The parametric investigation of composite cement

Farshad Farahbod1*, Mojtaba Yarmahmoudi2
1Department of Chemical Engineering, Firoozabad Branch, Islamic Azad University, Firoozabad, Fars, (IRAN)
2Department of Petroleum Engineering, Marvdasht Branch, Islamic Azad University, Marvdasht, Fars, (IRAN)
E-mail: mf_fche@iauf.ac.ir; mehran_sam05@yahoo.com

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. © 2015 Trade Science Inc. - INDIA

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 a 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 du-
rability and toughness for cement slurry[18]. Cement
grout is used for sealing geothermal wells for is
olate zones during drilling cementing operation.
Rheological behavior of cement slurry is impor-
tant 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, fundamen-
tal knowledge of OWC slurry rheology is neces-
sary 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 ineffect-
ive stimulation treatment[3]. A rheology is study
related to the flow of fluids and deformation of sol-
ids under stress and strain. In shear flows, ficti-
tious 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 equiva-
lent to the rate of increase of shear strain[7]. Rheol-
ogy of cement slurry is complex which has the ap-
pearance and interactions between the additives[3].
The chemical composition of cement, particle dis-
tribution, test in g methods, size shape, W/C ratio,
mixing time and temperature[8]. Cement slurry is vis-
cous plastic materials that exhibit yield stress and
tension below the yield stress ultimately slurry be-
haves as a rigid and solid[14]. Bingham plastic and
power-law model is widely used to describe the
rheological properties of cement slurry measure-
ments. 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[18]. Concentration and form of so lid par-
ticles 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 sta-
bility of slurry[4]. Equivalent Circulating Density
(ECD) is important factor to understand the flow
behavior, flow rate, annular velocity and differen-
tial pressure; for that purpose number of computer
simulation software is available to predict the ECD.
The displacement efficiency is achieving the maxi-
mum mud displacement. A standoff value of the per-
centage 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 evalu-
ating 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 inves-
tigated the current effective equivalent cement den-
sity[9].

Maximum drilling cement or colloids or emul-
sions as a non-Newtonian liquids in plastic or be-
have 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 circu-
lating drilling mud and fluids during cementing op-
erations 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 caus-
ing any form of collapse to the formation for this
condition to focusing on ECD and rheological prop-
erties.

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 pro-
cedure is according to AASHTO T 316 and ASTM
D 4402: Viscosity Determination of Asphalt Binder
Using Rotational Viscometer.
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.
REFERENCES


