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DETERMINATION OF THE FOAM AND THE FREEZING POINT OF THE MIXTURE SOLUTIONS FOR EXHAUSTING THE LIQUIDS FROM THE BOTTOM OF THE WELL WITH THE AID OF AUTOMATIC DEVICES INTRODUCING IN THE WINTER PERIOD

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Abstract: *In the present study we will focus on introducing liquid foam substances into gas wells using automatic devices during winter when temperatures are low and a solution such as methanol or triethylene glycol is needed in the water plus foam mixture to avoid frost, so that we proceeded to the laboratory of physico-chemical determinations to determine the freezing point of a mixing pallet, respectively of the tendency of foaming of these mixtures, foaming necessary to evacuate the liquids from the bottom of the well, with subsequent application in the field..*

Key words: *gas wells, automated devices, solutions, experiments, laboratory*

1. INTRODUCTION

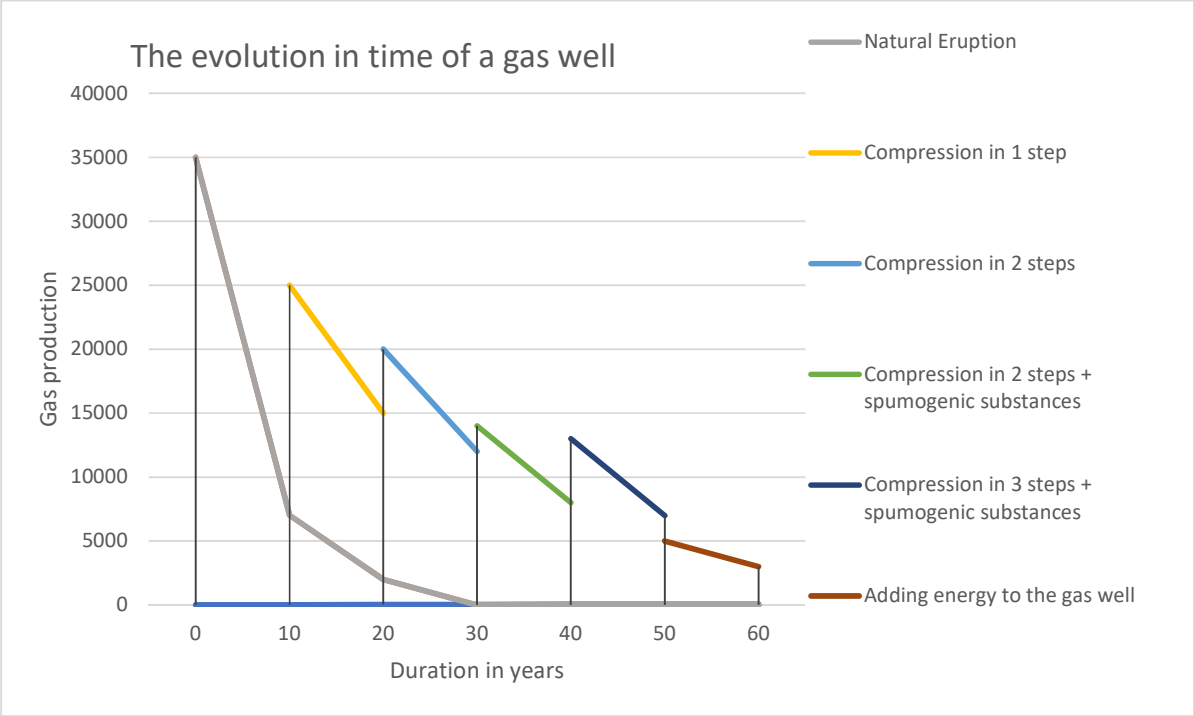
Currently, at more than 90% of the gas wells in Romania, the accumulation of liquids in the depth zone is recorded, the average flow per well is about 5000 Nm^3 / day, the static pressures at the wells are about. 10 bar, at 70% of the wells daily production is below 3000 Nm^3. At these flows and pressures there is accumulation of liquids in the deep area, resulting in the permanent tendency of self-flooding and stop from production.

In the following drawing we will present the evolution in time of a gas well:

Graph 1 - *Evolution over time of the production of a natural gas well*

As can be seen from the above graph, after about 10 years after the production of a gas well, it would tend to be exhausted, so that a large number of operations performed by the existing personnel are needed, of which we mention the use of field compressors and compressor stations, the need to introduce of foam substances in gas wells to facilitate the discharge of water from the bottom of the well, like solid subunit or superunit sticks, depending on their efficiency on each individual probe, or the introduction of liquid foam, using lubricators, or newer of the automatic devices for introducing foam substances into the probe, where the daily cycle is established, the latter having several benefits, among which we mention the need to refill them once every 10 days (a container of 500 liters).

In this study we will focus on introducing liquid foam substances into gas wells using automatic devices during winter when temperatures are low and a solution is needed in the water plus foam mixture to avoid frost, so we proceeded to determine the freezing point of a palette of mixtures but also of their foaming, foaming necessary to evacuate the liquids from the well of the probe, in the Laboratory of physico-chemical determinations.



2. THE EXPERIMENTAL PART

We present below the principles of the protection for explosion type for electric equipment and non-electic equipments
The proportion of introduction of liquid foam into wells, unanimously accepted, is 1: 9 where the number 1 represents the liquid foam and the figure 9 represents an industrial water solution with methanol or triethylene glycol. In the following we want to present two experiments performed in the laboratory where we want to determine the behavior of this mixture of 1: 9 from the point of view of the foaming tendency and of establishing the freezing point in different situations.

2.1 The first experiment:

For this purpose, an internal method and laboratory equipment were used in accordance with the American standard ASTM D 892-03. [1], the Petrotest apparatus having an adjustable plate (0-310 ˚C), a 500 ml graduated cylinder immersed in a glass vessel with a temperature sensor, inside the cylinder there is a porous stone (pore size = 50.7 micrometers) connected to a rotometer (divisions 0-110 mm) by means of which the dry air is bubbled in the sample.

Method description:

Approximately 2.5 liters of distilled water was transferred into the glass vessel and placed on the hob of the Petrotest appliance, the vessel into which the graded cylinder will be inserted. In the graded cylinder different solutions were introduced into the mix according to the experiments below and then the stopper rod with the tip of which is the porous stone connected to the rotor using which controls the air flow to be introduced into the sample. The temperature of the hob is set at 47 ˚C (estimated value of the temperature at the depth of a gas well at 1250 m). When the temperature of the solution in the glass vessel has reached the set temperature, dry air (up to the 15 mm split of the rotameter) is bubbled in the graded cylinder until a foam is set to its maximum height. At the same time with the beginning of the air bubble, the stopwatch is started and the height at which the foam has reached is noted by reading the cylinder gradations at different time intervals. When the

foam has reached around the 500 ml split of the graded cylinder, with the help of the exhaust valve, the air is removed from the sample and the time required to break the foam from the maximum volume to the smooth surface of the sample is measured.

The following measurement results were obtained:

Table 1 *- Experiment 1.1 : Mixture of 72 ml water + 8 ml liquid foam:*

Time	**Foam height (liquid + foam)**
25''	200 ml
50''	340 ml
1' 10''	450 ml
1' 20''	500 ml

In 24 minute the foam was broken.

Table 2 *- Experiment 1.2: Mixture of 72 ml water + 10 ml liquid foam + 18 ml methanol:*

Time	**Foam height (liquid + foam)**
25''	220 ml
50''	350 ml
1' 10''	460 ml
1' 20''	520 ml

In 23 minute the foam was broken.

Tabel 3 - *Experimentul 1.3: Mixture of 72 ml water +10 ml liquid foam +18 ml triethylene glycol:*

Time	**Foam height (liquid + foam)**
25''	215 ml
50''	335 ml
1' 10''	445 ml
1' 20''	485 ml

In 21 minute the foam was broken.

From experiments 1.1; 1.2; 1.3 results in substantially equal values of the foaming tendency, so that the mixtures formed from methanol or triethylene glycol, using the proportions of 1: 9 foam - water + methanol or water + triethylene glycol, do not influence the foaming.

1.2 The second experiment: Determination of the freezing point of the different mixtures by which we intend to observe the frost resistance of the mixture of 1: 9 having in the composition methanol or triethylene glycol.

For this, an internal method and laboratory equipment were used in accordance with the Romanian standard STAS 39/80. [2], the appliance used being the Julabo FP 50 cooler having an oil bath that can cool to -50 °C. The unit also contains a controller with digital warning / control / display / temperature control display for the oil bath, from which the operator can set the desired temperature.

Method description: The transparent plastic container containing the sample to be analyzed (approx. 100 ml of sample) was immersed in the oil bath of the cooler (with a support to which it is attached). With the help of the control panel, the temperature we want to have in the bathroom is typed, gradually decreasing until it is observed on the transparent walls of the container with the sample of ice crystals forming

For the frost resistance of the 1:9 mixture having methanol in composition the following measurement results were obtained:

Table 4 - *Experiment 2.1 :*

Mixture of:			**Freezing point (˚C)**	**Duration of time the first ice crystals formed (min)**
Liquid foam (ml)	**Water (ml)**	**Methanol (ml)**		
10	81	9	-8.5	5

Table 5 - *Experiment 2.2 :*

Mixture of:			**Freezing point (˚C)**	**Duration of time the first ice crystals formed (min)**
Liquid foam (ml)	**Water (ml)**	**Methanol (ml)**		
10	78	12	-12.5	5

Table 6 - *Experiment 2.3 :*

Mixture of:			Freezing point (˚C)	Duration of time the first ice crystals formed (min)
Liquid foam (ml)	Water (ml)	Methanol (ml)		
10	75	15	-16	5

Table 7 - *Experiment 2.4* :

Mixture of:			Freezing point (˚C)	Duration of time the first ice crystals formed (min)
Liquid foam (ml)	Water (ml)	Methanol (ml)		
10	72	18	-19.5	5

Table 8 - *Experiment 2.5 :*

Mixture of:			Freezing point (˚C)	Duration of time the first ice crystals formed (min)
Liquid foam (ml)	Water (ml)	Methanol (ml)		
10	69	21	-22.5	5

Table 9 *- Experiment 2.6 :*

Mixture of:			Freezing point (˚C)	Duration of time the first ice crystals formed (min)
Liquid foam (ml)	Water (ml)	Methanol (ml)		
10	66	24	-26.5	5

The results of experiments 2.1 - 2.6 are embodied in the exact mixing recipes necessary for the formation of solutions so that the automatic devices for introducing the foam into the gas wells are functional and the fluid inside does not freeze, thus:

Table 10. *Recipe: liquid foam +water+methanol for a 500 liters container:*

Current number	Liquid foam (liters)	Water (liters)	Methanol (liters)	Freezing Point ˚C
1	50	405	45	-8.5
2	50	390	60	-12.5
3	50	375	75	-16
4	50	360	90	-19.5
5	50	345	105	-22.5
6	50	330	120	-26.5

For the frost resistance of the 1: 9 foam + water and triethylene glycol mixture, the following measurement results were obtained:

Table 11 - *Experiment 3.1 :*

Mixture of:			Freezing point (˚C)	Duration of time the first ice crystals formed (min)
Liquid foam (ml)	Water (ml)	triethylene glycol (ml)		
10	73	17	-9	5

Table 12 *- Experiment 3.2 :*

Mixture of:			Freezing point (˚C)	Duration of time the first ice crystals formed (min)
Liquid foam (ml)	Water (ml)	triethylene glycol (ml)		
10	69	21	-13	5

Table 13 *- Experiment 3.3 :*

Mixture of:			Freezing point (˚C)	Duration of time the first ice crystals formed (min)
Liquid foam (ml)	Water (ml)	triethylene glycol (ml)		
10	65	25	-16	5

Table 14 *- Experiment 3.4 :*

Mixture of:			Freezing point (˚C)	Duration of time the first ice crystals formed (min)
Liquid foam (ml)	Water (ml)	triethylene glycol (ml)		
10	61	29	-19	5

Table 15 *- Experiment 3.5 :*

Mixture of:			Freezing point (˚C)	Duration of time the first ice crystals formed (min)
Liquid foam (ml)	Water (ml)	triethylene glycol (ml)		

10	57	33	-22	5

Table 16 *- Experiment 3.6 :*

Mixture of:			**Freezing point (˚C)**	**Duration of time the first ice crystals formed (min)**
Liquid foam (ml)	**Water (ml)**	**triethylene glycol (ml)**		
10	53	37	-25.5	5

The results of experiments 3.1 - 3.6 are embodied in the exact mixing recipes necessary for the formation of solutions so that the automatic devices for introducing the foam into the wells are functional and the fluid inside does not freeze, thus:

Table 17*- Recipe: liquid foam +water+ triethylene glycol for a 500 liters container:*

Current number	**Liquid foam (liters)**	**Water (liters)**	**Triethylene glycol (liters)**	**Freezing Point ˚C**
1	50	365	85	-9
2	50	345	105	-13
3	50	325	125	-16
4	50	305	145	-19
5	50	285	165	-22
6	50	265	185	-25.5

Note: From an economical point of view the price of methanol is much lower than the price of triethylene glycol, so this is a recipe that can be used by the reserve in special situations, namely in the absence of methanol. The internal method of determining the freezing point has an error of ± 1 ˚C.

3. CONCLUSIONS

From the first experiments, with the help of the Petrotest device, we determined the foaming tendency of the different solutions formed from methanol or triethylene glycol, using the proportions of 1: 9 foam - water + methanol or water + triethylene glycol and we noticed that methanol and triethylene glycol do not influence the foaming, and this is a very important thing in the operations of evacuating the water from the bottom of the wells with the help of the foam in composition with methanol or triethylene glycol during the winter period.

Following the experiments in different compositions of foam + water + methanol and foam + water + triethylene glycol, we determined the freezing point, which is also very important because the results from the centralizing tables were obtained: Table 10 and Table 17, recipes that in the meantime they applied in practice on automatic devices to introduce foam substances in gas wells at different temperatures below 0 ˚C, the solutions remained liquid, the pumps worked in good conditions, and the gas wells brought their water from the bottom to the surface and had produced under normal conditions.

4. REFERENCES

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4. Laboratory experiments.

DETERMINAREA SPUMARII SI A PUNCTULUI DE CONGELARE A SOLUTIILOR IN AMESTEC PENTRU EVACUAREA LICHIDELOR DIN TALPA SONDEI CU AJUTORUL DISPOZITIVELOR AUTOMATE DE INTRODUS SPUMANT PE PERIOADA DE IARNA

Rezumat: In prezentul studiu ne vom axa pe introducerea substantelor spumogene lichide in sondele de gaze cu ajutorul dispozitivelor automate pe perioada de iarna cand sunt temperaturi scazute si este nevoie de solutie cum ar fi metanolul sau trietilenglicolul in amestec cu apa+spumant pentru evitarea inghetului, astfel incat am procedat in laboratorul de determinari fizico-chimice la determinarea punctului de congelare a unei palete de amestecuri, respectiv a tendintei de spumare a acestor amestecuri, spumare necesara evacuarii lichidelor din talpa sondei.

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