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Research Article

Empirical evaluation of dynamic parameters of simple and nano drilling fluid

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Abstract: The energy of a nation is largely conditioned by the extent of prospective, surveyed and extracted oil and gas reserves and other natural resources. Hence this is the main source of somewhere economy. Experiments are held to investigate the effect of aging time and temperature on a prepared oil based drilling mud which contains nano ferric oxide particle. The rheological specifications of drilling mud in high temperature–high pressure viscometer are considered in this work to simulate the drilling conditions occurred in deep wells. Also, all results which are related to the rheological behavior of drilling fluid are at the higher range of shear rate value than those are related to the nano drilling fluid, at the constant temperature and the constant amount of shear stress.
Keywords: Rheological specifications; Oil based drilling mud; Strength; Yield point; viscosity.

INTRODUCTION

The energy of a nation is largely conditioned by the extent of prospective, surveyed and extracted oil and gas reserves and other natural resources. Hence this is the main source of somewhere economy. The oil and gas sector in somewhere has many aspects where it functions; firstly, the confirmation of any natural resources on the earth crust is through drilling [1, 2]. Drilling is a single important aspect of oil and gas sector for without drilling, there is no access to the natural resources available below the earth crust. Drilling is a process of making a hole in the earths' surface for the purpose of creating access to the desired resource below the earth crust. Drilling process should be conducted safely least cost and minimum or no damage to the environment [1]. One of the important materials used in drilling is the drilling fluids commonly call drilling mud. The is of two types – water based mud and oil based mud and drilling fluids and design and production of these drilling fluid becomes utmost important because of its role in drilling [2 , 3]. Companies involved in the design and production of drilling fluids in somewhere for the oil and gas sector have over the years imported the materials to produce mud or in some cases imported already designed and produced drilling mud. In this case, industry in this sector adjust the properties of the drilling fluid with the aid of the right types of additives which are also imported to suit the formation requirements of the area to be drilled. This has been a major challenge especially to the indigenous companies involved in the oil and gas because they have to import these materials at high costs and this has not allowed them to compete favorably with their foreign counterparts. Research into this area is thus necessary. Country like India, where cheaper substitutes for production of different goods and services are found (including the oil and gas sector and the production of drilling fluids), using their local materials. This has improved their economy with benefit of job opportunities that are created with their own natural resources which means reduction in the amount of importation [4, 5, 6]. Drilling fluid -mud - is usually a mixture of water, clay, weighing material and a few chemicals. Sometimes oil may be used instead of water, or oil added to the water to give the mud certain desirable properties [7]. Drilling fluid is used to raise the cuttings made by the bit and lift them to the surface for disposal [8]. But equally important, it also provides a means of keeping underground pressures in check. The heavier or denser the mud, is the more pressure it exerts. So weighing materials-barite-are added to the mud to make it exert as much pressure as needed to contain formation pressures. The equipment in the circulating system consists of a large number of items. The mud pump takes in mud from the mud pits and sends it out a discharge line to a standpipe [9, 10]. The standpipe is a steel pipe mounted vertically on one leg of the mast or derrick. The mud is pumped up the standpipe and into a flexible, very strong, reinforced rubber hose called the rotary hose or Kelly hose. The rotary hose is connected to the swivel. The mud enters the swivel the swivel: goes down the Kelly, drill pipe and drill collars and exist at the bit. It then does a sharp U-turn and heads back up the hole in the annulus. The annulus is the space between the outside of the drill string and wall of the hole. Finally the mud leaves the hole through a steel pipe called the mud return line and falls over a vibrating, screen like device called the shale shaker.

MATERIALS AND METHODS

Oil drilling mud contains emulsifier, viscosifyer, wetting agent, brine, lime and other components. Table 1 shows the composition of oil drilling mud.

Table-1: Components of oil based drilling mud

Component	Concentration Percent
Dearomatized oil	55
Filtrate reducer	0.7
Emulsifier	2.1
Wetting agent	0.34
Lime	2.3
Organophilic clay	1.7
Viscosifyer (Bentonite)	5
Brine	38

RESULTS AND DISCUSSION

Drilling mud performance has a significant effect in drilling purpose. Some dominant factors which influence the rheological behavior of drilling mud are considered experimentally. The amount of shear stress versus various shear rates has been considered as the representative of rheological behavior of fluids. Shear stress is defined as the amount of horizontal force divided by the adjacent surface area. Operating temperature affects the properties of fluids due to researches. The effect of operation temperature which varies from 30 C to 80 C is investigated in Figure 1 through 8 after 0, 1, 3, 5, 7, 10, 12 and 15 days, respectively. Also, a comparison in behavior of nano drilling fluid (NDF) and simple drilling fluid (DF) is shown. The increase in temperature looses the molecular cohesion and decreases the movement resistance of layers toward the force. So, the slope of lines decreases with increasing in the temperature. In other definition, the increase in temperature decreases the amount of required horizontal force at a constant shear rate value. There is one amount of initial shear stress which is needed to deform the layers from the initial state, at each temperature. However at 80 C, the amount of required force and shear stress decreases with the increase in the amounts of shear rates between 100 $s^{-1}$to 600 s^{-1}. Also, all curves which are related to the Rheological behavior of DF are at the higher range of shear rate value than those are related to the NDF, at the constant temperature and the constant amount of shear stress. This can indicate on the less amount of required pump power to recycle the oil based drilling fluid which contains nano particle after a static state than that is needed for simple oil based drilling fluid. This may show the improvement in properties of oil based drilling fluid by addition of nano particles. Comparison between results in Figure 1 and Figure 2, show the amounts of shear stress decrease after 1 day aging. Figure 2 to 8 shows the effect of temperature and also nano particle at 30 C and 80 C on the values of shear rate of drilling fluid during 15 days of aging time. Although, the initial amount of shear stress is decreased through the time but this seems that aging time doesn't affect the basic role of nano particle in decreasing of the amounts of shear rates. So, the structure of nano drilling mud seems to be maintained after 17 days.

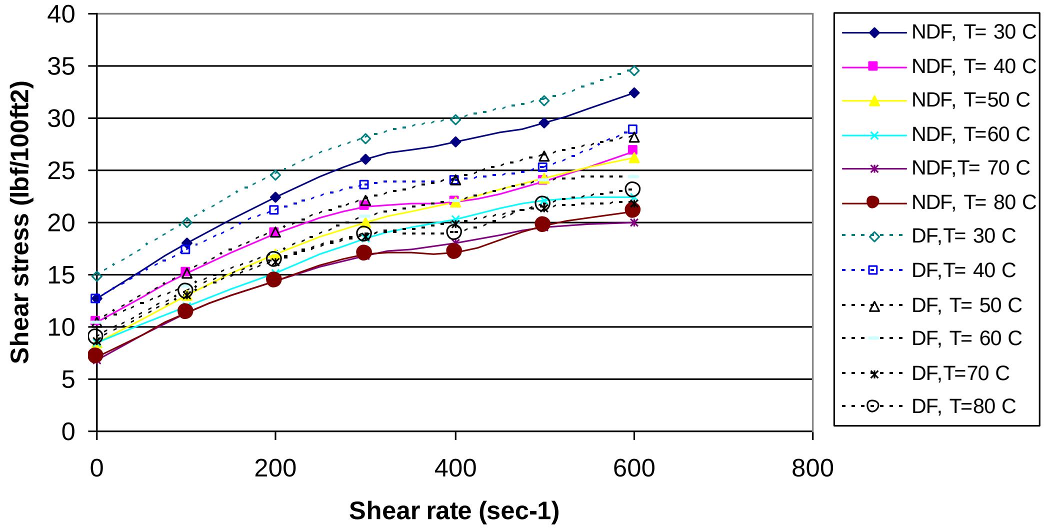

Fig-1: Influence of shear rate in different temperatures on the shear stress after 0 day.

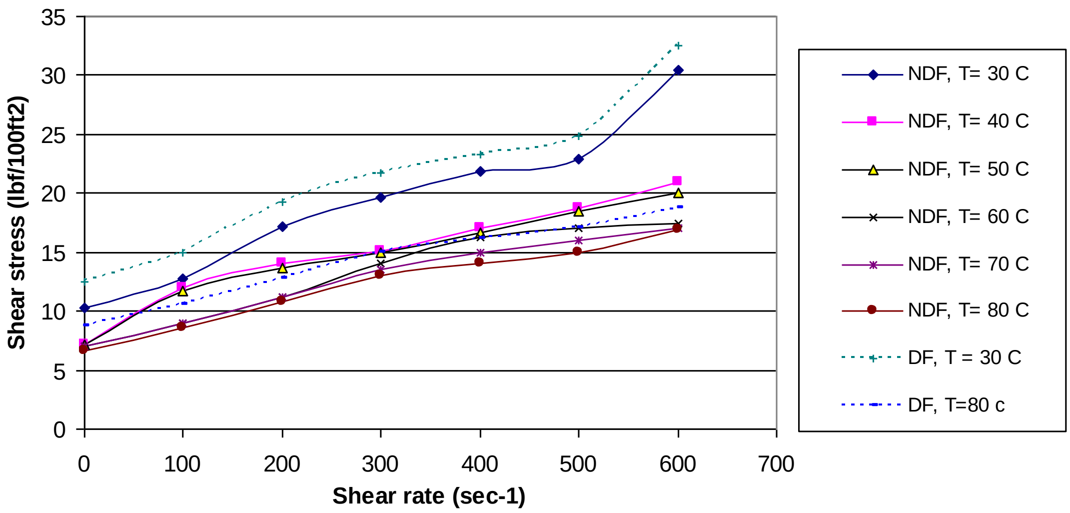

Fig-2: Influence of shear rate in different temperatures on the shear stress after 1 day.

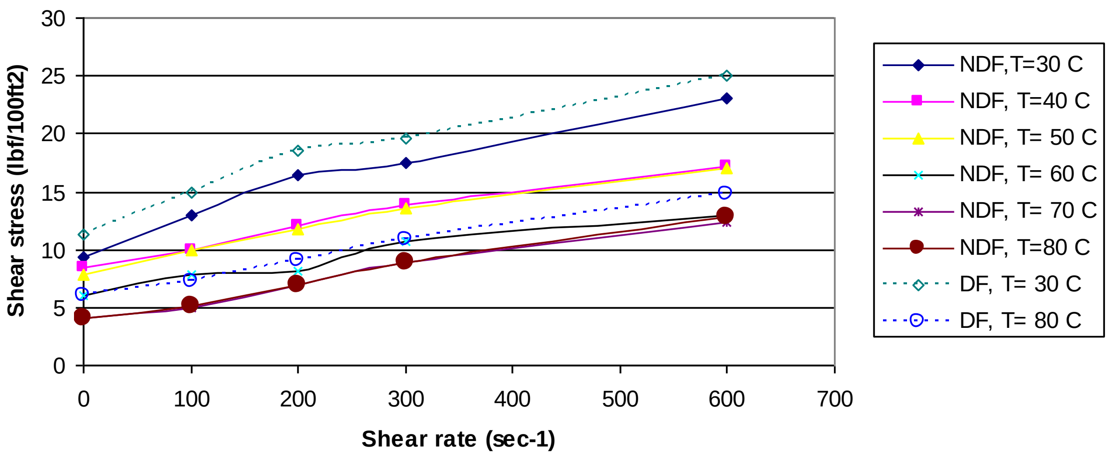

Fig-3: Influence of shear rate in different temperatures on the shear stress after 3 days.

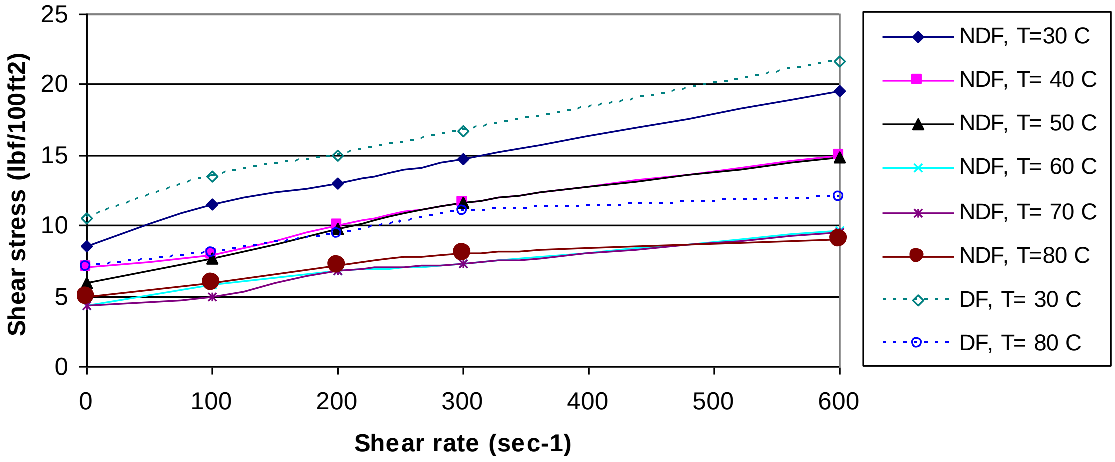

Fig-4: Influence of shear rate in different temperatures on the shear stress after 5 days.

Due to Figure 3 and Figure 4, an irregular increase is obtained in the increase in the shear rate as a curve other than a line. The initial strengths decreases and this indicates the lower strength of mud attributes to the age effect after 5 days; the cohesion force seems to be decreased.

CONCLUSION

Drilling problems depend on the drilling mud performance properties, significantly. In this work, experimental data of the amount of shear rate, shear stress, viscosity, gel strength and yield point are presented which introduce the treatment of oil based drill mud versus aging time (1, 3, 5, 7, 10, 12 and 15 days) and temperature (30, 40, 50, 60, 70 and 80 C). The obtained results show, there is one amount of initial shear stress which is needed to deform the layers from the initial state, at each temperature. However at 80 C, the amount of required force and shear stress decreases with the increase in the amounts of shear rates between 100 $s^{-1}$to 600 s^{-1}. Also, all curves which are related to the Rheological behavior of DF are at the higher range of shear rate value than those are related to the NDF, at the constant temperature and the constant amount of shear stress.

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