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Description of Measurements of Foaming Intensity During Amine Purification of Natural Gases from Acidic Components

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Abstract: In this article, the method for measuring the intensity of foaming of an inhibitor in a diethanolamine solution is based on passing gas through an aqueous solution of amine in a bubbler at a certain speed for a certain time and measuring its foaming characteristics. The stability time and foam quenching time in the amine solution are determined. The effect of the defoamer on the intensity of foaming is studied.

Keywords: Diethanolamine, regeneration, gas purification, foaming, defoamer, bubbling, foam height, foam quenching, block polymer alkylene oxide.

Introduction:

Absorption is one of the most popular methods for cleaning natural gases from acidic components (H2S and CO2). However, the absorption process often encounters various operational problems, including foaming. The main objective of this work is to determine the influence of various causes on foaming in a DEA solution and to evaluate the foam-fighting properties of the EG1951E antifoam agent based on an alkylene oxide block polymer.

The need to extract acidic components (H2S and CO2) from a natural gas stream is determined by their ability to exhibit corrosive activity in the presence of water, especially at high temperatures, as well as the formation of carbon dioxide crystal hydrates in a methane extraction unit.

METHODOLOGY

The process of cleaning natural gas from H2S and CO2 impurities is carried out by the method of selective absorption (chemical absorption) of acidic components by an absorbent liquid, therefore, the absorbed substances pass from the gas mixture into the liquid absorber, forming chemical compounds [1].

As a result of the interaction of gaseous substances H2S and CO2 with a solution of diethanolamine in the liquid phase, the following reactions occur:

$$R_2HN + H_2S \leftrightarrow [R_2NH_2]\,HS \leftrightarrow [R_2NH_2]^+ + HS^-$$

$$R_2HN + CO_2 + H_2O \leftrightarrow [R_2NH_2]\,HCO_3 \leftrightarrow [R_2NH_2]^+ + HCO_3^-$$

here, R- is the radical –CH2CH2OH

However, the use of amine solutions in the purification of acidic components has its drawbacks. One of the important drawbacks is the strong foaming of this absorbent. This leads to overconsumption of the absorbent as a result of its entrainment with the purified gas, simultaneously worsening the level of purification from acidic components and reducing the productivity of the plant.

Foaming of amines is a complex problem caused by the presence of various surfactants in the amine solution, so combating it is an urgent task in improving the process of purification of natural gas from acidic components.

The research was conducted and the results were summarized at the Shurtan Gas Chemical Complex. Obstacles in the technology of amine solution

purification were identified and the influence of mechanical impurities of various origins on foam formation was studied. The defoaming ability of various imported and domestic defoamers was studied.

RESULTS

Defoamers replace foaming agents between the gas and liquid phases, where they form a water-impermeable surface film and increase surface tension. They must be insoluble in the added liquids. Defoamers have the same composition, the same chemical structure and a similar mechanism of action as defoamers. They also form a thin film between the gas and liquid phases, thereby eliminating gas bubbles. In this case, the surface area is reduced and the system becomes thermodynamically more stable [2-3].

A block polymer defoamer containing alkylene oxides is described, which can be obtained by polymerizing alkylene oxide in the presence of an organic initiator to form the said polymer. It was found that such block polymers have improved foam suppression properties while maintaining their biodegradable properties. To date, studies on the removal of acidic components and the foaming behavior of DEA solution are still insufficient. In addition, studies of antifoam properties in absorption processes using DEA are more limited. Therefore, the objective of this study is to investigate the effect of decomposition products on foaming in a 30-33% DEA solution by weight and to evaluate the defoaming properties of EG1951E defoamer based on alkylene oxide block polymer at different operating temperatures and gas flow rates. At the Shurtan Gas Chemical Complex, during amine purification of natural gases from acidic components, the highest absorption of H2S and CO2 was found in a 30-33% DEA solution. Therefore, in this study, different defoamers were used for 30-33% DEA solution [4].

The main patterns of the influence of various substances on the process of foaming of amine solution in natural gas purification plants were obtained and an experimental assessment of the influence of the quality of the initial absorbent on its foaming was carried out under laboratory conditions (according to the standard KSt 39.2-22:2008).

Measurement procedure: assemble a setup from sequentially connected filters, a glass bubbler with a glass porous plate. Then pour regenerated 30-33% DEA amine solution into the bubbler in such quantity that the height of the solution was (20-25) mm (approximately 200 ml). The nitrogen flow rate was set to 4 dm3/h using the rheometer and the bubbler was connected. The solution was bubbled through the diffuser for 3-5 min until stable foam was formed to obtain the final foam height. Then the nitrogen gas supply was turned off and the foam destruction time was measured. The foam height is taken as the difference between the height of the foamed liquid and the height of the initial solution. Again, 200 ml of the test solution was poured into the bubbler and the measurements were repeated. The measurements were repeated at least three times. The experiment was also repeated with a saturated DEA solution.

DISCUSSION

Under laboratory conditions, tests of Nalco EC9055A and EG1951E antifoams based on alkylene oxide block polymer were conducted to compare their efficiency in preventing foaming during amine purification of natural gases. The density of the DEA solution was measured at various temperatures in the range from 20 °C to 40 °C, using an AON-1 hydrometer GOST 18481-811 (Ukraine, size from 1000 to 1060 / 1060 to 1120). The results are shown in the table below.

Name of the indicator	Nalco EC9055A		EG1951E	
	Saturated solution DEA	Regenerated solution DEA	Saturated solution DEA	Regenerated solution DEA
Solution density, g/cm^3	1,111	1,054	1,111	1,054
Defoamer concentration (at 20 °C), g/ml	0,31	0,29	0,31	0,29
pH of the tested solution	10,3	10,4	10,3	10,4
Foam height (at 5 s), mm	30	26	22	18
Foam height (at 15 s), mm	48	51	40	42

Foam quenching time (at 20 °C), s	20	25	12	10

The method consists of introducing a polymer alkylene oxide liquid (EG1951E), EO - PO, into an absorbent. EG1951E is introduced into an absorption solution with a pH of 9.5-10.5. The results of a study of the selectivity of acid gas absorption by a DEA solution with the addition of 0.14% defoamer showed a higher selectivity of EG1951E compared to Nalco EC 9055A [6].

CONCLUSION

Based on the positive results of laboratory experiments, a new defoamer EG1951E based on block polymer alkylene oxide was proposed and introduced into the amine purification of natural gas from acidic components for the first time at the Shurtan Gas Chemical Complex. Due to the introduction of the proposed defoamer, the degree of foaming was reduced by 2.5 times.

Field testing has shown that EG1951E alkylene oxide block polymer defoamer is more effective than Nalco's previous defoamer, EC 9055A, in preventing foaming during amine scrubbing of natural gas to remove sour components.

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