

RHEOLOGICAL ANALYSIS IN THE MAKING OF CEMENT PASTE FOR CEMENTING IN OIL WELLS

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ABSTRACT: According to former President of Petrobrás, Maria das Graças Silva Foster, in 2013 the Brazil produced about 1 million barrels per day, that is, much of the nation's economic demand is subject to extraction of oil, what determines the country scientific investments for the Betterment of this economic mode, in order to maximize the extraction and prevent environmental damage. On the extraction of oil in the drilling process, a step that is required is the cementing of the well. The cement used in the process is subject to strict conditions of temperature and pressure, and must support fragile and porous rocks, fluids corrosive and pressurized. Therefore, it is necessary to check the rheological behavior of cement paste. This work aims to evaluate the study of rheology and rotational dynamics in cementing oil wells. It is therefore important to improve the homogeneity of the cement and ceramic suspensions because they lose these characteristics when subjected to the transport, mixing and pumping. Was held the addition of minerals and additives in the folder for the oil well cement in accordance with the regulations in force, with the implementation of models of Bingham and dynamic power or oscillatory. Where was evaluated by testing the determination of the potential for speed and tests zeta compression and mechanical traction. Evaluated by testing for developers and rheological tests to determine zeta potential of more than 30 mV being the same stable and mechanical compression and traction test.

Keywords: Cement, Rheology, Petroleum wells, Rheological studies.

1. INTRODUCTION

According to former President of Petrobrás, Maria das Graças Silva Foster, in 2013 the Brazil produced about 1 million barrels per day, that is, much of the nation's economic demand is subject to extraction of oil, what determines the country scientific investments for the Betterment of this economic mode, in order to maximize the extraction and prevent environmental damage.

Besides, future expectations for the country is a large increase in extraction, with a goal of up to 4.2 million barrels per day. In view of the economic importance to this exploration, there is also the need to have new techniques and technologies. On the extraction of oil in the drilling process, a step that is required is the cementing of the well. Which is defined as the process carried out in the oil well that has to fill the void space between the coating, so that there is the grip between the outer wall of the coating and the rock formation, in order to secure the pipe and prevent fluid migration exists between the various zones permeable crossed shaft [1] (THOMAS , 2001).

This work aims to identify the models and studies related to rheological parameters found in the cementing paste for oil wells, in order to reveal the most appropriate that provides more accurate results. The cement used in the process is subject to strict conditions of temperature and pressure, and must support fragile and porous rocks, fluids corrosive and pressurized. Therefore, it is necessary to check the rheological behavior of cement paste. The parameters used to control the different rheological properties of cement paste are: the mixing procedure in equipment (additives), the pumpability time and the geometry of the shaft. The different amount of energy which will be absorbed by the folders before some balls will depend on these parameters.

According to Nelson, a good folder to cement most cementing operations shall provide low viscosity, don't gel when static, maintain their Consistency as much as possible the more steady occurrence of the handle, have low loss of filtered, without the effect of free water separation or settling of solids.

All this is of great importance, because, if there is no full isolation of areas, the well will never reach its full potential as a producer of oil or gas well. The success of cementing service demand maximum control of properties of cement pastes [2] (HODNEA et al., 2000).

Rheology is of fundamental importance, because it allows to know the properties of the fluid and how it will behave during the pumping of the folder [3] (Souza et al, 2011). Resulting the importance of the study of alternatives aimed at, in addition to contributing to the reduction of waste and improvement of techniques, the use of environmental resources available, enabling the development of a healthy environment, economically feasible and environmentally friendly.

Rheology can be defined as the science that studies the flow of matter and their deformations, occupying a vast area between the theory of elasticity and hydrodynamics. The laws of behavior or constitutive laws which correspond to relations between the tension and the deformations are main base of rheology [4] (CASTRO et al.,2001). Shear stress is the force per unit of shear area, necessary to maintain the flow of the fluid. The resistance to flow is the one that demands this shear, which can be expressed as:

$$\tau = \frac{F}{S} \quad (6)$$

Another property of fluids can be described by fields involving speed. Mathematically, velocity in a fluid is defined as the rate of average displacement of molecules contained in an elementary volume squared [5] (Pordeus, 2011).

Where F is the force applied in the direction of flow and S is the surface exposed to shear [6] (Machado, 2002).



Fig. 1 Representation of dilatant fluid.

Soon the rheological study qualify the folder. Since, according to [3] Souza et al (2011) it is possible to identify the characteristics of a given fluid. A fluid is as a substance that continually deforms when it's submitted a constant effort, no matter how small is this effort. Of all the properties of the fluid, the viscosity requires greater attention in the study of the flow of a fluid [7] (Lopes, 2010).

1.1 Characteristics of oil well cement

The cementing oil wells are a critical step during the drilling of a well, because problems during the operation of pumping of folder and a partial fulfillment of the annular space between the casing and the wall of the pit can cause the loss of the well [8] (Miranda, 2008). Thus, the choice of cementations folder used must be well calculated predicting problems that pass be caused during its application. A folder must provide efficient cement viscosity (water/cement) low, thus facilitates its penetration in the annular or channels, offering good pumping. For this, new technologies are being used in the formulation of cement pastes with the objective to improve the mechanical properties and chemical resistance. This technology is used to increase compactness of solid particles. Doing this the empty folder will be populated with adequate particle size solids.

According to Castro et al. [4] (2001), the appropriate tests on samples of the material to characterize it is essential to establish the laws of behavior. These tests should be used and appropriate instruments, so that the experimental results are reproducible and reflect the intrinsic properties of the material. Characterization tests can basically be divided into three groups: almost-static tests, testing and transient dynamic tests.

In the almost-static test, seeks to characterize the instant response of the material to a particular request. Usually the request consists of a uniform deformation applied to constant speed. The purpose of the transitional trial is to characterize the temporal dependence of the mechanical behavior of materials; in this model, are used two types of tests, known as relaxation and creep. In the category of dynamic test includes a wide range of experimental techniques, including those that use free vibrations and forced vibrations to the propagation of a pulse or waves.

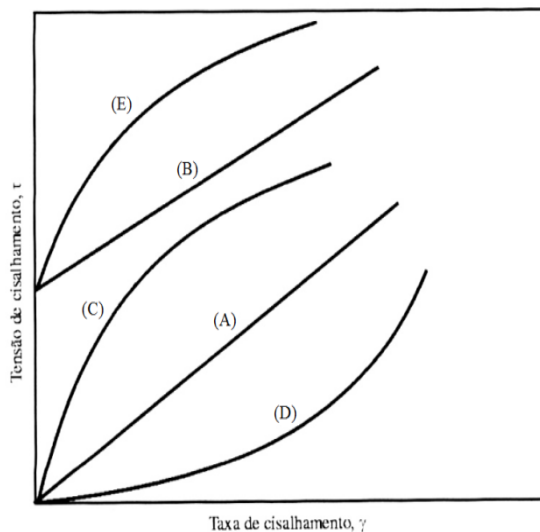


Fig. 2 Flow curves of some types of fluids: (A) Newtonian; (B) or ideal Bingham plastic; (C) pseudoplastic; (D) dilatant; and (E) pseudoplastic with yield strength [6] (Machado, 2002).

Fluids in which the shearing tension is not directly proportional to the rate of deformation are not Newtonian [9] (Fox et al, 2006).

These fluids are classified according to the aspect of the flow curve and correlation with any equation or mathematical model (6) (Machado, 2002). AND according to [8] Miranda (2008), the models are: Newtonian, Bingham, Power, Herschel-Bulkley.

The most used are called harmonics, where the materials are subjected to a simple deformation State ranging senoidalmente with time, with a certain amplitude and angular frequency ω ϵ_0 , namely: $\epsilon = \epsilon_0 \sin \omega t$. For many materials and under certain test conditions (amplitude, frequency and deformation temperature), the answer is a sinusoidal voltage with the same angular frequency ω , but behind of δ in relation to deformation applied, i.e.: $\sigma = \sigma_0 \sin(\omega t + \delta)$. Normally, the deformation and tension are represented in complex form, see: $\epsilon = \epsilon_0 i \omega t \in \epsilon$ and $\sigma = \sigma_0 e i(\omega t + \delta)$, being (i) the imaginary number $\sqrt{-1}$. Therefore, a response in phase in deformation to an applied voltage is called elastic response. While a response deformation, 90 voltage lag is called viscous response. If the angle of phase shift is set in the range $0 \delta 90$ says $< -if$, then, the answer is viscoelastic [6] (MACHADO, 2002).

2. MATERIALS AND METHO

The component materials for production of cement paste folder with additives and mineral additions, will be carried out, initially, with the selection and characterization of these materials in accordance with the current regulations. Then fix

the relationship a/c in 0.3 and 0.4-as well as the percentages of additives and mineral additions to. Elastic, viscous behavior verification and viscoelastico, through the application of rotational rheology models of power and dynamics Bingham and the momentum or oscillatory.

In the process of mixing the cement paste in the fresh State, will be assessed the slurry formulations in order to find a solution to meet the desired goals, with conducting the tests and rotational dynamic rheology determination of zeta potential, as well as mechanical tests as resistance to compression and traction by diametric compression.

It is therefore important to improve the homogeneity of the cement and ceramic suspensions because they lose these characteristics when subjected to the transport, mixing and pumping. True if the addition of minerals and additives in oil well cementing folder, according to the rules in force, with the application of models and Bingham and the momentum or oscillatory. Evaluate through testing, test developers and rheological determining rotation zeta potential and compression and traction mechanical essays.

3. RESULTS AND DISCUSSION

The results allow to conclude that the rheological behavior, noting the importance of the study of rotation and dynamic folders of cement to the oil wells. Since the fluid is determined for purposes of risky because as widely claimed [10] Costa et al. (2000) primary cementing deficiencies in a pit can generate several negatives in costs. Having the fluid rheological knowledge, one can identify the number of Reynolds, resistance to sedimentation. But, for the cases of non-Newtonian fluids is necessary the mathematical modeling for the findings of rheological parameters.



Fig 3 Remoter plate/plate initial tests.



Fig. 4 Initial assays expandable fluid.

The view, that the viscometers, in some cases, are instruments that limit best studies, as they are not accurate compared to Rheometers and does not allow multiple models during analysis. However, it may be noted that one should not use any reômetro for the purposes of a particular study, knowledge is required of the reômetro ideal, the geometry to the fluid, additional accessories required for the equipment and tests. However, such equipment have an expensive cost, which leads to research a few degrees of difficulties.

4. CONCLUSION

To develop models for studies able to characterize the rheological properties found in the folder to cement oil wells and find the most suitable and present the main conclusions, analysis of laboratory equipment, it will be necessary for the remoter. As there is currently a wide vast of various Rheometers and complementary accessories. Is required a prior knowledge of fluid to use the most appropriate equipment, because in this way obtain more accurate results. In addition, because the pressure variations provided by different forces, and changes in temperature of the fluid to cause different rheological characteristics. How should be simulated tests to forward the results to seek, for example, if the desired viscosity is found or the minimum voltage to start the flow of a stream of test should be applied.

It is important to improve the homogeneity of the cement and ceramic suspensions because they lose these features when subject to transport, mixing and pumping. The addition of minerals and additives in the folder for the oil well cementation, according to the rules in force, with the implementation of models of power and Bingham and momentum or oscillatory. Evaluated by testing for developers and rheological tests to determine the top zeta potential the 30 mV being the same

stable and mechanical compression and traction test. However, shows that the main influence is the temperature at which this exposed to folder alongside your application method.

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