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# RESEARCH OF REDUCING THE RISKS THAT MAY ARISE DURING THE PREPARATION OF GAS TRANSPORTATION

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**Abstract**

*In order to prevent risks that may occur due to hydrates and other reasons in the system during gas collection and preparation for transport, detailed information is provided due to the study results of methanol prepared on the basis of local chemical products and diethylene glycol, used as an absorbent in the gas-methanol-water system, in laboratory conditions. According to the results of the research conducted on the basis of samples taken from the fields, surfactants, i.e., methanol, used to prevent the hydrate formation in production facilities, pipelines for the purpose of preventing accidents, failures, and the risk of environmental pollution there are many possibilities to optimize the amount of reagents required. In the next stage, methanol can be captured and reused through the diethylene glycol regeneration unit. By capturing methanol from the gas phase and regenerating both methanol itself and the diethylene glycol inhibitor, it is possible to protect the environment and minimize the risks that may occur in technological processes.*

**Keywords:** gas condensate, risk, gas, hydrocarbon, hydrate, risk, highway, facilities

## Introduction

There are many opportunities to optimize the amount of reagents required according to the working conditions in order to reduce the risks occuring in the technological processes during the collection and preparation of gaseous hydrocarbons for transportation. During the preparation and transport of gases correctly predicting the requirements for the reagents used and the distribution of the active ingredients between the gas and liquid phases are essential to minimize hydrate formation and other manageable risks. The presence of water, mineral salts and acidic components ($H_2S$, $CO_2$) in the products of the exploited gas and gas condensate deposits creates technological difficulties in the system (hydrate compounds, corrosion and salt deposits). This, in turn, disrupts the operation of gas collection and transport preparation facilities and main gas pipelines, and creates operational risks, leading to large gas losses and environmental pollution. In this regard, many scientific and technical measures are implemented to prevent risks that may occur during the accumulation of hydrocarbon gases in the fields and preparation for transportation, which ensures the transportation of the produced gas to the consumer without any obstacles. It reduces the risk threshold that can be created by injecting active ingredients into the gas collection and transport preparation system to prevent gas hydrate formations. Methyl and isopropyl alcohols, ethylene, diethylene, triethylene, propylene glycol, etc. can be shown as inhibitors widely used in gas collection and transport preparation technology. However, due to the fact that active ingredients are volatile and well soluble in the gas phase, more than 50% of it is lost in contact with hydrocarbons. In addition to increasing the cost of the produced gas, this has a negative impact on the risk of spreading it to the environment [1].

## II. Methods

Methanol, which is used against hydrate formation, absorbs the water vapors contained in the gas, in turn increases the risk of environmental pollution during the accumulation and storage of formation waters. Part of the applied methanol dissolves in the gas phase, and the other part dissolves in the liquid phase and hydrocarbon condensate. All these should be taken into account when determining the consumption of methanol [2, 3]

The total consumption rate of methanol used as surfactant is found according to the following expression.

$$C = D_m + D_g + D_c \tag{1}$$

Here, C is the total consumption of methanol; $\frac{kg}{1000m^3}$;
$D_m$ – consumption of methanol in the liquid phase, $\frac{kg}{1000m^3}$;
$D_g$ – consumption of methanol in the gas phase, $\frac{kg}{1000m^3}$;
$D_c$ – loss of methanol in hydrocarbon condensate, $\frac{kg}{1000m^3}$;

The consumption of methanol in the gas phase mainly depends on the moisture content of the gas and the concentration of methanol and is found as.

$$D_g = \frac{(W_1 - W_2) \cdot C_2}{C_1 - C_2} + 0{,}001 C_2 \alpha \tag{2}$$

Here, $W_1$, $W_2$ are the amount of moisture in the gas phase before and after the injection of methanol, $\frac{kg}{1000m^3}$;

$C_1$, $C_2$ are concentration of new and used methanol to be injected into the gas stream, mass %; $\alpha$ is the ratio of the amount of methanol used for the saturation of the gas phase to the amount of the methanol used in aqueous solids.

According to norms the density of methanol used against the hydrate formation in technological systems is 97%. The density of methanol used in the technological system depends on lowering the equilibrium temperature of hydrate formation, as well as on the physical and chemical properties of the active substance. Since the hydrate formation temperature in gases is known, the density of methanol in an aqueous solution can be determined using the following formula:

$$C_2 = \frac{M \cdot \Delta t}{K + M \cdot \Delta t} \cdot 100 \tag{3}$$

Here, $C_2$ is the concentration of methanol in the treated solution, mass %;
M – molecular mass of methanol;
K – coefficient of methanol. K = 1220.
Δt – depression of hydrate formation temperature, °C.

Based on the conducted studies, the consumption rate of methanol should be calculated according to the stages shown below. Their thermodynamic conditions should be taken into account in the process of gas collection and preparation for transportation. Thus, the drop in gas hydrate formation temperature is determined by the formula given below.

$$\Delta T_{gas} = T_{hyd} - T_{rep} \tag{4}$$

Here, $\Delta T_{gas}$ – is the temperature of gas hydrate formation, °C;
$T_{hyd}$ – hydrate formation temperature of the gas at the starting point, °C;
$T_{rep}$ – the temperature of the gas at the reporting point, °C;

## III. Results

As a result of the increase in temperature in the hydrocarbon gas collection and transport preparation system, the surface tension of the surfactant decreases and the transition of hydrocarbon gases to the gas phase increases. Pressure has a much different effect on this process than temperature. As a result of the pressure increase at a constant temperature value, the transition of the surfactant to the gas phase also decreases and at a certain value it is at a minimum level. During the preparation of gas for transport, its dew point is significantly lowered by absorbing the moisture contained in it. At this time, while absorbing the liquid vapors contained in the gas through the diethylene glycol used as an absorbent, the methanol entering the gas phase will also be absorbed by the diethylene glycol. In the next process, methanol can be captured and reused through the diethylene glycol regeneration unit. The principle technological scheme of the experiment carried out in laboratory conditions is shown in Figure 1. The method of conducting the experiment is as follows: flask 1 was filled with methanol inhibitor of different concentrations, and then supplying of natural gas from its lower part was carried out. In the next step, diethylene glycol was added from flask 2 to the gas released in flask 1. Then, gas separation from diethylene glycol was performed in flask 3, and diethylene glycol regeneration was performed in flask 5. Meter 4 was used to measure the amount of gas coming out of flask 1. The amount of methanol absorbed from gas through diethylene glycol was determined by chromatographic analysis of samples taken from flask 3. We can see from the table that the concentration of methanol in an aqueous solution of diethylene glycol varies between (4.12 - 8.05) %. This means that approximately 50% of the methanol in the gas phase was regenerated through diethylene glycol and returned to the system. In the next step, let's focus on flask 5 for the regeneration of methanol from diethylene glycol.

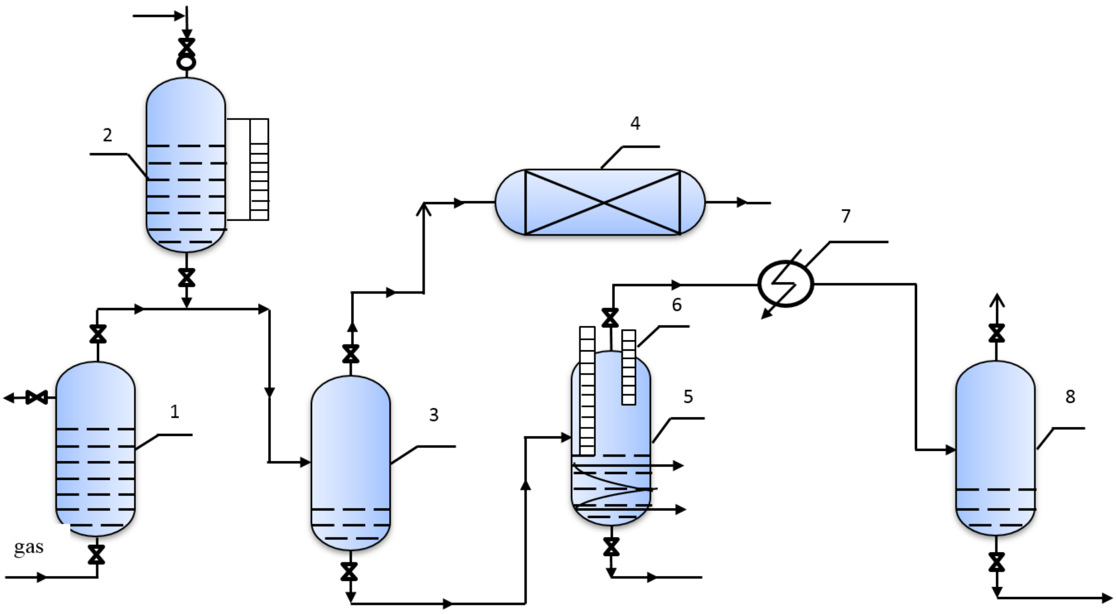


**Fig. 1:** *Experimental scheme of the regeneration unit for the absorption of methanol in the gas phase with the help of diethylene glycol and its return to the system*
*1 – flask for methanol, 2 – flask for diethylene glycol, 3 – flask for gas separated from diethylene glycol, 4 – gas meter, 5 – regeneration tank of diethylene glycol, 6 – thermometer, 7 – cooler, 8 – collection volume of methanol.*

For this, as an example, the diethylene glycol-methanol mixture obtained from flask 3 was introduced into flask 5, heated to the required temperature, and the process of separating methanol was carried out. Then, the methanol vapors separated from diethylene glycol were condensed through cooler 7 and turned into a liquid and collected in flask 8. For the separation of methanol from diethylene glycol, different temperatures were created in flask 5 and the temperature of (10–12)°C was given for turning the separated methanol vapors into liquid. By maintaining a temperature of (70–80) °C in the upper part of the regeneration flask, (90–92)% methanol can be obtained, which can be used to combat hydrate formation.

The results obtained from the experiment are given in the table below (Table 2).

**Table 1**: *Absorption rates of methanol from the gas phase through diethylene glycol*

| The amount of methanol in the gas phase, gr/m$^3$ | Content of diethylene glycol, mass % | | | | | The amount of methanol absorbed from the gas phase, mass% |
|---|---|---|---|---|---|---|
| | Starting composition | | Next ingredient | | | |
| | Diethylene glycol | Water | Diethylene glycol | Methanol | Water | |
| 0,88 | 85,0 | 15 | 81,0 | 4,12 | 14,88 | 50,0 |
| 0,92 | 82,0 | 18 | 74,5 | 8,05 | 17,45 | 59,0 |
| 1,05 | 79,0 | 21 | 75,0 | 6,65 | 18,35 | 51,0 |

**Table 2:** *Regeneration indicators of the diethylene glycol - methanol - water ( $DEG - CH_3OH - H_2O$) system*

| Composition of DEG absorbed methanol in the gas phase, mass% | | | Regeneration temperature above the tank,°C | Density of regenerated methanol, % mass | Composition of the residue after methanol regeneration, mass % | | |
|---|---|---|---|---|---|---|---|
| DEG | $CH_3OH$ | $H_2O$ | | | DEG | $CH_3OH$ | $H_2O$ |
| 81,0 | 4,12 | 14,88 | 70,0 | 90,0 | 85,6 | 1,10 | 13,30 |
| 74,5 | 8,05 | 17,45 | 78,0 | 93,0 | 80,0 | 1,30 | 18,70 |
| 75,0 | 6,65 | 18,35 | 72,0 | 92,0 | 78,0 | 0,70 | 21,30 |

Taking all this into account, the following technological scheme was developed for the regeneration of methanol from the diethylene glycol - methanol - water system (Fig. 2).

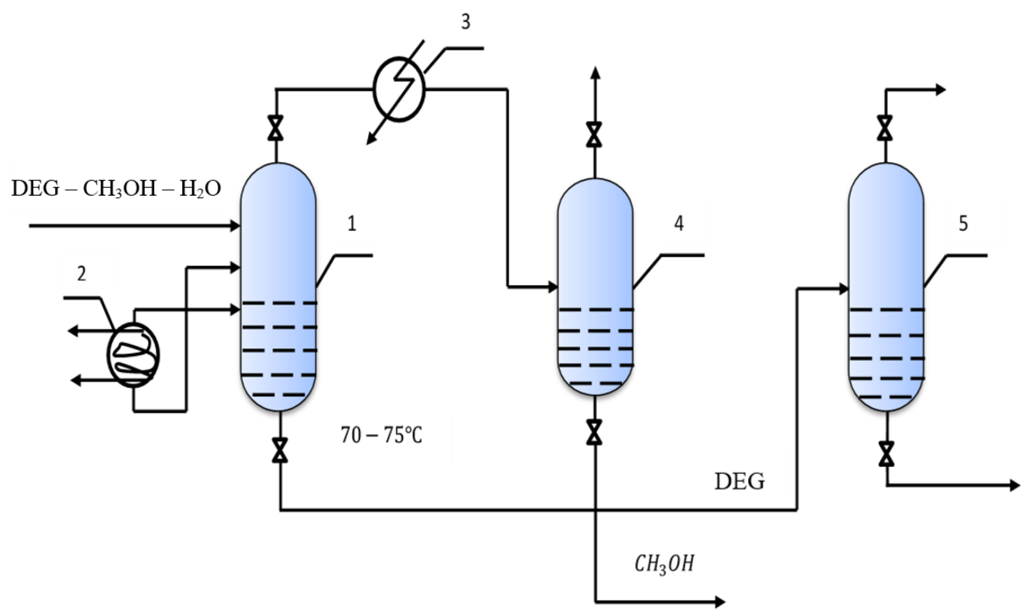


**Fig. 2:** *Technological scheme for regeneration of methanol from diethylene glycol - methanol - water system. 1 – methanol regeneration tank, 2 – heater, 3 – cooler, 4 – methanol collection volume, 5 – diethylene glycol collection volume.*

According to the planned scheme, the diethylene glycol - methanol - water system first enters tank 1 and the prescribed temperature regime is maintained. The separated $CH_3 - H_2O$ vapor enters the cooler 3 from the top of the boiler, turns into a liquid, collects in the volume 4, and returnes to the system for reuse below it. After all these performed processes, the diethylene glycol-water solution in tank 1 is collected in flask 5 with a concentration of (75-85) % and returned to the system for reuse. Finally, we can mention that the process of capturing methanol from the gas phase and regenerating both methanol itself and diethylene glycol inhibitor, which is a regeneration substance, was carried out.

## IV. Conclusions

In order to reduce the risks that occur in the technological processes of collection hydrocarbon gases in field conditions and preparing them for transportation, research studies were conducted in the laboratory to prevent the losses of methanol in the gas phase by capturing it through the diethylene glycol absorbent, regenerating and returning it to the system for reuse.

Methanol regeneration regimes were developed in order to reduce the risks that occur in the technological processes of gas collection and transport preparation, and to prevent methanol losses.

As a result of the calculations, it is possible to minimize the risks that may occur in the technological system, protect the environment, and prevent methanol losses up to 50%.

## References

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