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The parametric investigation of composite cement

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ABSTRACT

Experiments are held to investigate the effect of zinc oxide nano particles on the rheological properties of cement slurry. The main purpose of this study is to improve the rheological properties of cement slurry by nano zinc oxide. The objective of designing cement slurry for extreme and deep environment (HPHT wells) is to develop high performance cement system in well bore to achieve zonal isolation. The primary objective of cement slurry is to improve rheological properties and displacement efficiency of cement system.

KEYWORDS

Parametric study;
Cement;
Properties;
Slurry.

INTRODUCTION

During a well cementing operation purpose should be achieve zonal isolation[16]. That belongs to the slurry design, to ensure the best quality of cementing especially at high temperature environment such a HPCS Silica Fume (SF) use as a cement slurry additive to reduce the density of cement. SF increase slurry performance and control hydrostatic pressure during drilling cementing. This mixture used as primary source for a hydraulic seal in the well bore as secondary application is used for remedial operations including depleted zone closing, splits and leaks repair[16]. The function of SF is allows a well to reach full production potential besides producing a blocking effect in the oil well. It is also responsible to prevent gas migration and highly effective for proper placement and decrease permeability for better control of weak zones. Compressive strength of concrete containing SF is proved higher strength; as increase the concentration of silica fume it improves stress resistance in the early development and reduces the free water[12]. The mixing of silica fume into cement several optimum conditions are noticed[17]:

- It is nature to consume more water to prove as s function of extender and substitute for lightweight cements.
- High water adsorption to increased pozzolanic reactivity promotes enhanced compressive strengths.
- The purity and solubility of the material makes it suitable for combating strength retrogression in cements at temperatures above 230°F (110 °C).

History and literature review

Rheological properties of cement slurry play important role to determine the workability of slurry, fineness[12]. The mixing process is very important parameters for rheological behavior of cement slurry, the criteria of designing slurry depends

on formulation, density, plastic viscosity, shears tress, yield point and gel strength for enhance durability and toughness for cement slurry [18] Cement grout is used for sealing geothermal wells for is olatezones during drilling cementing operation. Rheological behavior of cement slurry is important for the drilling process; it will be optimum to predict correctly about slurry placement[3]. Cement slurry is concentrated suspensions of small and heavy particles so rheological measurements are suffering to the disruption of cement operation[13]. Rheology of Oil Well Cement (OWC) should be considered when it applied on the originally and primarily casing cementing. Therefore, fundamental knowledge of OWC slurry rheology is necessary to evaluate the ability to mix and pump grout, remove mud and slurry placement optimization and to predict the effect of temperature on the slurry pit[18]. Incomplete mud removal can result in poor cement bonding, zone communication and ineffective stimulation treatment[3]. A rheology is study related to the flow of fluids and deformation of solids under stress and strain. In shear flows, fictitious parallel layers of liquid past each other in response to a shear stress to produce a velocity gradient, in term of to shear rate, which is equivalent to the rate of increase of shear strain[7]. Rheology of cement slurry is complex which has the appearance and interactions between the additives[2]. The chemical composition of cement, particle distribution, test in g methods, size shape, W/C ratio, mixing time and temperature[5]. Cement slurry is viscous plastic materials that exhibit yield stress and tension below the yield stress ultimately slurry behaves as a rigid and solid[14]. Bingham plastic and power-law model is widely used to describe the rheological properties of cement slurry measurements. Frittella *et al*. (2009) that can be determined the properties of cement flow i.e., plastic is cosity, yield point, friction characteristics and gel strength[8]. Concentration and form of so lid particles has a significant impact on the rheological properties of the OWC slurry to yield stress and plastic viscosity of cement paste usually increase as the cement becomes finer and increases the stability of slurry[4]. Equivalent Circulating Density (ECD) is important factor to understand the flow behavior, flow rate, annular velocity and differential pressure; for that purpose number of computer simulation software is available to predict the ECD. The displacement efficiency is achieving the maximum mud displacement. A standoff value of the percentage of casing centralization in the wellbore, job operation time for proper thickening and Reynolds numbers base on laboratory methods is measuring rheological properties to understand flow behaviors[11]. These parameters will be evaluating the cement pump-ability and cement grout with strength correspond to behind the casing to increase efficiency and displacement. High flow rate may cause fracture the formation there should be investigated the current effective equivalent cement density[9].

Maximum drilling cement or colloids or emulsions as a non-Newtonian liquids in plastic or behave in such circumstances is that the gel analysis function of the intermolecular forces. The initial 10-sec and 10-min gelstrength measurements gelation indications of the gel that will occur after the flow is stopped and the cement remain static When circulating drilling mud and fluids during cementing operations abnormal results in bottom hole, which may cause challenge to the integrity and safety. Soliman *et al*. (2008) To maintain hydrostatic pressure of the fluid column below the fracture gradient but above the pore pressure and designing cement slurry to improve efficiency and displacement without causing any form of collapse to the formation for this condition to focusing on ECD and rheological properties.

MATERIALS AND METHODS

The basic RV test measures the torque required to maintain a constant rotational speed (20 RPM) of a cylindrical spindle while submerged in cement binder at a constant temperature. This torque is then converted to a viscosity and displayed automatically by the RV. The standard Rotational Viscometer procedure is according to AASHTO T 316 and ASTM D 4402: Viscosity Determination of Asphalt Binder Using Rotational Viscometer.

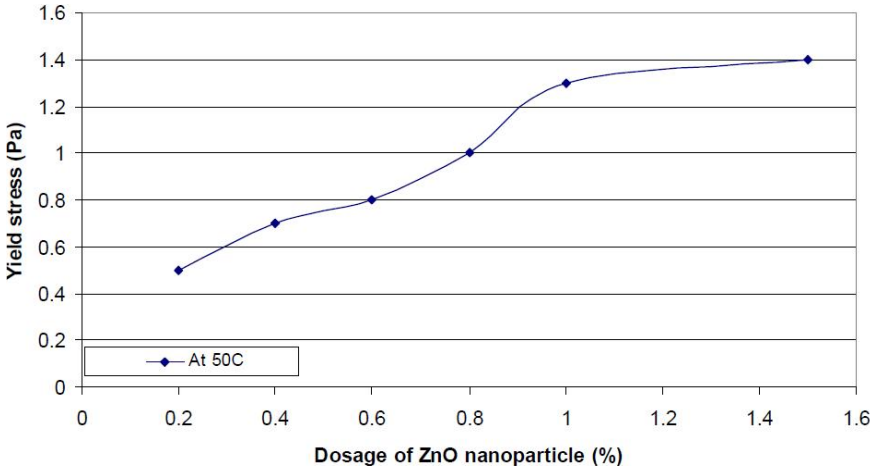

Figure 1 : Yield stress versus amount of nano particles

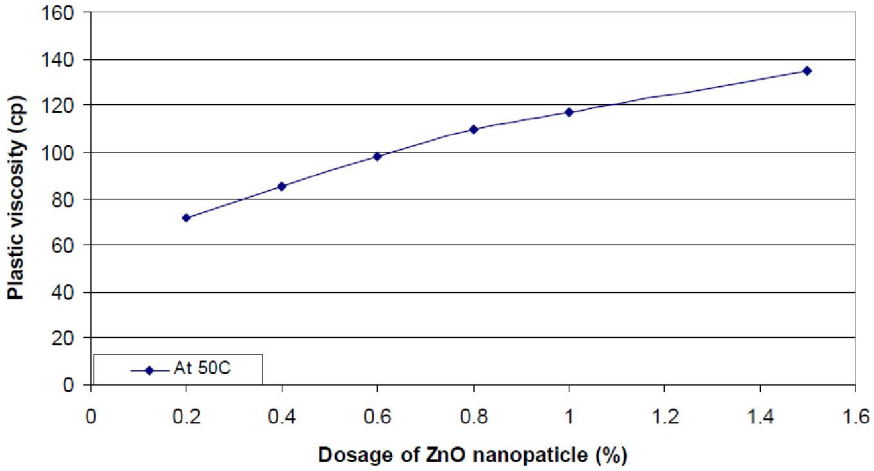

Figure 2 : Plastic viscosity versus amounts of nano zinc oxide

RESULTS AND DISCUSSION

The effect of zinc oxide nano particles

At constant temperature 50 C the effect of dosages of nano zinc oxide on the amounts of yield stress is shown in Figure 1. The increase in the amount of zinc oxide (0.2% to 1.5%) increases the amounts of yield stress (0.5 Pa to 1.4 Pa). So, the molecular interaction between nano zinc oxide and cement seems to make the slurry cement to bear higher stress to flow.

Figure 2 shows the effect of nano zinc oxide addition on the amounts of plastic viscosity, at the constant temperature 50 C**.** Experiments show the increase in the amount of plastic viscosity due to the increase in the amount of nano zinc oxide.

CONCLUSIONS

The quantity of these parameters in various temperatures and also in presence of nano particle are measured and compared with what are measured without nano particles. Nano particles in drilling cement, prevents variations in yield stress in various temperatures in range of 20 C to 80 C. Nano particle decreases the amount of plastic viscosity and apparent viscosity about 10% and 6%, respectively. At average working temperature about 50 C, addition of 1.2% nano particle increases the yield stress and plastic viscosity about 0.9 Pa and 70 cp, respectively. Results are reported through figures. Also, present valuable experimental data which introduce the quality of drilling cement with nano particles.

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