EFFECT OF POLYMER COMPOSITIONS ON THE ISOLATION QUALITY OF ABSORPTION AREA OF DRILLING FLUIDS

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The article describes the implementation of experimental research and tests of polymer compositions with drilling fluids under laboratory conditions in order to improve the efficiency of drilling fluid absorption complications and taking into account the permeability characteristics classification analysis of rocks field. The main purpose of this test is to create non-permeable screen or reduce the rock permeability significantly in the areas where mud absorption is observed to reduce mud losses. Key methodology used during the researches and tests were homogeneous model of the formation line composed of flanges welded from both side made from the steel, and at the same time valves allowing connecting the line were built. Modelling the water injection process was the main driver to select adequate length (1m) of the formation. Quartz sand milled during experiments was taken as porous medium model. All lab tests were performed in isometric environment. Based on the results achieved during experimental research, the dependence of remaining resistance factor on polymer composition concentration and permeability coefficient was built. The dependence was achieved of the required polymer composition concentration providing high value of remaining resistance factor from absorber layer permeability allowing finding concentration. This result will significantly improve drilling fluid properties and characteristics in order to avoid mud losses in difficult areas of drilled reservoir.

Introduction

In order to improve the efficiency of drilling fluid absorption complications and taking into account the permeability characteristics classification analysis of rocks field, it is required to create non-permeable screen or reduce the rock permeability significantly in the areas where mud absorption is observed.

Till now, many formation plugging fluids were developed in order to create water-separation screens in the absorption areas and to prevent mud losses into the reservoir. It is almost impossible to review all these formation plugging fluids in practice. Research on the formation permeability characteristics was performed, where formation was divided into several severity levels of absorption categories, chemicals creating waterproof screen in the shortest time and reducing several times formation permeability of well horizontal slice were reviewed. Apart from this and depending on different conditions, chemicals chosen have to be more economical in regards of finance and available in the area where drilling operations were ongoing. Nowadays apart from polymer application for the 2nd oil recovery (Гяллямов, Рахимкулов, 1978) mentioned the above chemicals are used to prevent drilling fluid absorption into the formation (Абасов и др., 2009). In (Абасов и др., 2009) it was determined that, polymer filtering with the low permeability core occurs with the reduction and high differential pressure. During lab tests it was discovered that solution of KMS and PA fluids created the composition with synergistic effect. In comparison with bentonite clay, this composition has higher flocculating characteristics. It was also discovered in the lab test that PAA fluid in the concentration of 0.15-0.20% has hydro filling and stabilizing characteristics, showing flocculating characteristics in other concentrations more clearly. In (Шарипов, 1995) special attention was paid to the change in dynamic viscosity and effect of KMS dynamic viscosity on PAA concentration expression was achieved. Rheological characteristics of KMS and PAA composition was fully analyzed (Агамалиева, 2012). The research showed that polymer based fluids played an important role in the isolation of absorption areas. Their isolation capabilities also depends on formation geological and petro-physical characteristics. That’s the main reason to manage polymer based fluid contents.

Problem statement

Lab test was performed in order to study the isolation characteristics of polymer based fluids. Test was carried out with the application of the theory of the five level variations based on two factors. Permeability and polymer fluid concentration were considered as these two factors. **Rrem** resistance characterizing polymer fluid isolation was assumed as an output parameter. To describe permeability reduction effect after contact of porous medium with polymers, Smith created concept of remaining resistance (**Rrem**) in 1970, defined as ratio of polymer fluids in porous medium with its water permeability development before and after:

$$R_{rem} = \frac{K_w}{K_p} \quad (1)$$

Where K_w is permeability of porous medium to water, K_p is permeability of porous medium to polymer fluids. Remaining resistance factor is important factor showing the permeability reduction porous media interacting with polymer based composition. Known in (Абасов и др., 2009) test equipment was used to perform lab test on remaining resistance factor and its different influencing parameters. This equipment consisted of formation model, is covered with electrical heater, and container for gasified oil, rude oil and fluid and vacuum pumps, gas container with the redactor, separator, gas meter and measurement cylinder.

The methodology of the researches

Homogeneous model of the formation line is composed of flanges welded from both side made from the steel, and at the same time valves allowing connecting the line were built. Modelling the water injection process was the main driver to select adequate length (1m) of the formation. Quartz sand milled during experiments was taken as porous medium model (Эфрос, 1968). The required resistance of porous medium was achieved by quartz sand milled in the round mill in accordance with established factions. Laboratory tests were performed for remaining resistance factor formula, the analysis of different parameters influencing on remaining resistance formulation process via application of polymer based fluids as follows. Formation homogeneous model was put in vacuum and then was saturated with water. Later the resistance of porous medium based on water samples was determined in several pressure drops.

All lab tests were performed in isometric environment.

Formation static temperature was achieved by electrical heater. Later polymer composition was pumped into the formation model in specific pressure drops and kept in static conditions. After that water and polymer composition were pumped into the formation model at the same pressure drop figures, the resistance of porous medium which was worked with polymer composition in stabilized filtering regime at the given pressure drop was determined.

Remaining resistance was determined (Smith, 1970) by formula (1).

Filtering characteristics depend on flow rate, permeability and appraisal are made by the change of remaining resistance factor. The isolation function of polymer composition is determined as following formula:

$$W = \frac{K_{bef} + K_{aft}}{K_{aft}} \cdot 100\% \quad (2)$$

Where K_{bef} is porous medium resistance factor before being filtered by polymer composition, K_{aft} after. mkm^2.

Laboratory test results

Planning matrix and test results completed with output and input numbers were given in the below table:

Planning matrix and test results

№	C	Kbef	Kaft	Rres		Errors		$W = \frac{K_{bef} + K_{aft}}{K_{aft}} \cdot 100\%$
				Actual numbers	Calculated numbers	Certain	Relative	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1	0.005	0.05	0.005	11	12.06	1.06	9.63	90.91
2	0.1	0.05	0.002	30	27.58	2.42	8.07	96.67
3	0.5	0.05	0.001	95	90.47	4.53	4.77	98.95
4	1	0.05	0.000	200	166.83	33.17	16.59	99.5
5	2	0.05	0.000	350	316.14	33.86	9.67	99.71
6	0.005	0.25	0.031	8	8.01	0.1	0.18	87.50
7	0.1	0.25	0.017	15	18.33	3.33	22.19	93.33

1	2	3	4	5	6	7	8	9
8	0.5	0.25	0.004	60	60.13	0.13	0.21	98.33
9	1	0.25	0.002	120	110.88	9.12	7.60	99.17
10	2	0.25	0.001	250	210.11	39.89	15.96	99.6
11	0.005	0.45	0.075	6	5.33	0.67	11.23	83.33
12	0.1	0.45	0.045	10	12.18	2.18	21.82	90.00
13	0.5	0.45	0.011	40	39.96	0.04	0.09	97.50
14	1	0.45	0.006	80	73.69	6.31	7.89	98.75
15	2	0.45	0.003	130	139.64	9.64	7.42	99.23
16	0.005	0.65	0.163	4	3.54	0.46	11.50	75.00
17	0.1	0.65	0.108	6	8.10	2.10	34.93	83.33
18	0.5	0.65	0.403	22	26.56	4.56	20.72	93.33
19	1	0.65	0.016	40	48.97	8.97	22.44	97.50
20	2	0.65	0.008	80	92.81	12.81	16.01	98.75
21	0.005	1.2	0.800	1,5	1.15	0.35	23.27	33.33
22	0.1	1.2	0.400	3	2.63	0.37	12.26	66.67
23	05	1.2	0.150	8	8.64	0.64	7.94	87.50
24	1	1.2	0.0122	15	15.92	0.92	6.15	93.33
25	2	1.2	0.034	35	30.17	4.83	13.79	97.14

The results shown in table 3-5 are the average cost of each of the pieces repeated in the tests. Graph reflecting the dependence of remaining resistance in the average numbers of permeability coefficient polymer composition from concentration and permeability was built based on the lab test results (fig. 1,2). For this case the average number is taken which suits polymer composition concentration and remaining resistance factor. For example, average number suitable for 0.005% polymer concentration and remaining resistance factor defining 1 single point takes place where with the definition of other numbers of graph for the dependence of remaining resistance factor and polymer concentration can be built. The following graph was given in (fig.1). As it is clearly seen, the analyzed dependence in the graph is straightforward. As a result of the statistical processing the dependence of approximation was as follows:

$$R_{rem} = 82{,}41C + 5{,}3623 \qquad (3)$$

At the same time, the graph of remaining resistance and medium permeability dependence was built accordingly (fig.2).

As it is obvious from the picture, the following dependence graph is subjected to exponential law. As a result of statistical processing, following analytical approximation was achieved:

$$R_{rem} = 143{,}88\, e^{-2{,}116 K_{bef}} \qquad (4)$$

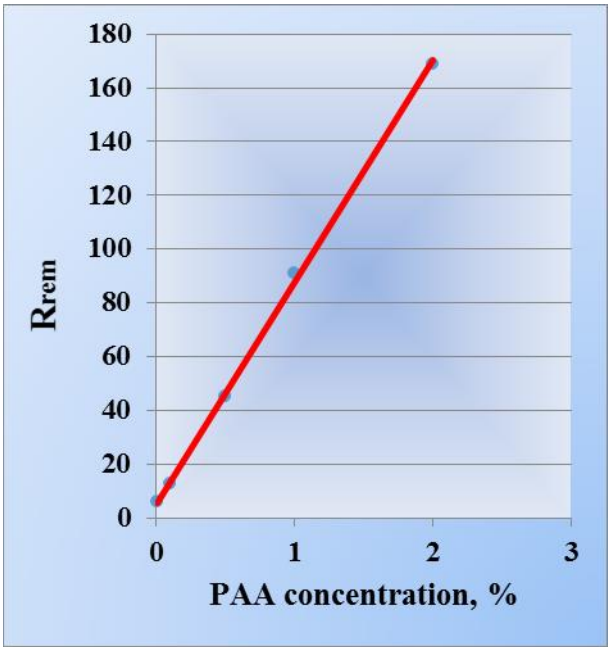

Figure 1. Remaining resistance factor and polymer concentration dependence graph

Mathematical statistics given below were used in order to achieve total dependence of remaining resistance factor on polymer compositions and medium permeability:

$$R_{rem} = 2{,}46(82{,}41C + 5{,}3623)^{0{,}9654}\, e^{-2{,}043 K_{bef}} \qquad (5)$$

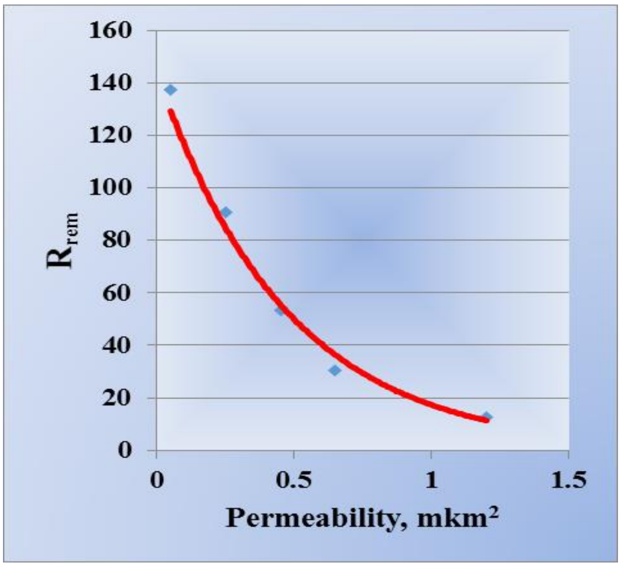

Figure 2. Remaining resistance factor and medium permeability dependence graph

Results achieved in formula (5) showed the similarity of estimated and the actual numbers of remaining resistance factor. Table 1 also reflected PAA fluid isolation ability from formula (2). As it is obvious from table 1, PAA fluid isolation ability is achieved by concentration and porous medium resistance. Based on polymer composition concentration, required numbers for porous medium resistance were set.

Below shown analytic formula refers to required concentration of polymer in the composition based on the highest number of isolation effect taken numbers of dependence of porous medium resistance:

$$C = \frac{0,47(1-2,043K_{pr}+2,087K_{pr}^{2})}{1-2,036K_{pr}} - 0,065 \quad (6)$$

Using the achieved results in the formula above, it is possible to calculate the maximum number of isolation coefficient and formation of rock permeability similar to polymer composition concentration.

Thus:

Based on the results achieved during experimental research, the dependence of remaining resistance factor on polymer composition concentration and permeability coefficient was built;

The dependence was achieved of the required polymer composition concentration providing high value of remaining resistance factor from absorber layer permeability allowing finding concentration.

Effect of the analysis of polymer compositions on the drilling fluid properties

Normally water based muds are used in the less absorber formation intervals with small permeability during drilling the wells. This is a normal practice and commonly used in other places and literature.

When oil well walls are not stable and formation has high permeability the requirement for chemical treatment of drilling fluids is necessary and technological parameters of drilling fluids are kept at the required level via the chemical compositions. Depending on the geological conditions, the required parameters of drilling fluids can be achieved by the regulation of chemical composition content. Based on the modeling of polymer composition properties, the values raise speed of the drilling fluids in the annular area provided by PAA and KMS composition concentration can be proved (Агамалиева, 2012). Depending on the geological conditions, following results can help to identify the concentration of polymer composition in the drilling fluids.

The effect of polymer composition on structure-mechanical properties of drilling fluid creates a great interest.

Bentonite oily based muds properties of structure-mechanical properties achieved in different concentration values of polymer compositions were measured and the dependence were built based on the results reflected in concentration values. Results are reflected in figure 3. As it is obvious, once chemical composition concentrations increase, viscosity and static friction tension also increases, water transfer property of fluids decreases. The same case is observed during chemical treatment of KMS polymer composition (Шарипов, 1995; Лушпеева и др., 2001).

Viscosity and static friction tension increase rate increases once fluid weight and composition concentration increase.

P.A.Rebinder explained the mechanism of structure-mechanical properties of water-based mud and it is obvious in the other articles as well (Агамалиева, 2012; Лушпеева и др., 2001; Шайхымежденов, 2006).

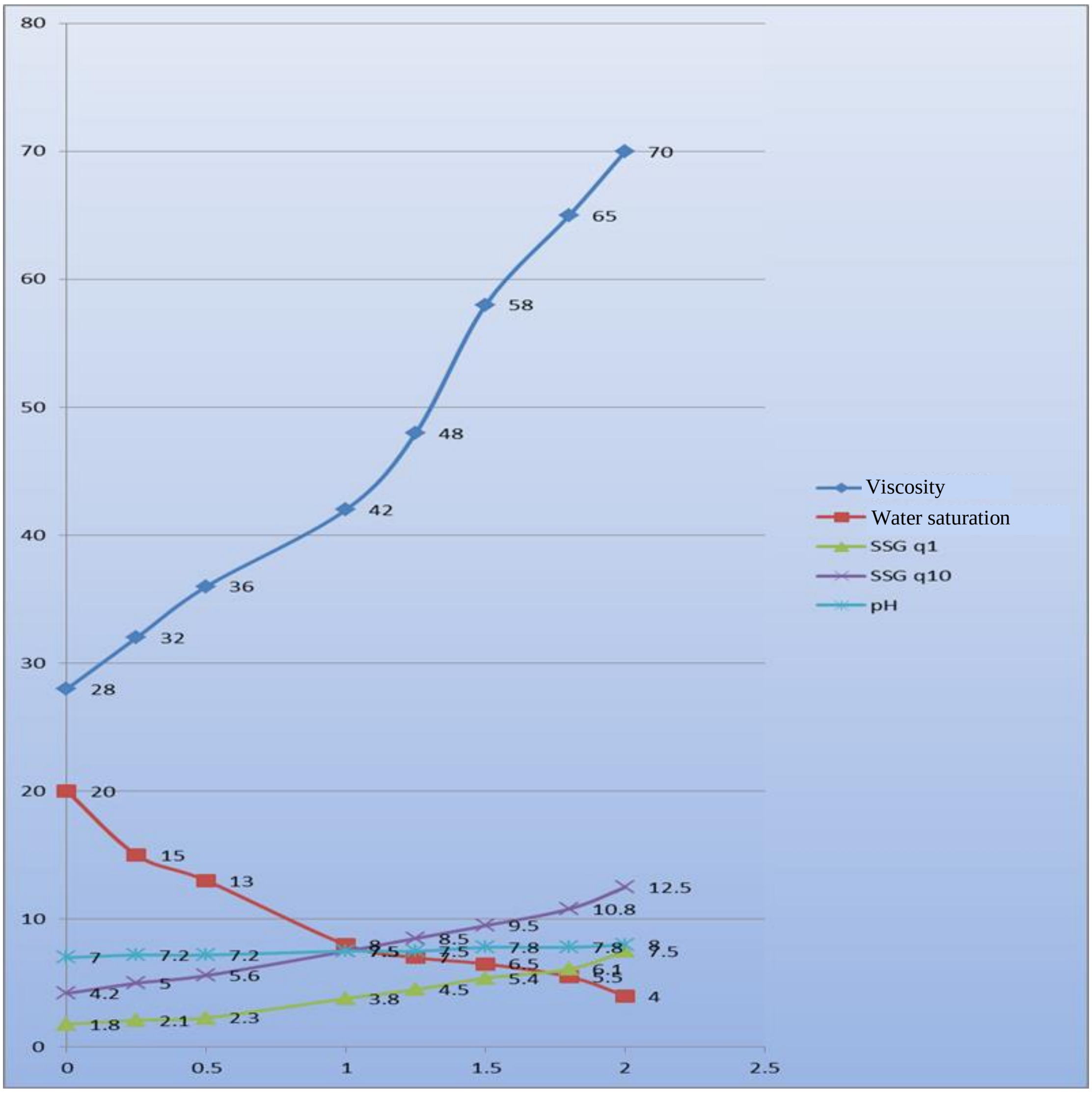

Figure 3. Dependence of polymer oily based mud structure-mechanical properties on polymer concentration

Conclusion

Based on the results achieved during experimental research, the dependence of remaining resistance factor on polymer composition concentration and permeability coefficient was built. The dependence was achieved of the required polymer composition concentration providing high value of remaining resistance factor from absorber layer permeability allowing finding concentration. Once chemical composition concentrations increase, viscosity and static friction tension also increases, water transfer property of fluids decreases. The same case is proved during chemical treatment of KMS polymer composition. Viscosity and static friction tension increase rate increases once fluid weight and composition concentration increase.

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