the activity and selectivity of absorbent compositions obtained on the basis of MEA+DEA+PEGDME+PEGMME in absorption purification of natural gases from acidic components, natural gas processed at the "Mubarak Gas Processing Plant" was used as natural gas.

Research results of determining the effect of "Qutramin 1001" corrosion inhibitor on the foaming properties of absorbents used in gas absorption purification showed that the height of the foam increases with the increase in the concentration of the corrosion inhibitor in the absorbent. In this case, when the amount of corrosion inhibitor in the composition of the absorbents is up to 30 ppm, the foam height is 25 mm, while the absorbent compositions DPP-1, MDPP-1 and MDPP-5 have a foam height of 25 mm even at a concentration of up to 50 ppm. did not reach mm.

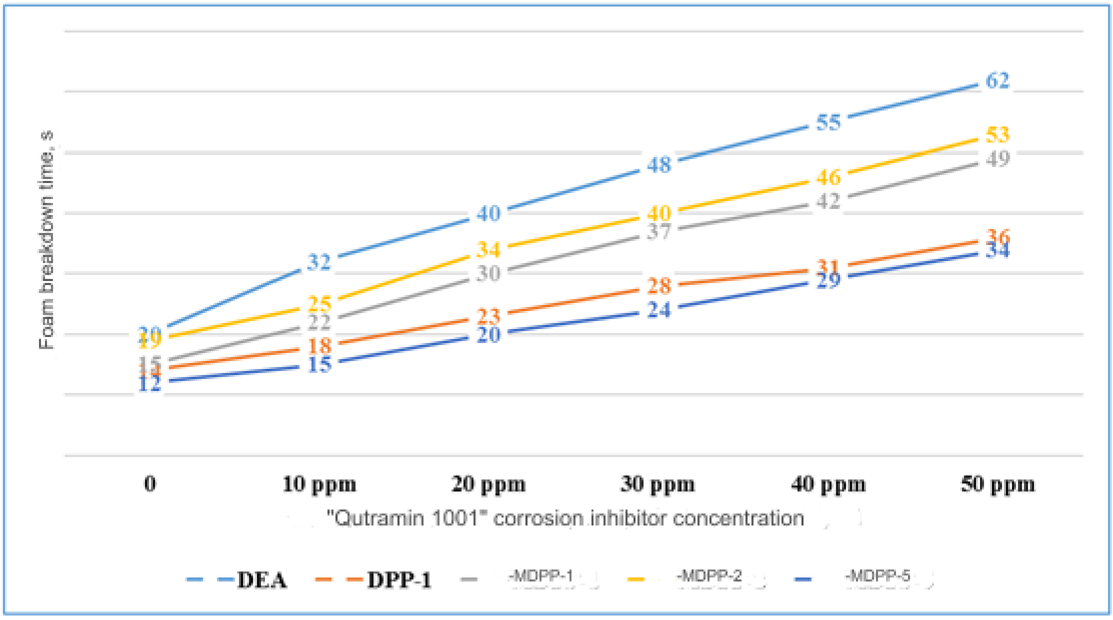

Figure 1. Dependence of foam stability of absorbent compositions on the concentration of "Qutramin 1001" corrosion inhibitor

If the initial low concentration of corrosion inhibitors had a rapid effect on the foam height, then with an increase in concentration, we can see that this increase increased in much smaller intervals [9,10,15,16].

The results of research on the dependence of the foam stability of absorbent compositions on the concentration of the corrosion inhibitor "Qutramin 1001" in the presence of this corrosion inhibitor in absorbent compositions DPP-1, MDPP-1, MDPP-2 and MDPP-5 at 50 ppm, the time of foam breakdown is 60 showed less than s, and the compositions obtained on this show that it corresponds to the middle class. It was found that the DEA solution belongs to a high class of foam stability.

At the next stage of research, the ability of absorbent samples to form foam and the dependence of foam stability on the concentration of mechanical particles in their composition were studied. The obtained results are presented in Figure 2.

Figure 2 shows that when DEA and MDPP-2 absorbents contain 0.005%, the foam height increases dramatically. DPP-1, MDPP-1 and MDPP-5 absorbents also showed that such a change increased with relatively small indicators. When adding mechanical particles to 0.1% in the composition of amine solutions, the height of foaming increased in small intervals, and in amounts above this concentration, it

AMERICAN JOURNAL OF EDUCATION AND LEARNING
ISSN: 2996-5128 (online) | ResearchBib (IF) = 9.918 IMPACT FACTOR
Volume-3| Issue-5| 2025 Published: |30-05-2025|

almost did not affect the height of foaming. It was concluded that it may have decreased the strength of the foam with the increase in the amount of solid particles at the liquid-air interphase boundaries [11,12,13].

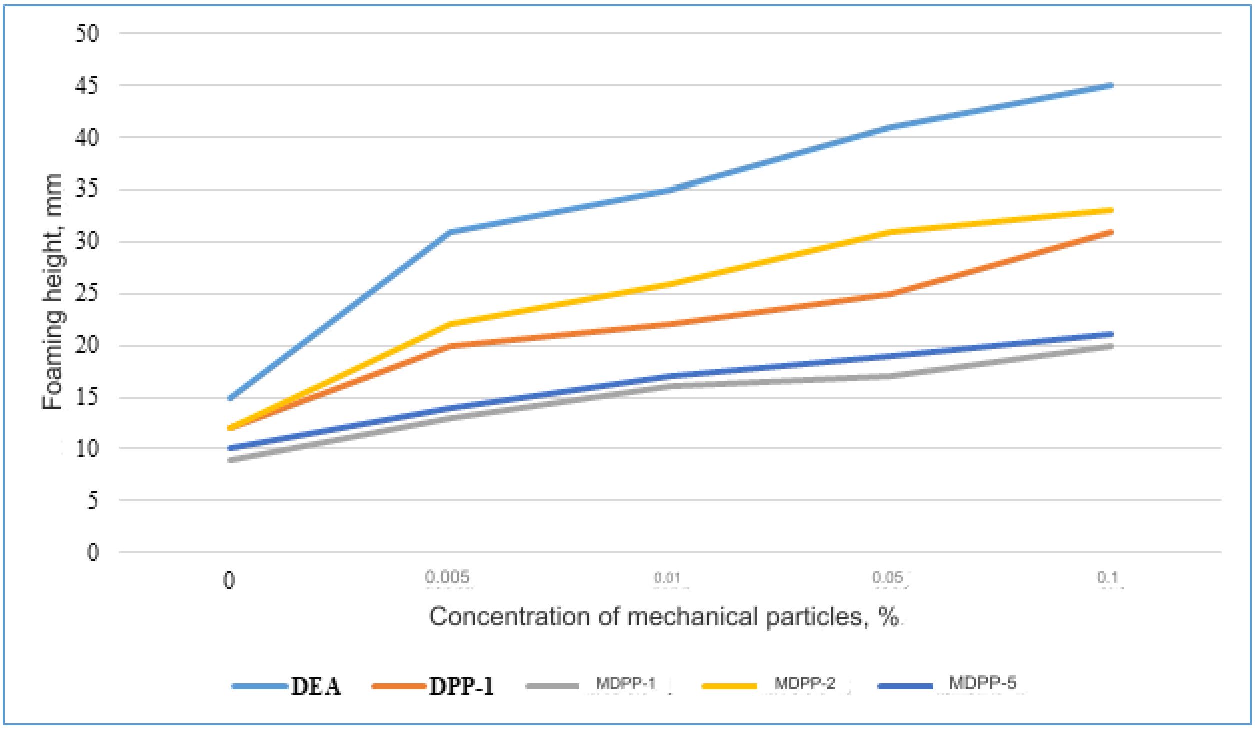

Figure 2. The effect of mechanical particles in absorbents on the foaming ability of absorbent compositions

Corrosion activity of absorbent compositions and DEA obtained during our research was determined at the first stage, in their pure water solution state. The obtained results are presented in table 3.

Table 3

Corrosion activity of absorbent compositions and DEA

№	Absorbent type	Corrosion rate, mm/year	№	Absorbent type	Corrosion rate, mm/year
1	MPP-1	0,04	10	DPP-4	0,09
2	MPP-2	0,05	11	DPP-5	0,08
3	MPP-3	0,05	12	DPP-6	0,06
4	MPP-4	0,06	13	MDPP-1	0,05
5	MPP-5	0,07	14	MDPP-2	0,09
6	MPP-6	0,06	15	MDPP-3	0,08
7	DPP-1	0,06	16	MDPP-4	0,07
8	DPP-2	0,05	17	MDPP-5	0,06
9	DPP-3	0,06	18	30% li DEA	0,07

The most recent factor in scientific research on the factors affecting foam formation of amines is the substances formed as a result of the decomposition of absorbents. We know that during desorption, as a result of various external factors, partial decomposition of amines and the formation of other substances are observed as a result. Today, it is established that absorbents can be used in the amount of 25%, depending on foaming and corrosion activity.

It was found that the foam stability of absorbent compositions depends on the concentration of substances formed as a result of the decomposition of absorbents in them.

Summary. In general, the results of the study of absorbent compositions with the presence of foam-inducing substances showed a high result of DPP-1, MDPP-1 and MDPP-5 absorbent compositions. These absorbents are completely suitable for industrial use, depending on the concentration of liquid hydrocarbons, corrosion inhibitors, mechanical particles and substances formed as a result of the decomposition of absorbents on the ability of absorbent compositions to form foam and foam stability. suitability has been proven as a result of conducted research.

The results obtained in determining the corrosion activity of absorbents showed that among these absorbent compositions, compositions based on MEA have less corrosion properties. In this case, it was found that absorbents that showed high results in gas cleaning and foaming had the following corrosion activity: DPP-1 absorbent composition - 0.06 mm/year, MDPP-1 absorbent - 0.05 mm/year and MDPP-5 absorbent and 0.06 mm/year. These obtained results revealed that the above-mentioned absorbent compositions exhibit better corrosion properties compared to absorbents used in gas cleaning.

Based on these results, it can be assumed that the low corrosion aggressiveness of absorbent compositions based on MEA and DEA, obtained during the research, was improved due to their composition due to ethers.

REFERENCES:

1. Афанасьев А.И. Применение МДЭА для очистки природного газа / А.И. Афанасьев, С.П. Малютин, В.М. Стрючков // Газовая промышленность. - 1986. - № 4. - С. 20-21.

2. Стрючков В.М. Применение МДЭА для очистки газов от $H_2Б$ на установке Л24/6 в ООО «ПО Киришинефтеоргсинтез» / В. М. Стрючков, А.И. Афанасьев,

3. Н.Н. Кисленко // Научно-технический прогресс в технологии переработки природного газа и конденсата. - М.: ВНИИГАЗ, 2003. - С. 57-62.

4. Настека В. И. Новые технологии очистки высокосернистых природных газов и газовых конденсатов / В.И. Настека. - М.: Недра, 1996. - 107 с.

5. В.Г. Антонов, А.Е. Корнеев, С.А. Соловьев и др. // Газовая промышленность. - 2000. - № 10. - С. 58-60.

6. Юлдашев Ташмурза Рахмонович (2023). ОСНОВА ОБОРУДОВАНИЯ, ИСПОЛЬЗУЕМОГО В ПРОЦЕССЕ ОЧИСТКИ ГАЗОАБСОРБЦИОННОЙ ТЕХНОЛОГИИ. Universum: технические науки, (5-6 (110)), 20-24.

7. Юлдашев Ташмурза Рахмонович (2023). АКТУАЛЬНЫЕ ПРОБЛЕМЫ АМИННОЙ ОЧИСТКИ ПРИРОДНЫХ ГАЗОВ И ПУТИ ИХ ИСПОЛЬЗОВАНИЯ. Universum: технические науки, (4-6 (109)), 24-27.

8. T.R.Yuldashev (2023). TABIIY GAZLARNI VODOROD SULFID VA UGLEROD OKSIDLARIDAN TOZALASHDA QO'LLANILADIGAN ABSORBENTLAR. Sanoatda raqamli texnologiyalar / Цифровые технологии в промышленности, 1 (1), 92-99. doi: 10.5281/zenodo.8377079

9. T.R.Yuldashev (2023). TABIIY GAZNI NORDON KOMPONENTLARDAN TOZALASHDA SELEKTIVLIGI YUQORI BO'LGAN AMINLI ERITMALARDAN FOYDALANISHNING SAMARADORLIGI. Sanoatda raqamli texnologiyalar / Цифровые технологии в промышленности, 1 (1), 86-92. doi: 10.5281/zenodo.8377015

10. Makhmudov, M. J., & Yuldashev, T. R. (2023). Cleaning of Industrial Emissions from Gas and Dispersive Particles.

11. Юлдашев, Т. Р. (2022). АБСОРБЕНТЫ ДЛЯ ОЧИСТКИ ПРИРОДНЫХ ГАЗОВ ОТ H2S И CO2. THEORY AND ANALYTICAL ASPECTS OF RECENT RESEARCH, 1(10), 72-74.

12. Юлдашев, Т. Р. (2022). ОПТИМИЗАТSIЯ ТЕХНОЛОГИИ ГЛУБОКОЙ ОЧИСТКИ ПРИРОДНОГО ГАЗА ОТ КИСЛЫХ КОМПОНЕНТОВ. MODELS AND METHODS FOR INCREASING THE EFFICIENCY OF INNOVATIVE RESEARCH, 2(18), 62-64.

13. Yuldashev, T. R., & Makhmudov M, J. (2023). Cleaninng of Natural from Sobe Component. Journal of Siberian Federal University. Engineeng & Technologies, 16(3), 296-306.

14. Makhmudov, M. J., & Yuldashev, T. R. (2023). Cleaning of Natural Gases from Sour Components.

15. Юлдашев, Т. Р. (2016). ДВИЖЕНИЕ НЕРАВНОВЕСНЫХ БУРОВЫХ РАСТВОРОВ В ЦИРКУЛЯЦИОННОЙ СИСТЕМЕ СКВАЖИН. In РЕАЛЬНОСТЬ-СУММА ИНФОРМАТSIОННЫХ ТЕХНОЛОГИЙ (pp. 265-268).

16. Jonkobilov, U., Jonkobilov, S., Tashmurza, Y., & Xoshiyev, S. (2021). Influence of the drag coefficient on the maximum pressure of water hammer. In

IOP Conference Series: Materials Science and Engineering (Vol. 1030, No. 1, p. 012132). IOP Publishing.