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Elaboration of Some Clear Bore-Hole Fluids for Crossing the Productive Formations

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Abstract

Laboratory tests have elaborated several types of clear borehole fluids that maintain their properties in time and at temperatures of 20 – 80 °C, have a strong inhibitive character and a reduced filtration. These types of fluids can be successfully used when crossing productive formations, as well as in the case of intervention operations on the wells.

Key words: *drilling fluids; cost fluids; clear borehole fluids; environmental impact.*

Introduction

Within the area of water-based drilling fluids, the topical tendency is that of using fluids with the following characteristics: low density (thus ensuring the pressure in the well to be approximately equal or lower to that of the formations in the case of sub-equilibrium drilling); low filtrate and a strong inhibitive character; low level of solid components (even towards a clear consistence); a fluid phase, compatible with the pool water; low pH.

Nowadays, on a world-wide scale, the electrolyte-based clear drilling fluids are used as water-based crossing fluids [1, 2, 4-6].

The electrolyte-based clear drilling fluids are made of clinging polymers and filtering reductive devices, degradable while being stimulated (by means of acids, oxides, enzymes).

To these, a temporary blocking poly-granular material is added, equally destructible in acids.

The analysis of the methods through which the potential unwanted phenomena, technical conditions or opportunities could be diminished, indicated the fact that the working instrument required for the designing of the fully effective drilling fluid envisages, on one hand, getting rid of the blocking during the crossing of the productive formations and, on the other hand, identifying and designing of a drilling fluid-adjunction fluid couple, which would ensure a productivity a lot higher for the depleted area, as compared to the one already present.

Premise

Starting with the '90s, the company M – I PETROGAS from Romania has used with satisfactory result KCl - poly-glycol (Glydrill) types fluids and carbonate, KCl-XCD and carbonate (FLOPRO), KCl-polyacrylamidic-polyacrylates (POLYPLUS).

At the present time solutions tips of fluid with diluted solutions tips of KCl (concentration < 5 %) with XCD (but no carbonate) are applied.

Also it should be noted that by using fluids based on copolymers, which is synergetic action of the type poly-acrylic – poly- α -glucose (PANAD-35), positive results were obtained when drilling in over 60-70 wells of different structures and different geological formations, although the fluid contained relatively high amount of dispersed clay.

Upon selecting salts in view of achieving clear completion fluids, the following essential aspects should be taken into account:

- o control of the formation pressure;
- o facilities for maintaining the integrity of permeability (prevention of blockage);
- o facilities for injection of stimulating fluid;
- o irrefragable functioning of the bottom equipment;
- o availability of large amounts;
- o the costs;
- o stability in time and at high temperatures – for example CaBr_2 respectively ZnBr_2 , hydrolyses giving precipitates of insoluble types hydroxides – $\text{Ca}(\text{OH})_2$ – $\text{Zn}(\text{OH})_2$;
- o crystallisation point (the concentration which generates the separation of solid crystals) given a significant difference of temperature at the top as compared to the bottom of the well;
- o toxicity;
- o corrosiveness;
- o operating temperature;
- o compatibility with the storing rocks and with the irons in the formations water (in order to avoided the formation of inorganic precipitate).

By test performed in laboratory with developed clear (FLE_1 , FLE_2) and pseudo clear (FESR_1 , FESR_2) fluids which conserved in time their properties in the temperature domain 20 – 80 °C exhibit low strong inhibiting character and give reduced initial filtrate (at 30 sec) and API (at 30 min). The superficial tension of the filtrate being low the fluids may be developed, in accordance with the study, in the domain of density 1050 – 1200 kg/m³. In the same time they exhibit low corrosiveness and accentuated lubricating properties.

In respect to the performer tests we appreciated that, by ample studies, by complex research times it is possible to extend the density domain of the achieved fluids, by using also other salts (electrolyte solutions), respectively of harder synergetic mixture of surfactants which assure diminished blockages caused by capillary phenomenal and by formations of “in situ” emulsions. The checking of the efficiency of the achieved fluids was performed by the control of the elimination plugging and by tests for determining the re-build up of the permeability.

Verification Tests for the Possibility of Removal of Plugging in the Case of the Use of Clear and Pseudo-clear Fluids

The most frequently used operation of stimulation consists in acidating, in which case solutions of 10 – 24 % HCl are used – basic component of the acidating compositions the main scope being the dissolution of mineral components of the type lime stone, calcite, dolomite, aragonite, etc. Using solutions of electrolyte NaCl (concentration 26 %) KCL (concentration 8 – 20 %) HCl 30 %, we have studied the rheologic behaviour of certain viscosants (XANTHAN GUM, HEC, SG) and of filtration reducers (poly-anionic cellulose, pregelling starch, oxiethylated and carboximethylated starch).

Based on the laboratory tests in an initiated stage, crossing fluid was developed of pseudo clear tip based on solution of KCl of 8% concentration which is a inhibiting character, with suitable rheologic properties, is reduced filtrate (due to the presence in the composition of filtrate reducers and of a temporary blockage material), with suitable surface tension of the reduced filtration. The rheologic and tixotropic properties generated by HEC respectively SG polymer in concentrations 0,15 % in various solution of electrolyte are show in Table 1.

Table 1. Rheologic and tixotropic properties generated by the polymers HEC respectively SG in concentration 0,15 % in various electrolyte solutions

Characteristic	UM	KCl 8 %		KCl 20 %		NaCl 26 %		CaCl ₂ 30 %	
		SG 15%	HEC 18 %	SG 15%	HEC 18 %	SG 15%	HEC 18 %	SG 15%	HEC 18 %
Density	Kg/m ³	1056	1056	1148	1148	1200	1200	1282	1282
Apparent viscosity	cP	20	22	30	32	20	21,5	20	23,5
Plastic viscosity	cP	14	14	18	20	15	13	9	14
Dynamic torque	lb/100ft ² (N/m ²)	12 (5,73)	16 (7,65)	14 (6,69)	24 (11,47)	10 (4,78)	17 (8,12)	23 (10,99)	20 (9,56)
Initial gelation	lb/100ft ² (N/m ²)	9 (4,30)	12 (5,73)	9 (4,30)	18 (8,60)	8 (3,82)	12 (5,73)	19 (9,08)	19 (9,08)
Final gelation	lb/100ft ² (N/m ²)	11 (5,73)	12 (6,26)	16 (7,65)	32 (15,29)	12 (5,73)	16 (7,65)	24 (11,47)	22 (10,51)
V _f	cm ³	27	29	42	48	69	71	101	94

$$1 \text{ lb/100ft}^2 \times 0,4788 = 1 \text{ Pa}$$

In order to facilitate the rapid formation of the cake, respectively reducing of initial filtrated we included in the composition 2 % colloidal bentonite percentage which in spite of current performance of the mechanical cleaning equipment, is accumulated anyhow during the drilling process. The developed fluid, named basic electrolyte fluid with reduced solids (FESR₁) was tested for resistance to contamination (10 % clay) and for corrosiveness.

The dynamic testing on natural drill core of the cake breaking pressure and of the degree of permeability restoration, comparative with a dispersed fluid and a fluid based on chloride of potassium polyacrylamidic, has indicated a clear advantage of the developed fluid FESR₁.

Conclusions

The performer laboratory tests indicated the fact that the direct emulsion types fluid (after inversion), displaced from the well with electrolyte solutions by “multi-spacer” technique (multi-separation plugs including also washing plug) may be transported to another well and may be reconverted with a basic composition (CB) into inverted emulsion type fluid.

After conditioning, this may be used again in the drilling process, a very important aspect, if taking into account the extremely high cost of such fluids.

Taking into account the information accumulated in the speciality literature, the partial interpretation of such information, the result obtained by laboratory testing (efficiency, simplicity of composition, availability, low impact on environmental) and the importance and actuality of the problems, the authors consider opportune the necessity of continuing the laboratory study, to improve and diversify the crossing fluids.

The amplitude and complexation of the work requires the procurement of specific equipment and setting up complex research teams including deposit engineers, geologists, chemists, geophysicians, drilling engineers in view of a rapid implementation of the results in the site profile.

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Elaborarea unor fluide limpezi de foraj pentru traversarea formațiunilor productive

Rezumat

Prin teste de laborator efectuate s-au elaborat mai multe tipuri de fluide de foraj limpezi care își mențin proprietățile în timp și în domeniul de temperatură 20 – 80 °C, prezintă caracter puternic inhibitiv și au filtratul redus. Aceste tipuri de fluide pot fi utilizate cu succes atât la traversarea formațiunilor productive, cât și în cazul operațiilor de intervenție la sonde.