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Effects of Polymeric Additives on the Properties of Oil Drilling Muds

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Abstract: This research aims to design drilling muds using different polymers and nano filler for a certain section in Al-Halffia oilfield in Maysan Government (Iraq) and study their properties. Carboxymethyl Cellulose (CMC), Poly Vinyl Alcohol (PVA) and Superabsorbent Polymer (SAP) were added in five ratios (1, 1.6, 2.1, 2.6, 3.2 wt. %) individually. Silica Nano Particle (SNP) was added to the best formula in five ratios (1, 2, 3, 4, 5 wt. %). Properties of drilling muds such as gel strength, density, viscosity, filtration and alkalinity were studied. Results showed that the PVA addition causes fluctuation in filtration and viscosity properties and decreasing in PH values, while the density remain constant approximately. SAP addition causes sharp decreasing in the filtration ability and increasing in viscosity, alkalinity and density. CMC addition causes the same behavior as SAP effect but with little decrease in filter loss and increasing in gel strength property. From the optimization view point, CMC with 2.1 wt% seems to be the best formula for the certain section of Al-Halffia oilfield. The addition of SNP to the best formula increased the filtration and the alkalinity, while viscosity and density sever from fluctuations.

Key words: Drilling mud, Al-Halffia oilfield, carboxymethyl cellulose, poly vinyl alcohol, superabsorbent polymer, density

INTRODUCTION

Drilling mud is a heavy, viscous fluid mixture used to facilities the drilling process. Mud is pumped down the hollow drill pipe to the drill bit where it exits the pipe and then is flushed back up the borehole to the surface (Aadnoy, 1988, 1996).

Each section in the oilfield has an its own structure. This structure required a certain properties of drilling mud to recovery the petroleum. Drilling muds can be classified to the water-based mud, oil-based mud and pneumatic fluid system in which air, mist, foam and gases can be utilized (Shah *et al.,* 2010).

A lot of additives can be used to improve mud properties, for example, filter cake can be improved by addition of bentonite, natural and synthetic polymer and asphalt. Cost, technical performance and environmental impact are the key factors which usually determine the type of fluid selected for a specific well. Mud is designed to deposit thin, low permeability filter cake to limit the invasion. Problems occur if a thick filter cake is formed; stuck pipe, lost circulation and formation damage (Abrams, 1977). Weight of the mud must be within the necessary range to balance the mechanical forces.

Drilling muds have many functions such as providing hydrostatic pressure to prevent formation fluids from entering into the well bore (Braihi, 2015), keeping the drill bit cool and clean during drilling, remove cuttings from well, suspending the drill cuttings (Annis and Monaghan, 1962), maintain wellbore stability, transmit hydraulic energy to tools and bits (Azar and Samuel, 2007) and acts as seal permeable formations. The drilling fluid used for a particular job is selected to avoid formation damage to limit corrosion and to facilitate cementing and completion.

Drilling muds carries the rock excavated by the drill bit up to the surface. Its ability to do so depends on cutting size, shape and density and speed of fluid traveling up the well.

MATERIALS AND METHODS

The neat mud composed of Bentonite; 0.33 Na ($Al1.67MgO\ 0.33O_3$) $4SiO_2.H_2O$, Caustic soda; NaOH, Soda ash; Na_2CO_3, Ferro chrome lignosulphonate; GAC-FeCrLS, Chrome lignite; GLO CR-LIG 1000 and Barite; $BaSO_4$. All these materials were obtained from the Al-Halffia oilfield.

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Three polymers were added individually to the net mud (with PH = 8) in five ratios 1, 1.6, 2.1, 2.6, 3.2 they are Carboxymethyl Cellulose (CMC), Polyvinyl Alcohol (PVA) and Superabsorbent Polymer (SAP). Silica Nano Particles (SNP) with 25-43 nm were added to the best formula in five ratios (0.021, 0.042, 0.063, 0.084, 0.105). All these additives were obtained from Alibaba company, China.

Tests: The density was measured with a mud balance, while viscosity with Marsh viscosity funnel. Filtration was determined with a filter press. Gel strength was measured with a rheometer and the acidity measured by pH meter.

RESULTS AND DISCUSSIONS

Figure 1-4 shows the calculated properties of the mud in the presence of different ratios of PVA. The filtration property (Fig. 1) fluctuated with PVA content and generally increased. This is due to the fact, that PVA is water soluble to some extent in the operating temperature, therefore, some of PVA molecules dissolve in water and the rest molecules will aggregate generating a block for filtration action. Dissolved PVA invade the formation matrix, reducing porosity and causing skin effect.

For viscosity property (Fig. 2), the same behavior occurs; there is fluctuation and roughly increment. This is due to nature of interaction between PVA molecules and the mud components which is a resultant between two opposite actions; the hydrogen bonding action and the dissolving action. Hydrogen bonding arises between the Hydroxyl group (OH) in PVA polymer and the oxygen in the water which present in the drilling mud.

Small amount (1 wt .%) of PVA increased the PH value from 10 (for neat mud) to 12.6 (Fig. 3). This because of the polarity of the PVA polymer which arises from its structure. At ratios higher than 1 wt.%, there is some fluctuations and reduction in the alkalinity degree due to the balancing between the dissolving ability and the agglomeration tendency of PVA molecules within the drilling mud structure.

Generally, there is no obvious effect of the PVA content on the mud density (Fig. 4). This is due to the dissolving state of PVA molecules within the mud structure which maintain density values constants approximately.

Figure 5-8 show the effect of the SAP content on the mud properties. Filtration property decreased progressively and linearly with the SAP content because of the swelling nature of SAP molecules.

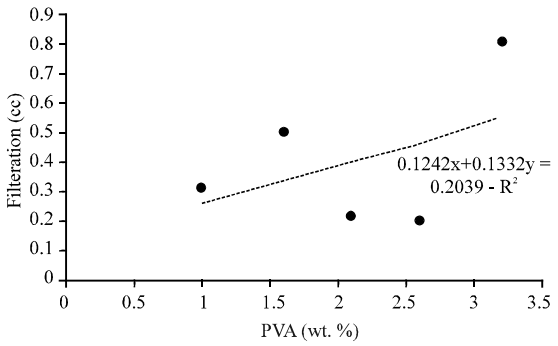

Fig.1: Filtration of the mud as a function of PVA content

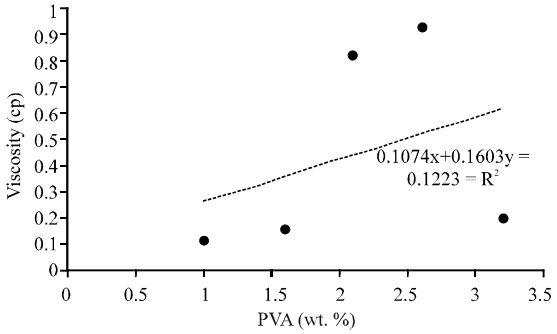

Fig 2. Viscosity of the mud as a function of PVA content

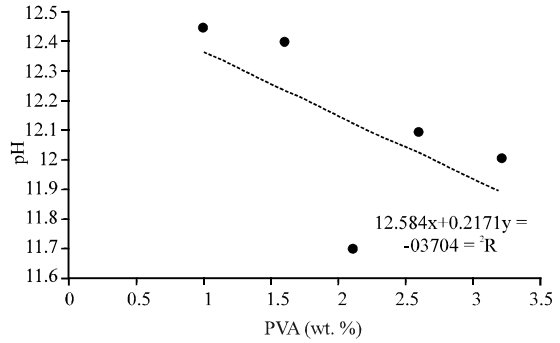

Fig 3. Alkalinity of the mud as a function of PVA content

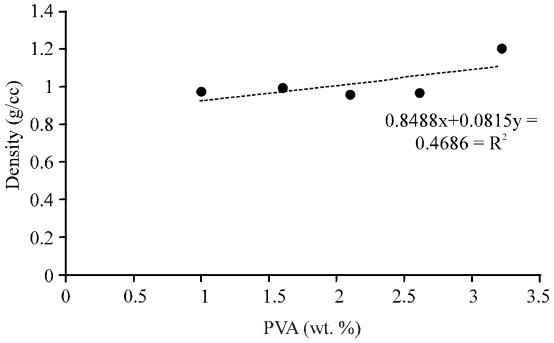

Fig 4: Density of the mud as a function of PVA content

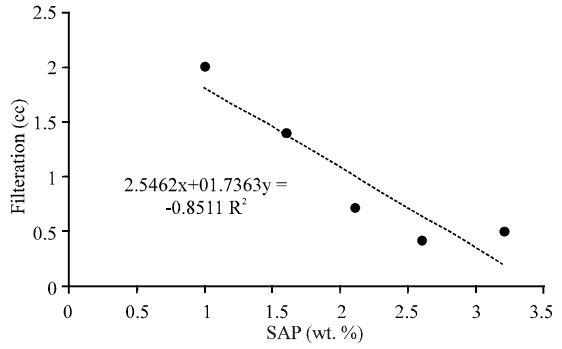

Fig 5. Filtration of the mu as a function of SAP content

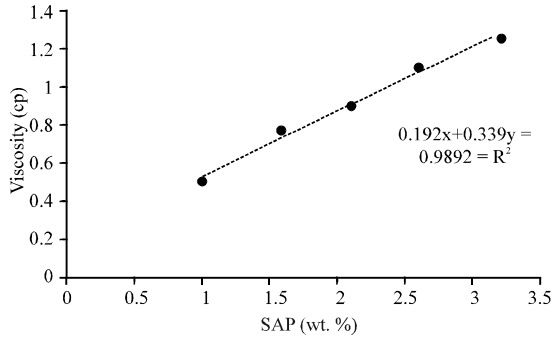

Fig. 6: Viscosity of the mud as a function of SAP content

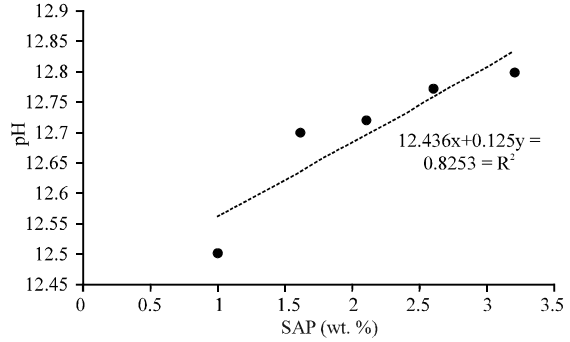

Fig. 7: PH of the mud as a function of SAP content

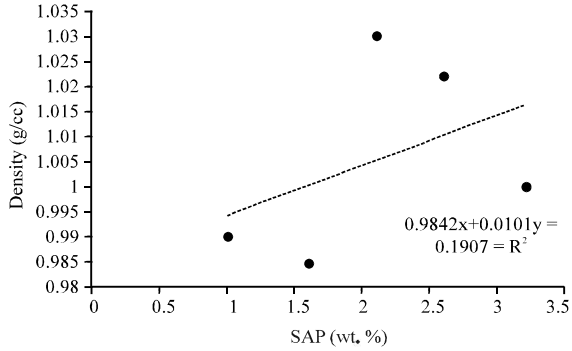

Fig. 8: Density of the mud as a function of SAP content

When SAP molecules be contact with water molecules, the later molecules will penetrate the voids in the PVA structure causes this structure to swell. This behavior enables more water molecules to enter the swollen structure. The new swollen component in the mud will decreases its filtration ability due to blocking all paths those enables small molecules to escape away from mud structure. This is desired property in designing any mud but with SAP swelling behavior the filtration increased too high, so that, stuck pipe problem may occur.

Figure 6 shows the dependency of mud viscosity on SAP content. It is clear that the viscosity increased linearly due to that swollen particles will resist the flow. Excessive viscosity is undesirable because of the pressures that can be generated by higher viscosity in the borehole when pumping horizontally. Since, the primary objective in drilling is to maintain flow, SAP content in drilling mud utilizes in reduces filtration loss to some extent and at higher contents will became disadvantages.

SAP addition increased the alkalinity of the mud (Fig. 7) which enhances the mud ability to resist corrosion, because low pH (acidic) aggravates corrosion. This is desired action since the drill-string and casing in continuous contact with drilling fluid may cause a form of corrosion. This behavior proved that the mud is free from dissolved gases (O_2, CO_2, H_2S), mud aeration, foaming and other O_2 trapped conditions which causes corrosion damage in short period time.

Density of the mud in the presence of different SAP ratios (Fig. 8), exhibits fluctuations due to the uncontrolled behavior of the swelling tendency. Figure 9 shows that the filtration of the mud decreased linearly with the CMC content due to that the swollen CMC molecules act as bridging agents blocking the large opening, thus, making an effective sealant and reducing the permeability. It is clear that with the CMC addition, a desirable mud with low filtrate (water loss) can be obtained.

The density is used to measure the solids content of the return flow. If the solids content is too high, there is an indication to need to turn up the pump or there is needing to slow down the drilling speed.

Figure 10 shows that CMC additions causes a linear increment in the mud density. Acidity and alkalinity is an indicator of water quality. Low pH also indicates the possible presence of calcium. Figure

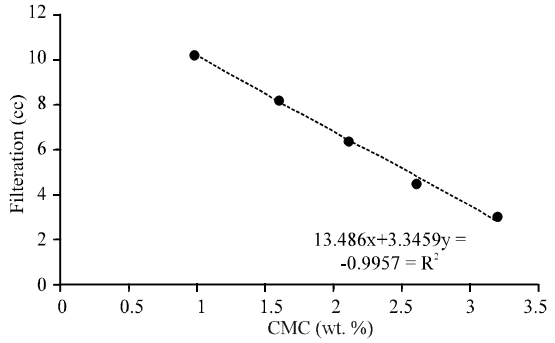

Fig. 9: Filtration of the mud as a function of CMC content

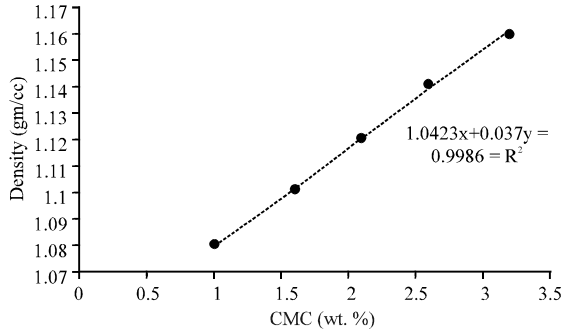

Fig. 10 : Density of the mud as a function of CMC content

11 shows that CMC addition causes slight increment in the alkalinity of the mud and this media is suitable to prevent corrosion effects. The viscosity of the mud also increased with the CMC content (Fig. 12) due to the new restriction forces from CMC molecules.

Gel strength is the mud ability to suspend the cuttings such as sand, gravel and rock. It is an important property, especially in coarse-grained soils to suspend the cuttings and keep them in suspension state until they can be transported out of the hole. Figure 13 shows that the CMC addition causes increases the gel strength, which means that the new mud can acts as conveyor belt to remove these cuttings.

Figure 9-13 showed that the optimum CMC ratio in the drilling mud which is suitable for a certain section for AL-Halfia oilfield is 2.1 wt.%. This is because that this ratio give the required properties for the mud to achieve its functions such as rising cutting stone due to its suitable density and viscosity (PV = 6 cp), decreases the losses filtration due to its suitable porosity and its save acidity (pH = 8) which is suitable from corrosion

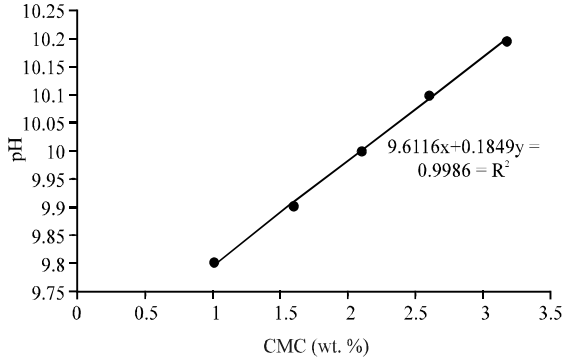

Fig.11: PH values of the mud as a function of CMC content

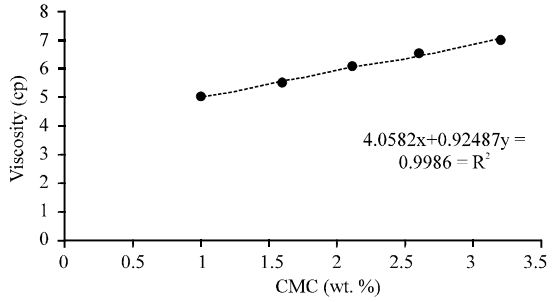

Fig. 12: Viscosity of the mud as a function of CMC content

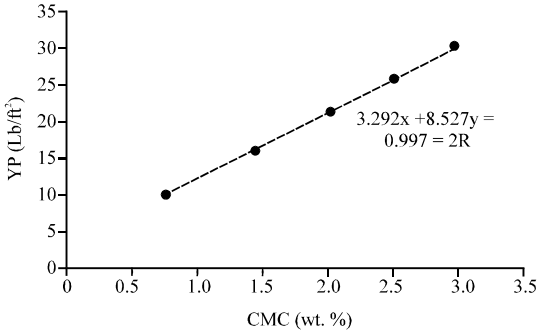

Fig. 13: Gel strength of drilling mud as a function of CMC content

viewpoint. Figure 14-17 show the effect of silica nano particles (SNP) on the mud properties. Filtration property (Fig. 14) increased with SNP content due to the poor interaction between SNPs and the other mud components which result in creating voids and baths. These paths enable the filtrates to escape from the mud bulk. Viscosity property exhibits some fluctuations (Fig. 15) due to the precipitation of the SNPs, since, this leads to the precipitation of insoluble salts. Also, this is cause the formation of

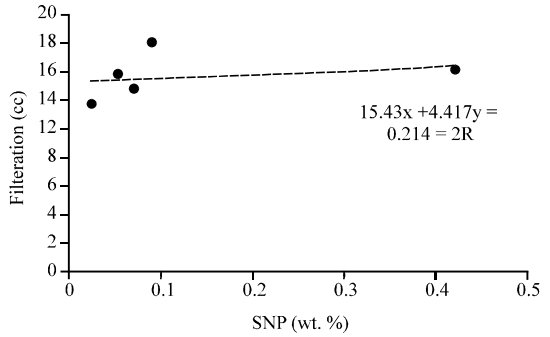

Fig. 14: Filtration of drilling mud as a function of SNP content

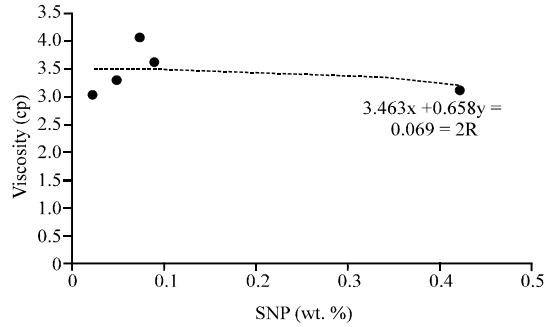

Fig. 15: Viscosity of drilling mud as a function of SNP content

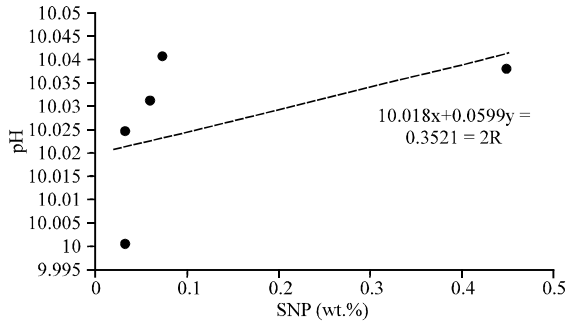

Fig. 16: PH values of drilling mud as a function of SNP content

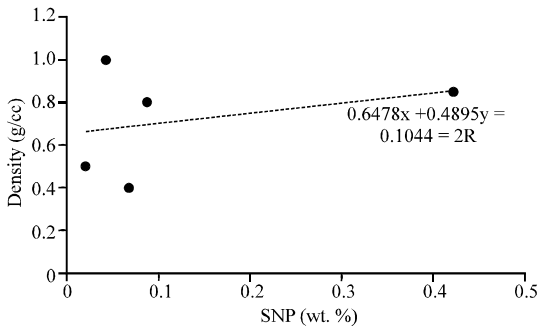

Fig.17: Density of drilling mud as a function of SNP content

an emulsion, reducing porosity and permeability. Slight increment in alkalinity occurs (Fig. 16) due to the limited hydroxyl groups on SNP surface. The density also exhibited some fluctuations due to the uncontrolled precipitation (Fig. 17).

CONCLUSION

The mud viscosity is another important property as cuttings will settle to the bottom of the well if the viscosity is too low (Becker *et al*., 1991).

REFERENCES

Aadnoy, B.S., 1988. Modeling of the stability of highly inclined boreholes in anisotropic rock formations (Includes associated papers 19213 and 19886). SPE. Drill Eng., 3: 259-268.

Aadnoy, B.S., 1996. Modern Well Design. Taylor & Francis, Rotterdam, Netherlands, Pages: 239.

Abrams, A., 1977. Mud design to minimize rock impairment due to particle invasion. J. Pet. Technol., 29: 586-592.

Annis, M.R. and P.H. Monaghan, 1962. Differential pressure sticking-laboratory studies of friction between steel and mud filter cake. J. Pet. Technol., 14: 537-543.

Azar, J.J. and G.R. Samuel, 2007. Drilling Engineering. PennWell Corporation, Tulsa, Oklahoma, ISBN-13:978-1-59370-072-0, Pages: 465.

Becker, T.E., J.J. Azar and S.S. Okrajni, 1991. Correlations of mud rheological properties with cuttings-transport performance in directional drilling. SPE. Drill. Eng., 6: 16-24.

Braihi, A.J., 2015. Synthesis and characterization of advanced CMC/Starch/ nanomaterials composite and its applications. Ph.D Thesis, University of Technology, Iraq, Baghdad, Iraq.

Shah, S.N., N.H. Shanker and C.C. Ogugbue, 2010. Future challenges of drilling fluids and their rheological measurements. Proceedings of the Conference on AADE Fluids Conference and Exhibition, April 6-7, 2010, Hilton Houston North, Houston, Texas, pp: 1-16.