

Comparative Study on the Introduction of Solid Foam Substances in Gas Wells to Remove Water from the Bottom of the Well

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ABSTRACT

Currently, at more than 90% of the gas wells in Romania, the accumulation of liquids in the depth area is recorded, the average flow per well is about $5000 \text{ Nm}^3 / \text{day}$, the working pressures at the wells are between 2.5 - 10 bar, at 70% daily wells are below 3000 Nm^3 . At these flows and pressures there is accumulation of liquids in the deep area, resulting in the permanent tendency to stop production, and one of the methods by which we manage to train the water from the surface of the well to the surface is the use of solid foam substances.

Keywords—solid foam substances, wells, production, comparison, tests, parameters, gas production fields

I. INTRODUCTION

Considering that the gas fields are in an advanced state of depletion, the working pressures are relatively small, between 2.5-10 bar, most of the wells produce flow rates between 1-5 thousand Nm^3 / day , and the fact that these wells produce accumulations of liquid at the bottom of the well, it is necessary to bring water to the surface to extend the life of the well and thus avoid its self-flooding. One of the methods used is the introduction of foam substances into the gas wells, namely solid subunit or superunit sticks, depending on their efficiency on each individual probe, or the introduction of liquid foam, with the help of lubricants, or newer. automatic devices for inserting foam substances into the well.

For the wells for which the use of superunit solid foam substances is suitable, we present in the following a comparative study on the behavior of the probes when stimulated with two types of superunit solid foam substances, having different compositions.

II. COMPOSITION AND TECHNICAL CHARACTERISTICS OF ANALYZED SPUMOGENIC SUBSTANCES

The two types of solid superunitary foam substances, which we will refer to below, type A sticks and type B sticks, have the following compositions:

Sticks type A: The composition is a mixture of nonionic and anionic surfactants, namely sulphated and ethylated fatty alcohols in different percentages.

Curr. number	Physico-chemical characteristics	Conditions of admissibility
1	Appearance at 20 ° C	Waxy yellow-white stick
2	Solubility in water	Soluble
3	Active substance content%	97 %
4	Density, g / cm ³	>1
5	Ph of the solution	6-9.5
6	Diameter, cm	3.2-3.5
7	Length, cm	35
8	Foaming power in water with a content of 200 g / l NaCl	200 cm ³ at 5 minutes

Table 1 Technical characteristics of type A sticks

Type B sticks: The composition is a mixture of nonionic surfactants with varying degrees of ethoxylation.

Curr. number	Physico-chemical characteristics	Conditions of admissibility
1	Appearance at 20 ° C	Solid white
2	Solubility in water	Soluble
3	Active substance content%	97 %
4	Density, g / cm ³	>1
5	Ph of the solution	6-7
6	Diameter, cm	3.5
7	Length, cm	35
8	Foaming power in water with a content of 200 g / l NaCl	220 cm ³ at 5 minutes

Table 2 Technical characteristics of type B sticks

Since the recipes are kept under control by the manufacturers, the chemical composition of the products is not fully known.

III. COMPARATIVE ANALYSIS ON THE INTRODUCTION OF THE TWO TYPES OF STICKS

In the following we will present the comparative analysis regarding the use of the two types of sticks on a number of six probes:

Day	Date	Nozzle (Ømm)	Pt (barr)	Pc (barr)	P ₁ (bar r)	P ₂ (barr)	Flow (m ³ /day)	Impurities (Liters)	Sticks introductions (Pieces)
Well parameters for stimulation with type A sticks									
1	20.01.2020	5.5	4	5.7	4	2.8	1.9	180	1
2	21.01.2020	5.5	4.8	6.2	4.8	3	2.4	100	1
3	22.01.2020	5.5	3.8	7.2	3.8	3	1.6	220	1
4	23.01.2020	5.5	4.1	5.8	4.1	3.2	1.7	160	1
5	24.01.2020	5.5	3.8	5.8	3.8	2.7	1.8	180	1
6	25.01.2020	5.5	4	5.2	4	2.7	2	155	1
7	26.01.2020	5.5	3.9	6.3	3.9	2.8	1.8	150	1
8	27.01.2020	5.5	3.9	5.2	3.9	2.8	1.8	180	1
Total							15	1325	8
Well parameters for stimulation with type B sticks									
1	28.01.2020	5.5	3.9	5	3.9	2.8	1.8	180	1
2	29.01.2020	5.5	4.2	5.3	4.2	2.8	2.1	110	
3	30.01.2020	5.5	3.6	7	3.6	2.7	1.6	220	1
4	31.01.2020	5.5	4.3	5	4.3	2.8	2.1	150	
5	01.02.2020	5.5	3.3	7.6	3.3	2.7	1.3	210	1
6	02.02.2020	5.5	4.2	5.3	4.2	2.8	2.1	110	

7	03.02.2020	5.5	3.1	7.5	3.1	2.8	0.9	185	1
8	04.02.2020	5.5	4.2	5.6	4.2	2.7	2.1	150	
Total							14	1315	4

Table3: Well 1 tracking sheet

From the analysis of the aforementioned parameters, there is a significant equal value of the water discharged from the top of the well, the frequency of introduction of the type B sticks is 1 piece every two days, compared to 1 daily piece type A sticks, but the flow of the well is not constant.

Day	Date	Nozzle (Ømm)	Pt (barr)	Pc (barr)	P ₁ (barr)	P ₂ (barr)	Flow (m ³ /day)	Impurities (Liters)	Sticks introductions (Pieces)
Well parameters for stimulation with type A sticks									
1	19.01.2020	8	4.1	7.1	3.1	2.4	3.1	280S	2
2	20.01.2020	8	4.4	7.5	3.5	2.4	3.7	130S	2
3	21.01.2020	8	5.4	7.5	4.4	3.7	3.5	270S	2
4	22.01.2020	8	5.6	7.8	4.5	3.5	4.1	310S	2
5	23.01.2020	8	5.4	7.3	4.4	3.4	4	200S	2
6	24.01.2020	8	4.5	7.5	3.5	2.6	3.5	222S	2
7	25.01.2020	8	4.4	7.3	3.5	2.4	3.7	500S	2
8	26.01.2020	8	4.4	7.2	3.4	2.4	3.5	280S	2
Total							29.1	2192	16
Well parameters for stimulation with type B sticks									
1	27.01.2020	8	4.3	7	3.4	2.5	3.4	220S	1
2	28.01.2020	8	4.3	7	3.5	2.4	3.7	270S	1
3	29.01.2020	8	4.4	6.9	3.4	2.3	3.6	290S	
4	30.01.2020	8	2.8	9.2	2.4	2.3	1.1	445S	1
5	31.01.2020	8	4	7.2	3.5	2.3	3.8	150S	1
6	01.02.2020	8	5	7.4	3.7	2.4	4	220S	1
7	02.02.2020	8	4.4	7.3	3.5	2.5	3.6	240S	1
8	03.02.2020	8	4.4	7.1	3.5	2.4	3.7	200S	1
Total							26.9	2035	7

Table4: Well 2 tracking sheet

From the analysis of the aforementioned parameters, there is a very equal value of the water discharged from the bottom of the well, the frequency of insertion of the sticks type B is 7 pieces in 8 days, compared to 2 daily pieces of sticks type A.

Day	Date	Nozzle (Ømm)	Pt (barr)	Pc (barr)	P ₁ (barr)	P ₂ (barr)	Flow (m ³ /day)	Impurities (Liters)	Sticks introductions (Pieces)
Well parameters for stimulation with type A sticks									
1	19.01.2020	7	3.8	26.7	3.7	2.4	3.1	650S	2
2	20.01.2020	7	3.3	26.9	3.3	2.9	1.8	600S	2
3	21.01.2020	7	3.3	26.6	3.3	2.7	2.2	600S	2
4	22.01.2020	7	3.4	26.7	3.4	2.8	2.2	520S	2
5	23.01.2020	7	3.4	27	3	2.9	0.9	620S	2
6	24.01.2020	7	3.4	26.8	3.2	2.4	2.4	700S	2

7	25.01.2020	7	3.1	26.5	3.1	2.5	2.1	730S	2
8	26.01.2020	7	2.5	20	2.5	2.4	0.8	515S	2
Total							15.50	4935	16
Well parameters for stimulation with type B sticks									
1	27.01.2020	7	3.5	26.7	3.4	2.2	2.8	500S	2
2	28.01.2020	7	3	26.8	3	2.7	1.5	600S	2
3	29.01.2020	7	2.7	24.9	2.7	2.4	1.5	800S	2
4	30.01.2020	7	3.2	26.5	3.2	2.8	1.8	740S	2
5	31.01.2020	7	3.1	26.5	3.1	2.7	1.8	930S	2
6	01.02.2020	7	3	26.8	3	2.2	2.3	900S	2
7	02.02.2020	7	3.6	26.6	3.6	2.8	2.6	940S	2
8	03.02.2020	7	2.7	26.9	2.7	2.4	1.5	730S	2
Total							15.80	6140	16

Table5: Well 3 tracking sheet

From the analysis of the aforementioned parameters, it appears that probe 3 involved more water when stimulated with type B sticks, the frequency of introduction being the same of two pieces of sticks per day, and the flow values being substantially equal.

Day	Date	Nozzle (Ømm)	Pt (barr)	Pc (barr)	P ₁ (barr)	P ₂ (barr)	Flow (m ³ /day)	Impurities (Liters)	Sticks introductions (Pieces)
Well parameters for stimulation with type A sticks									
1	19.01.2020	8	6.3	8.5	6.3	2.6	6.8	300	1
2	20.01.2020	8	6	8.1	6	2.6	6.6	310	1
3	21.01.2020	8	6	8	6	2.5	6.6	350	1
4	22.01.2020	8	5.8	8.4	5.8	3	6.3	320	1
5	23.01.2020	8	6.1	8.1	6.1	3.1	6.6	300	1
6	24.01.2020	8	6	6.3	5.7	2.9	6.2	320	1
7	25.01.2020	8	6.2	8.5	6.2	3.1	6.7	320	1
8	26.01.2020	8	6.2	8.3	6.2	2.5	6.7	300	1
Total							52.50	2520	8
Well parameters for stimulation with type B sticks									
1	27.01.2020	8	5.7	8.3	5.7	2.5	6.3	320	1
2	28.01.2020	8	5.7	8.3	5.7	2.5	6.3	400	1
3	29.01.2020	8	5.9	8.1	5.9	2.5	6.5	250	
4	30.01.2020	8	6	8.1	6	2.5	6.6	300	1
5	31.01.2020	8	5.8	8.1	5.8	2.5	6.4	250	
6	01.02.2020	8	5.8	8	5.8	2.5	6.4	150	1
7	02.02.2020	8	5.8	8.1	5.8	2.5	6.4	340	
8	03.02.2020	8	5.4	8.5	5.4	2.5	6	300	1
Total							50.90	2310	5

Table6: Well 4 tracking sheet

From the analysis of the aforementioned parameters, results are obtained of equal values of the water discharged from the bottom of the well, the frequency of insertion of the sticks type B is 1 piece every two days, compared to 1 daily piece of sticks type A, the flow values being substantially equal.

Day	Date	Nozzle (Ømm)	Pt (barr)	Pc (barr)	P ₁ (barr)	P ₂ (barr)	Flow (m ³ /day)	Impurities (Liters)	Sticks introductions (Pieces)
Well parameters for stimulation with type A sticks									
1	17.01.2020	5	5.8	6	5.7	5.4	1.06	5	2
2	18.01.2020	5	6	6.2	5.9	5.4	1.36	350	
3	20.01.2020	5	5.7	6	5.7	5.3	1.21	5	2
4	21.01.2020	5	6.1	6.4	6	5.5	1.37	300	
5	23.01.2020	5	5.8	6	5.8	5.5	1.07	5	2
6	24.01.2020	5	6.2	6.4	6.1	5.6	1.38	300	
7	26.01.2020	5	5.8	6	5.7	5.4	1.06	5	2
8	27.01.2020	5	6.1	6.3	6	5.6	1.24	400	
9	29.01.2020	5	5.9	6.1	5.9	5.6	1.07	0	2
10	30.01.2020	5	6.3	6.6	6.1	5.6	1.38	350	
11	01.02.2020	5	6	6.2	5.9	5.7	0.89	5	2
12	02.02.2020	5	6.1	6.4	5.9	5.5	1.23	300	
13	04.02.2020	5	6	6.1	5.9	5.7	0.89	10	2
14	05.02.2020	5	6.2	6.4	6.1	5.7	1.25	350	
15	10.02.2020	5	6.1	6.3	6.1	5.8	1.09	5	2
16	11.02.2020	5	6.4	6.8	6.2	5.8	1.26	250	
17	13.02.2020	5	5.7	6	5.7	5.4	1.06	10	2
18	14.02.2020	5	6.3	6.7	6.1	5.7	1.25	400	
19	16.02.2020	5	5.6	5.7	5.6	5.5	0.62	0	2
20	17.02.2020	5	6.2	6.6	6	5.5	1.37	400	
21	19.02.2020	5	5.7	5.9	5.7	5.4	1.06	10	2
22	20.02.2020	5	6.2	6.6	6.1	5.7	1.25	300	
23	22.02.2020	5	6.2	6.3	6.1	5.8	1.09	5	2
24	23.02.2020	5	6.4	6.8	6.2	5.8	1.26	350	
Total							27.77	4115	24
Well parameters for stimulation with type B sticks									
1	25.02.2020	5	5.3	5.5	5.2	4.8	1.16	5	2
2	26.02.2020	5	5.9	6.8	5.8	5.3	1.35	500	
3	27.02.2020	5	6	6.2	5.8	5.3	1.35	20	2
4	28.02.2020	5	5.7	6	5.6	5.2	1.2	100	
5	29.02.2020	5	5.9	6	5.9	5.3	1.48	50	
6	01.03.2020	5	5.8	6	5.7	5.3	1.21	100	
7	02.03.2020	5	5.8	6	5.6	5.3	1.05	30	2
8	03.03.2020	5	5.8	6.4	5.8	5.2	1.47	450	
9	04.03.2020	5	6	6.2	5.8	5.3	1.35	150	
10	05.03.2020	5	5.7	6	5.6	5.2	1.2	10	2
11	06.03.2020	5	6	6.7	5.8	5.3	1.35	500	
12	07.03.2020	5	5.8	6	5.8	5.3	1.35	50	

13	08.03.2020	5	5.7	6.2	5.5	5.2	1.04	50	2
14	09.03.2020	5	6.2	6.5	5.6	5.2	1.2	450	
15	10.03.2020	5	5.8	6	5.7	5.3	1.21	150	
16	11.03.2020	5	5.8	6	5.7	5.2	1.34	0	
17	12.03.2020	5	6	6.2	5.7	5.5	0.87	10	2
18	13.03.2020	5	6.4	7.1	5.9	5.5	1.23	400	
19	14.03.2020	5	6.1	6.3	5.9	5.4	1.36	200	
20	15.03.2020	5	6.2	6.4	5.9	5.5	1.23	100	2
21	16.03.2020	5	6.2	6.7	6	5.4	1.49	450	
22	17.03.2020	5	6	6.2	5.9	5.4	1.36	100	
23	18.03.2020	5	6	6.2	5.9	5.4	1.36	20	2
24	19.03.2020	5	5.8	6	5.7	5	1.56	100	
Total							30.77	3995	16

Table7: Well 5 tracking sheet

From the analysis of the aforementioned parameters, there is a very equal value of the water discharged from the bottom of the well, the frequency of insertion of the sticks type B is 2 pieces every three / four days, compared to 2 pieces every two days of type A sticks, and the volume of extracted gas is higher due to the use of type B sticks, with about 3 thousand Nm³ / 24-day period, the flow can be influenced also by the fact that the suction pressure is lower.

Day	Date	Nozzle (Ømm)	Pt (barr)	Pc (barr)	P ₁ (barr)	P ₂ (barr)	Flow (m ³ /day)	Impurities (Liters)	Sticks introduction s (Pieces)
Well parameters for stimulation with type A sticks									
1	22.02.2020	12	6.1	15.4	5.7	5.4	6.24	5	2
2	23.01.2020	12	7.4	9.1	6.3	5.5	10.22	500	
3	24.01.2020	12	6.6	10.8	6.1	5.6	8.17	10	2
4	25.01.2020	12	7.1	8.8	6.4	5.6	10.3	600	
5	26.01.2020	12	5.9	16	5.6	5.4	5.1	10	2
6	27.01.2020	12	7.2	9.4	6.3	5.6	9.64	600	
7	28.01.2020	12	6.3	17	6	5.6	7.31	10	2
8	29.02.2020	12	7.7	9.5	6.4	5.6	10.3	500	
9	30.01.2020	12	5.8	18.2	5.6	5.3	6.19	5	2
10	31.01.2020	12	8	10.3	6.3	5.5	10.22	600	
11	01.02.2020	12	6.7	10.5	6.2	5.7	8.23	20	2
12	02.02.2020	12	7.3	9	6.2	5.5	9.57	700	
13	03.02.2020	12	6.8	11.5	6.3	5.7	9.01	10	2
14	04.03.2020	12	6.8	11.5	6.3	5.7	9.01	500	
15	05.02.2020	12	6.6	11.4	6.1	5.7	7.37	20	2
16	06.02.2020	12	8.1	10.1	6.4	5.7	9.72	600	
17	07.02.2020	12	6.6	12	6.1	5.7	7.37	10	2
18	08.02.2020	12	8.8	10.4	6.4	5.7	9.72	500	
19	09.02.2020	12	5.9	17.3	5.8	5.6	5.18	15	2
20	10.02.2020	12	8.6	10.2	6.6	5.8	10.46	700	
21	11.02.2020	12	7.6	9.8	6.4	5.8	9.08	20	2

22	12.02.2020	12	8.6	10.4	6.5	5.8	9.79	500	
23	15.02.2020	12	7	11	6.5	5.7	10.38	10	2
24	16.02.2020	12	6.5	8.2	6.2	5.5	9.57	850	
Total							208.15	7295	26
Well parameters for stimulation with type B sticks									
1	25.02.2020	12	5.4	17	5.2	4.8	6.84	10	2
2	26.02.2020	12	8.6	11.3	6	5.3	9.42	800	
3	27.02.2020	12	6.5	8.4	6.1	5.3	10.06	30	2
4	28.02.2020	12	9	11.3	5.9	5.2	9.34	800	
5	29.02.2020	12	7	8	6.2	5.3	10.65	100	2
6	01.03.2020	12	8.7	10.8	6	5.3	9.42	800	
7	02.03.2020	12	6.8	9.5	5.9	5.3	8.73	10	2
8	03.03.2020	12	9	12	5.9	5.2	9.34	700	
9	04.03.2020	12	6.7	7.9	6.1	5.3	10.06	150	
10	05.03.2020	12	6.7	12.5	5.7	5.2	7.91	20	2
11	06.03.2020	12	8.8	11	5.9	5.3	8.73	1000	
12	07.03.2020	12	6.5	8.5	6.4	5.4	11.31	150	
13	08.02.2020	12	6.2	23.1	5.7	5.2	7.91	100	2
14	09.03.2020	12	8.8	11.5	5.8	5.2	8.65	1000	
15	10.03.2020	12	6.5	8.2	6.1	5.3	10.06	150	
16	11.03.2020	12	6.2	12.4	5.7	5.2	7.91	20	2
17	12.03.2020	12	9	11.7	6	5.5	8.1	800	
18	13.03.2020	12	6.7	8.3	6.3	5.5	10.22	200	
19	14.03.2020	12	6.3	13.3	5.8	5.4	7.2	10	2
20	15.03.2020	12	9	10.3	6.1	5.5	8.87	950	
21	16.03.2020	12	6.8	8.1	6.2	5.4	10.14	100	
22	17.03.2020	12	6.4	13.5	5.9	5.4	8.04	100	2
23	18.03.2020	12	9.1	12.6	6.2	5.5	9.57	750	
24	19.03.2020	12	6.4	8.3	5.8	5	9.81	100	
Total							218.29	8850	18

Table8: Well 6 tracking sheet

From the analysis of the aforementioned parameters, higher values of 8850 liters of water are generated (following the stimulation with B-type sticks compared to 7295 following the stimulation with A-type sticks, the frequency of insertion of the B type sticks is stabilized at 2 pieces at 3 days, and the frequency of introducing A type sticks is 2 pieces at two days, and the volume of extracted gas is higher after using B type sticks, with about 10 thousandNm³ / 24 days period .

CONCLUSIONS

The above study was conducted on a number of six wells, of which four wells are freshwater and two wells are saltwater. The frequency of insertion of the superunitary sticks type B is lower than the frequency of insertion of the superunitary sticks type A, in all the wells, the quantities of water drawn are relatively similar to an increase of the water trained on the wells 3 and 6 after the use. B-type superunit sticks, also the quantities of gas produced are relatively similar to a small plus on probe 6 after using B-type superunit sticks. We make the specification that the values of the flow rates of the probes may vary depending on the collection pressure, which differs from one day to another.

Considering the technical aspects we consider the possibility of using the type B superunitarian sticks optimally, of course the economic aspect must be taken into account when making a decision.

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