Effect of Temperature on rheological properties of Drilling Mud in Nasiriyah oil field

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Abstract—To meet the increased global demands on oil and gas exploring deep and ultra-deep wells is increasing rapidly. Drilling at such faces a wide range of difficult challenges and issues, one of the challenges is the negative impact on the rheological properties of the drilling fluids when exposed to high temperature high pressure (HT/HP) conditions. For a successful drilling operation, the drilling engineer must have a good estimate for the values of rheological properties of drilling fluids, such as viscosity, density, yield point, gel strength etc. in this work, experiment was conducted on water-based mud, from ambient condition to very high temperature and pressure.

I. INTRODUCTION

Drilling fluids were once only regarded as means of bringing rock cuttings to the surface, but today drilling fluids are recognized as one of the major factors leading to the success or failure of any drilling operation. Not only does it lift cuttings out of the wellbore, it also performs other important functions that are essential to the efficient, economic and safe completion of a drilling operation. Some of the major functions of drilling mud for a rotary

drilling process are Transport drill cuttings to the surface, Suspend drill cuttings when circulation is suspended Lubricate and cool drill bit, Control of subsurface pressure, Support the walls of the drilled hole and Seal permeable formation..

One of the greatest problems encountered in deep wells drilling is that drilling fluid requires excellent thermal stability for rheological properties due to the high temperature and high pressure reservoir conditions. Therefore, with increasing in drilling depth the wellbore temperature increases and this effect on drilling mud properties such as (density ,viscosity , yield point (YP) and plastic viscosity (PV)).

Rheology refers to the deformation and flow behavior of all forms of matter. Certain rheological measurements made on fluids, such as viscosity, gel strength, etc. help determine how this fluid will flow under a variety of different conditions. This information is important in the design of circulating systems required to accomplish certain desired objectives in drilling operations.

To be able to achieve most of the functions listed above, the drilling fluid must attain desired viscosity, density and other rheological properties. In today's drilling operations, great emphasis is always laid on the rheological properties of the drilling fluid to be used. This is because these properties greatly influence drilling fluid performance in terms of hole cleaning, static and dynamic carrying capacity, rate of penetration, etc. Inadequate drilling fluid design or negative changes in theology may lead to drilling problems

Determination of the mud properties requires the experimental examination of the mud system at both the standard API and the high temperature, high pressure conditions at intervals throughout the duration of the drilling process . After conducting the experiments and discovering a change in the properties, many chemicals are added to improve the rheological properties of the drilling mud so that the drilling mud can perform its required functions without problems.

II. DRILLING FLUID FUNCTIONS

to minimize the cost of fluids and to ensure an efficient drilling program, the fluid properties must be maintained continuously during the drilling operation. In addition, the high temperature and high pressure conditions faced in ultra-deep oil and gas drilling environments pose major challenges for the fluids used in these environments reduces drilling efficiency by slowing the rates of penetration and creates sever problems that leads to leaving behind most of the oil unrecovered.. A selected drilling fluid must offer a host of functionalities, which include:

- Control subsurface pressures, maintaining well control;
- Remove drilling cuttings from beneath the bit and circulate them to the surface;
- Maintain wellbore stability, mechanically and chemically;
- Cool and lubricate the drill string and bit;
- Allow adequate formation evaluation;
- Provide a completed wellbore that will produce hydrocarbons;
- Suspend or minimize the settling of drill cuttings or weight material when circulation is stopped, yet allow the removal of drill cuttings in the surface fluids processing system; and

- Form a low permeability, thin and tough filter cake across permeable formation.

The performance of these functions depends upon the type of formation being drilled and the various properties of the drilling fluids.

II.TYPES OF DRILLING FLUIDS

There are many types of drilling fluids are used on a day-to-day basis. Some wells require that different types be used at different parts in the hole, or that some types be used in combination with others. The various types of the fluid generally fall into a few broad categories.

1. AIR DRILLING (AIR FLUIDS)

Compressed air is pumped either down the bore hole's annular space or down the drill string itself.

2. WATER BASED MUD

The most basic water-based mud systems begin with water, then clays and other chemicals are incorporated into the water to create a homogeneous blend resembling something between chocolate milk and a malt (depending on viscosity). The fluid is the mud in which water is the continuous phase. This is the most common drilling mud used in oil drilling. The following designations are normally used to define the classifications of water base drilling fluid.table-1 shows the quantities of mixing.

Table-1

Components	B_0	B_1	B_2	B_3	B_4
Water	350ml	350ml	350ml	350ml	350ml
Bentonite	21g	21g	21g	21g	21g
Caustic Soda	0.4g	0.4g	0.4g	0.4g	0.4g
Soda ash	0.4g	0.4g	0.4g	0.4g	0.4g
PAC R	0.3g	0.3g	0.3g	0.3g	0.3g
Unweighted Mud weight	8.6ppg	8.6ppg	8.6ppg	8.6ppg	8.6ppg
Barite	70g	70g	70g	70g	70g
Weighted Mud weight	9.3ppg	9.5ppg	9.3ppg	9.4ppg	9.4ppg+

3. OIL BASED MUD

Oil-based mud is a mud where the base fluid is a petroleum product such as diesel fuel. Oil-based muds are useful for many reasons, such as increasing the lubricity, enhanced the shale inhibition, greater cleaning abilities with less viscosity, and the oil-based muds also withstand greater heat without breaking down. There are 2 types of oil-based muds which are Invert emulsion oil muds and Pseudo oil based muds.

If the amounts of water are more than 5 %. It will become water-in-oil emulsion or Invert emulsion.

All solids in Oil-based mud are considered inactive, because they do not react with oil. table-2 shows the quantities of mixing.

Table-2

Diesel	238 ml
Emulsifier	4.2 ml
Wetting agent	1.7 ml
Viscofire	8 g
Lime	3 g
Barite	255 g
Filter loss reducer	2.5 g
Fresh water	(33 ml water + 15 g $CaCl_2$)

4. SYNTHETIC BASED MUD

Synthetic-based fluid is a mud where the base fluid is a synthetic oil. This is most often used on offshore rigs because it has the properties of an oil-based mud, but the toxicity of the fluid fumes are much less than an oil-based fluid. Synthetic-based fluid poses the same environmental and analysis problems as oil-based fluid.

IIII.STUDAY AREA

The Nasiriyah oil field is located in Dhi Qar Governorate, about (38) km northwest of the city of Nasiriyah. The dimensions of the structure within the studied area at the level of the Mushrif reservoir are about (47 * 20) km and the structural closures are up to 42 meters and the presence of stratigraphic phenomena that led to catching hydrocarbon aggregates

The Mishref reservoir is located at an average depth of (1950) meters above sea level and an average thickness of formation (170) meters. The reservoir consists of two domes.

The Mushrif reservoir / Nasiriyah field is considered one of the main reservoirs in southern Iraq, extending for a distance of 34 km and a width of more than 13 km. It is located at a depth of approximately 1914-1922 meters below sea level

The field Discovered in 1973. The field started its experimental work in June 2009 with a capacity of 10,000 barrels per day, the figure-1 below show the field location .

Fig-1

The table-3 below show the geological sequence and details to one of Nasiriyahs wells table-3

FORMATION	DEPTH(m)	THICKNEESS(m)	Discirption OF Formation
Upper Fars	(250-288)	-	Caly,Anhydrite,Gypsum,sandston
Lower Fars	(289-375)	87	Anhydrite,Marl,claystone,Gypsum, limestone
Jeribe- Euphrates	(376-425)	50	Dolomite, Anhydrite .
Dammam	(426-645)	76	Limestone dolomite,Anhydrite
Rus	(646-721)	220	Anhydrite,dolomite
Umm-Er-Radhumma	(722-1151)	430	Dolomite,Anhydrite,limestone ,shale
Tayarat	(1152-1237)	86	shale dolomite,limestone
Shiranh	(1238-1441)	204	Limestone,Marl
Hartha	(1442-1566)	125	Limeston,dolomite
Sadi	(1567-1801)	234.5	Limestone
Tanuma	(1801.5-1854)	53	Shale,limestone,Marl
Khasib	(1855-1904)	49.5	Limestone,shale
Kifl	(1904.5-1919)	15.5	Anhydrite.limestone,shale
Mishrif	(1920-2089)	170	
CR1	(1920-1928)	8	
mA	(1929-1985)	56	
CR11	(1986-1995)	9	
MB1	(1996-2072)	76	Limestone,shaleMarl,chert
MB2	(2073-2089)	16	
Rumaila	(2090-2106)	16	Limestone,chert

IIIII. MATERIAL AND METHODOLOGY

The main object of this work to:

⇒ Find out the effect of HT/HP on the rheological properties of water-based drilling fluid

Before find out this effect We should take a view about the rheological properties that is variable with temperature and pressure and the used material.
These parameters as shown below:

1. DENSITY

For all practical purposes ,density means weight per unit volume and is measured by weighing the mud. The weight of mud may be expressed as a hydrostatic pressure gradient in lb/in2 per 1,000 ft of vertical depth (psi/1,000 ft), as a density in lb/gal, lb/ft3, kg/m³ or Specific Gravity (SG)

$$SG=\frac{gm}{cm3} \text{ or } \frac{lb/gal}{8.345} \text{ or } \frac{lb/ft3}{62.3}$$

mud density can be regarded as a measure of the suspended solids. And can be expressed in the equation:

$$density(\rho)=\frac{mass}{volume}$$

The density of the drilling fluid must be controlled to provide adequate hydrostatic head to prevent influx of formation fluids, but not so high as to cause loss of circulation or adversely affect the drilling rate and damaging the formation. Normal pressure gradient by water is equal to (0.433 psi/ft) and equal to 433 psi/1000 ft. It is an important property to maintain the well hydrostatic and prevent gas influx migration into the wellbore. Some of weight material such as barite and hematite are added into the mud to increase the mud weight. Mud in the wellbore column must exert a greater pressure than the fluids in porous rocks that are penetrated by the bit. The pressure exerted by the drilling mud at any depth or gradient of pressure is related to its density. Too dense or viscous mud may exert excessive pressure to the wellbore and causing loss of circulation.

to control on layer pressure use the hydrostatic pressure, which is the pressure exerted by a column of fluid and is a function of fluid density and true vertical depth (not measured depth).i.e.:

$Ph = 0.052 * \rho * h$

Where:

Ph= hydrostatic pressure.

ρ = mud density.

h = mud height.

to determine density of the drilling fluid the mud balance is used as shown below . this instrument consists of a constant volume cup with a lever arm and rider calibrated to read directly the density of the fluid in ppg (water 8.33), pcf (water 62.4), specific gravity (water = 1.0) and pressure gradient in psi/1000 ft. (water 433 psi/1000 ft).

Laboratory results of mud balance on a sample of Bentonite and fresh water mixture for different temperatures are as shown

Temperature/C	Density/ppg
26°	10.01
37°	10.07
47°	10.03
57°	10
67°	9.97

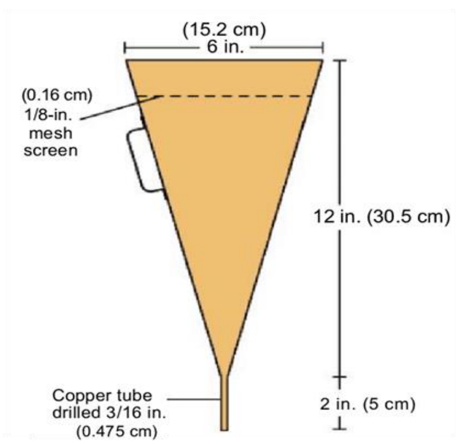
2. VISCOSITY

Viscosity **(μ)**of drilling mud is the representation of a fluid's internal resistance to flow, defined as the ratio of shear stress to shear rate. Viscosity is expressed in poise or centi poise.

$$Viscosity(\mu)=\frac{share\ stress\ \tau}{share\ rate\ \gamma}$$

mud density, hole size, pumping rate, drilling rate, pressure system and requirements, and hold problems. The indicated viscosity as obtained by any instrument is valid only for that rate of shear and will differ to some degree when measured at a different rate of shear.
The viscosity of a mud is a function of three components:
1. Viscosity of the base liquid, or continuous phase.
2. The size, shapes and number of solids particles in the mud (plastic viscosity).
3. Inter-particle forces (yield point).
the marsh funnel has become the standard instrument. For laboratory .The Marsh funnel is used for routine field measurement of the viscosity of drilling mud.

The Marsh Funnel is a device that is common to every drilling rig. Details of the Marsh Funnel and receiving cup are shown in Figure (2), is 6" in diameter at the top and 12" long. At the bottom, a smooth-bore tube 2" long having an inside diameter of 3⁄16" is attached in such a way that there is no constriction at the joint. A wire screen having 1⁄16" openings, covering one-half of the funnel, is fixed at a level of 3⁄4" below the top of the funnel.



The viscosity is reported in seconds allowed to flow out of the funnel. API specifications call for 1500 ml and one quart (946) ml out. For API water at 70+ 0.5oF (21 ± 3°C) in 26 + 0.5 second. The Marsh Funnel measures the apparent viscosity, its consist :
a. Funnel Cone
b. Orifice
c. Screen
Funnel viscosity is used as a relative indicator of fluid ,condition. It does not provide sufficient information to determine the rheological properties or flow characteristics of a fluid. It should be used in the field to detect relative changes in the fluid’s properties. The funnel viscosity of most fluids is controlled at four times the density (lb/gal) or less. There are exceptions, however, as in areas where high-viscosity fluids are necessary. Polymer and invert-emulsion (oil or synthetic-base) systems do not necessarily follow these rules

we use this equation to find the viscosity **$\mu=\rho(T-25)$**
Laboratory results of marsh funnel on a sample of Bentonite and fresh water mixture for different temperatures are as shown

Temperature/C	Viscosity/CP
26˚	7.355
31	5.25
37˚	4.72
42˚	3.99
52˚	3.15

3.PLASTIC VISCOSITY AND YIELD POINT (PV AND YP)

PV is a function of solids concentration, size and shape of the solid particles and viscosity of liquid phase [3]. It is regarded as a guide to solid control for field application [5]. PV increases if the volume percent of solid increases, or if the volume percent remains constant and the size of the particles decreases. Decreasing particle size may increase surface area that lead to fractional drag problem. This plastic viscosity is sensitive to the concentration of solid and depends largely on the bulk volume of solids in the mud [5]. A low PV implies lower ECD exerted at bottom while high PV trigger to an increase of ECD because high pumping pressure is needed to break the gel. YP/PV ratio is a significant indicator of drilling fluid condition, low ratio indicates smaller tendency for gas cutting, swabbing pressure and greater settling velocity of cuttings whereas high ratios indicate coagulation and flocculation [6]. Removal of drilled solids from a drilling fluid will decrease plastic viscosity and if this solid remain in the fluids, it will grind into smaller and more numerous particles which increases plastic viscosity and decreases drilling performance[8] .
YP is the initial resistance of the fluids to flow caused by the electrochemical forces between the particles. It is also expected to be a function of the solid concentration of the solids and those factors, such as surface charges and potential, which affect the inter-particle forces [9]. YP and gel strength should be low enough to allow sand and shale cuttings to settle out and entrained gas to escape, Efficient elimination of drilled solids right after the fluid leaves the annulus was the best solution to avoid drilling fluid-cutting interaction that subsequently can increase the fluid density [11]. A change in the PV of drilling mud can cause small changes in YP. Therefore, it is always important to keep the viscosity of a mud from getting too low. The mud should have minimum viscosity properties to lift the cuttings from bottom of the hole to surface. The mud must capable to keep the weighting material and drilled cuttings in suspension while circulating or stop pumping.

Normal reaction in the event of poor cutting transport is to increase the YP of the mud. However, significant increase in YP may result poor performance of finest mesh at shaker screen. Changing the mesh screen to a coarser screen decreases the quantity of drilled solid that can be removed [12]

A good drilling fluid should have the lowest possible viscosity when it strikes the bottom of the hole to remove drilled solids created by the drill bit. Then the fluid must have a sufficient viscosity to transport drilled solids out of the bore hole. This change in viscosity is created by having a fluid which changes viscosity with shear rate (Figure Fg-2).

Shear Stress = (PV) (Shear Rate) + YP……..Eq-1

The PV and YP can be quickly calculated from the shear stress values measure at rates of 600 and 300 rpm. The PV in centipoise (cps) is calculated from the 600-rpm dial reading (θ600) minus the 300-rpm dial reading (θ300). The PV depends mainly on the concentration of solids and the viscosity of the base liquid. The YP in (lb/100 ft2) is then calculated from the 300-rpm dial reading minus the PV. Typical six speed shear rates are taken at 600, 300, 200, 100, 6, 3 rpm Hughes10.

Based on above definition, plastic viscosity represents the viscosity of mud when subjected to infinite shear rate.

PV(cps)=θ600-θ30 0 ……….. YP($\frac{lb}{100sq\ ft}$)=θ300-PV

.Laboratory results of rheometer on a sample of Bentonite and fresh water mixture for different temperatures are as shown

TEMP C	yield point (lbf/100 ft^2)
37˚	3.4
71˚	3
93˚	2.4
121˚	0.7
148˚	0.5
176˚	0.5

TEMP C	plastic viscosity (cp)
37˚	5.2
71˚	4.1
93˚	3.5
121˚	1.98
148˚	1.3
176˚	0.3

4.GEL STRENGTH

Gel Strength is the shear stress measured at low shear rate after a mud has set quiescently for a period of time (10-sec. and 10-min. in the standard API procedure, although measurements after 30-min. or 16-hrs may also be made". Based on the previous studies gel strengths of drilling fluid/ mud could be defined as a measure of the shearing stress required to initiate flow after static period of time and finite rate of shear, so gel strength is the ability of the drilling mud to suspend drilling cuttings and other solid additives. They are measured by observing the maximum shear stress value while slowly turning the 3-rpm setting after being static for some period of time (lb/100 ft2. With sufficient
gel strength can help suspend drill cuttings in the hole and allow them to settle out on the surface.

Gel strength measured by observing the maximum shear stress value while slowly turning the 3-rpm setting after being static for some period of time. Standard values for gel strength are taken after 10sec, 10 minutes and 30 minutes.

Laboratory results of rheometer on a sample of Bentonite and fresh water mixture for different temperatures are as shown

TEMP /C	gel strength ,bf/100 ft^2
37˚	3
65˚	2.4
93˚	2.2
121˚	1.5
176˚	1.4
232˚	1

IIIII. RESULTS AND DISCUSSION

According to the results obtained from the experiments, the effect of high temperature on different properties of drilling fluid is discussed below.

1. PLASTIC VISCOSITY

Table-1and figure-1 show that plastic viscosity decrease with increasing in temperature. An increase in temperature significantly reduces the plastic viscosity of the mud sample to very low values (less than 1 cp)

Table-1

TEMP(C)	plastic viscosity (cp)
37˚	5.2
71˚	4.1
93˚	3.5
121˚	1.98
148˚	1.3
176˚	0.3

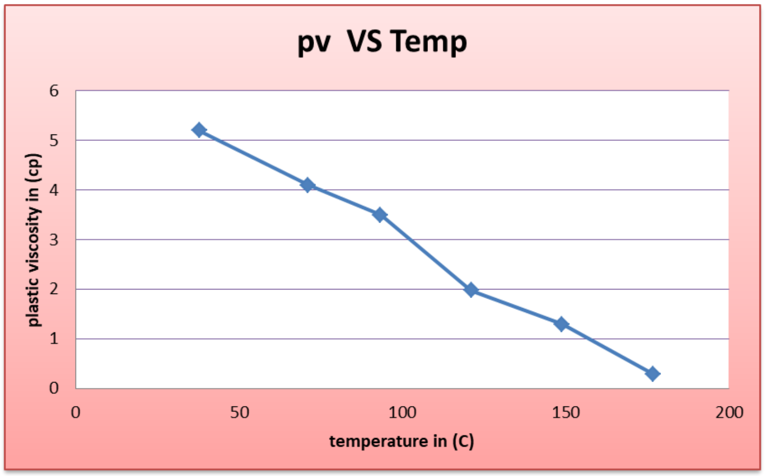


Fig-1

the viscosity resulting from the friction between clay particles and water particles with solids particles or water particles with each other or solids particles with each other. Will transport drilled solids out of the bore hole If the viscosity decrease, it will lose its function and thus generate problems that impede the drilling process and may stop it.

Therefore, it is necessary to add substances that raise the viscosity, including:

A - Bentonite

B. P A C-R

C- HEC (Hydroxy Ethyle

D-Xanthangum cellulose) (viscosifier polymer)

E-salt clay (Zeogel)

F- Deovise.

G- NaoH (caustic soda)

H- Attaplugite (Salt Clay)

substances that reduce the viscosity, including:
A- Lignosulfonate
B. Lignite
C - Xp- 20
D- Resinex
E- Na-Dichromate
F-Na-Bicarbonate
We should notice :

- high calcium content increase viscosity (contamination) preferably max content of $caf^{+}{}_{2}$ 400ppm
- high temperature increase viscosity, especially with high basic, so it is recommended to reduce the basic to pH = 9 at high temperature
- good mixing of materials increase the temperature stability of drilling mud

2. YIELD POINT (YP)

table-2 and figure-2 show that the yield point for Mud Sample was generally decreasing with increasing temperature until 150 at which the yield point dropped to a minimal value. For temperatures higher than 150 degree Celsius the curve for yield point plateaued with slight increment. After that the height does not affect.

Table-2

TEMP C	yield point (lbf/100 ft^2)
37˚	3.4
71˚	3
93˚	2.4
121˚	0.7
148˚	0.5
176˚	0.5

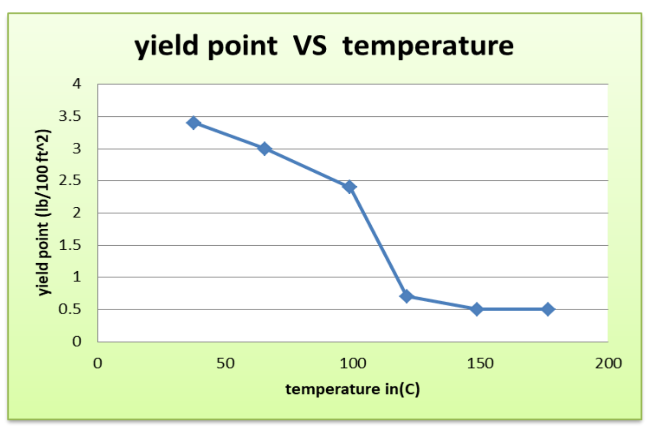


Fig-2

The decreasing in the yield point due to the increasing in temperature will affect its function :

1- The amount of pressure (shearing stress) needed to be applied to flow the mud.
2- Very important in determining pump capacity and the amount of pressure needed to be applied to flow the mud from static positions.
3- ability of the drilling mud to carry cuttings to the surface.

other reasons to increase yield point :

- Contamination of the drilling fluid with the following solutes (salt, cement, anhydrite) that neutralize the negative charge found in clay, which leads to their aggregation, so the yield point increases.

- Clay particles are broken by hammers (bits) or drill pipes, which generates new forces of attraction between the broken parts. These forces attract the broken particles to each other, which increases yield point .
- The entry of inert solids into the drilling fluid leads to a reduction in the distance between the particles of the drilling fluid, which leads to an increase in the attraction and as a result an increase in yield point
- . Drilling a shale or clay that can absorb water leads to an increase in the number of charges in the drilling fluid, which leads to an increase in the attraction and thus an increase in the yield point .

Therefore, it is necessary to add substances that raise the yield point, including:

A-Bentonite

It is used to raise viscosity and yield point and contribute to the formation of Mud cake, which is a thin layer formed by the drilling fluid on the inner wall of the plant to protect it from precipitation. This substance works only in fresh water, and in the case of salt water we use Attaplugite.

B-CMC-HV

A polymer that raises the viscosity and yield point and works only in fresh environments and at a temperature of 121 degrees Celsius. It is not used in the production layer because it causes the pores to close and does not dissolve in acid. This substance is called Sodium Carboxymethyl Cellulose.

C-Pac–R . substance

A modified polymer that raises the viscosity and yield point and works in all mediums, fresh and salty, and at a temperature of 135 degrees Celsius. It is also used to drill the production layer.

D-(Lignosulphonite)

3. GEL STRENGTH (10-SEC)

Table-3 and Figure-3 show the effect of varying temperature on 10-sec gel strengths of Mud Sample. This figure shows that gel strength was decreasing with increasing temperature until a temperature of 121 degree Celsius after which there was a general increase in gel strength.

Table-3

TEMP /C	gel strength ,bf/100 ft^2
37 °	3
65 °	2.4
93 °	2.2
121 °	1.5
176 °	1.4
232 °	1

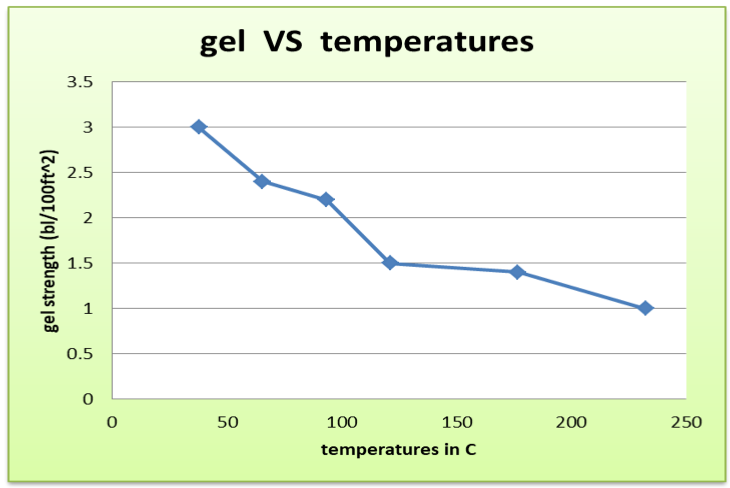


Fig-3

The decreasing in the gel strength due to an increasing in temperature will affect its function :

1-The ability of mud to suspend solids (especially weighting materials, drilled cuttings).

2-Very important in suspended drilling operation.

Substance to increase Gel Strength :

1-Sodium chromate (Na_2CrO_4 $10H_2O$)

A yellow substance used at high temperatures to control the gelatinous strength and viscosity. Usage ratios (6-0.5) kg/m3.

2-Sodium Dichromate (Na_2 Cr_2 O $2H_2O$)

An orange substance that converts in the base environment to sodium chromate and is usually used for the purpose of protection against corrosion, as well as to maintain the stability of clay at high temperatures and to control On gelatinous strength and viscosity usage rates (6-0.5) kg/m3.

4. MUD DENSITY

Table-4 and Figure-4 show that the density for Mud Sample was generally small decreasing with increasing temperature

Table-4

Temperature/C	Density/ppg
26°	10.01
37°	10.07
47°	10.03
57°	10
67°	9.97

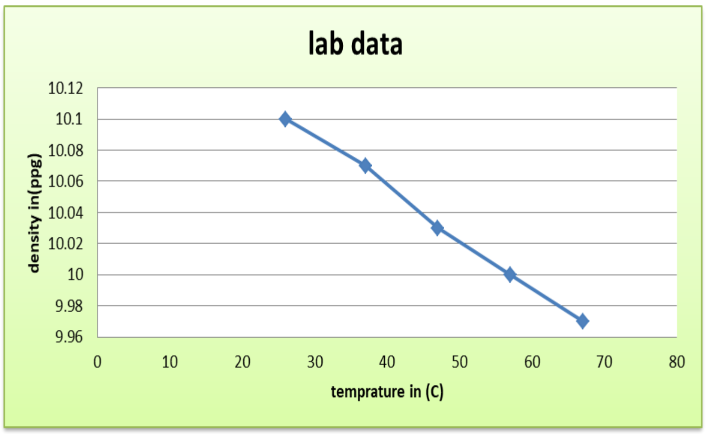


Fig-4

density of the drilling fluid must(0.41-0.25) p/gal or(0.05-0.03)gm./cm^3 be in excess of the density, which generates a hydrostatic pressure that balances the pressure of the fluids present in the drilled layers.

substances to increase density of mud

A-Barite

It is added to drilling mud for the purpose of increasing the density due to its high density (4.2 gm/cc), and it is also a non-toxic substance.

A reactant that does not affect the properties of clay except for its effect as a solid substance. Barite raises the weight of the drilling fluid up to 20 ppg and is not used in drilling the production layer because it does not dissolve in HCl ,Thus, it is difficult to get rid of them during cleaning the oil reservoir with Acid job 3

. To calculate the amount of barite for the purpose of increasing the density, the equation is used:

X= 4200(W2 – W1)/ (4.2 – W2)……

X : (kg/m3) Amount of barite.

W1: The first density of clay.

W2: The second density of clay, i.e. after adding barite.

B- Calcium Carbonate : raises the weight of the drilling fluid up to 12 ppg.

C-Hematite: raises the weight of the drilling fluid up to 30 ppg.

6. APPARENT VISCOSITY

Table-5 and Figure-5 show that the apparent viscosity of Mud Sample was generally decreasing with increasing temperature.

table-5

Temperature/C	Viscosity
26°	**7.355**
31	**5.25**
37°	**4.72**
42°	**3.99**
52°	**3.15**

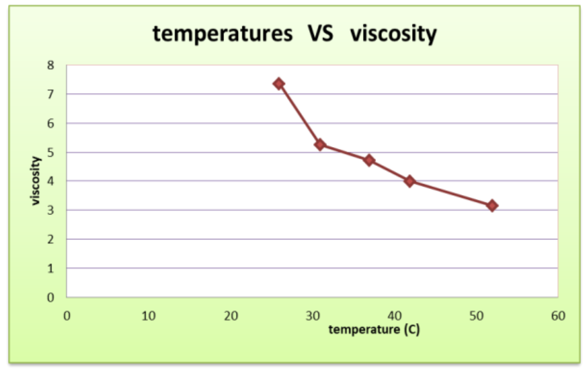


Fig-5

in the tables below show how the effect of these substances on the drilling mud and maintenance on the required properties in three wells in Nasiriyah oil field.

WELL:NS-43

DEPTH	71	211	316	396	446	584	659	674	734	868	1020	1125	1230	1362	1404	1427	1543	1572	1678	1711	1780	1837	1940	2100	2112
TEMP	26.775	30.275	32.9	34.9	36.15	39.6	41.475	41.85	43.35	46.7	50.5	53.125	55.75	59.05	60.1	60.675	63.575	64.3	66.95	67.775	69.5	70.925	73.5	77.5	77.8
PV	17	12	5	9	11	8	9	11	14	14	8	11	10	9	8	9	11	11	13	13	13	13	15	12	18

WELL:NS-38

DEPTH	211	320	433	448	638	668	802	979	1039	1100	1256	1337	1436	1503	1563	1598	1661	1792	1848	1901	1985	2098	2104
TEMP	30.275	33	35.825	36.2	40.95	41.7	45.05	49.475	50.975	52.5	56.4	58.425	60.9	62.575	64.075	64.95	66.525	69.8	71.2	72.525	74.625	77.45	77.6
PV	9	9	10	14	10	12	13	17	16	16	16	16	17	14	15	15	16	17	19	19	17	16	16

WELL:NS-34

DEPTH	43	310	447	460	639	674	701	818	980	1053	1125	1561	1587	1618	1660	1745	1848	1925	2101	2106
TEMP	26.075	32.75	36.175	36.5	40.975	41.85	42.525	45.45	49.5	51.325	53.125	64.025	64.675	65.45	66.5	68.625	71.2	73.125	77.525	77.65
PV		10	10	9	11	13	12	13	14	15	19	12	12	16	14	13	13	13	12	15

WELL:NS-43

DEPTH	49	71	158	297	316	444	521	666	711	734	840	959	1020	1197	1290	1309	1404	1445	1497	1572	1686	1780	1800	1940	2100	2112
TEMP	26.225	26.775	28.95	32.425	32.9	36.1	38.025	41.65	42.775	43.35	46	48.975	50.5	54.925	57.25	57.725	60.1	61.125	62.425	64.3	67.15	69.5	70	73.5	77.5	77.8
Y.P	18	18	19	71	71	22	12	12	14	14	14	12	12	15	16	16	20	18	16	10	19	19	19	16	15	16

WELL:NS-34

DEPTH	43	310	447	452	460	639	674	701	818	980	1053	1125	1561	1566	1587	1601	1618	1660	1745	1848	1925	2101	2106
TEMP	26.075	32.75	36.175	36.3	36.5	40.975	41.85	42.525	45.45	49.5	51.325	53.125	64.025	64.15	64.675	65.025	65.45	66.5	68.625	71.2	73.125	77.525	77.65
Y P	19	20	20	20	14	12	7	15	15	14	16	16	29	29	29	22	20	12	16	12	12	16	16

WELL:NS-38

DEPTH	211	320	448	668	676	802	979	1025	1256	1337	1436	1503	1598	1661	1792	1890	1901	2104
TEMP	30.275	33	36.2	41.7	41.9	45.05	49.475	50.625	56.4	58.425	60.9	62.575	64.95	66.525	69.8	72.25	72.525	77.6
Y.P	24	18	15	14	25	15	16	14	16	16	14	18	18	17	19	21	22	18

WELL:NS-34

DEPTH	43	310	447	452	460	639	674	701	818	980	1053	1125	1561	1587	1601	1745	1848	1925	2101	2106
TEMP	26.075	32.75	36.175	36.3	36.5	40.975	41.85	42.525	45.45	49.5	51.325	53.125	64.025	64.675	65.025	68.625	71.2	73.125	77.525	77.65
0GEL	8	10	10	10	10	10	4	8	8	6	8	8	18	18	12	5	7	7	10	8
10 GEL	206	25	25	25	45	50	22	38	42	30	35	35	76	76	48	34	38	38	40	35

WELL:NS-43

depth	49	71	211	316	446	584	659	674	868	1020	1125	1230	1362	1404	1453	1598	1678	1780	1837	1940	2100	2112
T	26.225	26.775	30.275	32.9	36.15	39.6	41.475	41.85	46.7	50.5	53.125	55.75	59.05	60.1	61.325	64.95	66.95	69.5	70.925	73.5	77.5	77.8
0 gel	8	8	8	35	8	12	12	10	12	12	10	8	8	8	10	10	10	10	10	12	12	12
10 gel	32	32	32	105	38	24	42	35	45	24	35	34	35	35	52	52	52	52	52	50	58	58

WELL:NS-38

DEPTH	211	320	433	448	638	668	802	979	1039	1100	1337	1436	1464	1519	1563	1598	1661	1792	1890	1985	2098	2104
TEMP	30.275	33	35.825	36.2	40.95	41.7	45.05	49.475	50.975	52.5	58.425	60.9	61.6	62.975	64.075	64.95	66.525	69.8	72.25	74.625	77.45	77.6
0 gel	8	7	7	8	5	5	5	5	5	8	8	8	6	6	6	6	7	6	6	10	8	8
10 gel	42	38	38	28	26	28	28	28	28	35	35	35	29	29	29	36	48	39	39	40	38	38

WELL:NS-34

depth	49	71	158	211	297	316	444	584	634	674	734	959	1020	1290	1394	1427	1598	1686	1780	1800	1940	2045	2112
TEMP	26.225	26.775	28.95	30.275	32.425	32.9	36.1	39.6	40.85	41.85	43.35	48.975	50.5	57.25	59.85	60.675	64.95	67.15	69.5	70	73.5	76.125	77.8
DENSITY	1.8	1.8	1.06	1.06	1.06	1.06	1.11	1.07	1.07	1.06	1.11	1.12	1.12	1.13	1.13	1.13	1.13	1.18	1.19	1.19	1.28	1.32	1.33

WELL:NS-43

DEPTH	43	310	447	452	460	639	674	701	818	980	1053	1125	1561	1587	1618	1660	1745	1848	1925	2101	2106
TEMP	26.075	32.75	36.175	36.3	36.5	40.975	41.85	42.525	45.45	49.5	51.325	53.125	64.025	64.675	65.45	66.5	68.625	71.2	73.125	77.525	77.65
DENSITY	1.05	1.12	1.12	1.1	1.09	1.08	1.09	1.1	1.1	1.1	1.14	1.14	1.14	1.16	1.18	1.17	1.17	1.17	1.28	1.33	1.33

WELL:NS-38

DEPTH	211	320	433	448	638	668	802	979	1039	1100	1256	1337	1436	1464	1503	1519	1563	1598	1661	1792	1848	1890	1901	1985	2098	2104
TEMP	30.275	33	35.825	36.2	40.95	41.7	45.05	49.475	50.975	52.5	56.4	58.425	60.9	61.6	62.575	62.975	64.075	64.95	66.525	69.8	71.2	72.25	72.525	74.625	77.45	77.6
DENSITY	1.07	1.08	1.07	1.07	1.07	1.11	1.12	1.13	1.15	1.14	1.14	1.14	1.13	1.13	1.13	1.13	1.14	1.16	1.17	1.18	1.24	1.32	1.33	1.32	1.32	1.32

WELL:NS-34

DEPTH	43	310	447	674	701	980	1053	1561	1587	1618	1745	1848	1925	2106
TEMP	26.075	32.75	36.175	41.85	42.525	49.5	51.325	64.025	64.675	65.45	68.625	71.2	73.125	77.65
VISCOSITY	42	47	43	40	43	47	47	55	55	52	42	45	45	45

WELL:NS-38

depth	211	320	433	668	802	933	1039	1256	1399	1464	1503	1521	1598	1661	1792	1890	1985	2098	2104
T	30.275	33	35.825	41.7	45.05	48.325	50.975	56.4	59.975	61.6	62.575	63.025	64.95	66.525	69.8	72.25	74.625	77.45	77.6
vescosity(sec)	48	47	46	46	49	49	48	48	48	46	46	46	47	47	47	47	48	47	47

WELL:NS-43

depth	49	71	158	297	446	584	601	634	734	840	959	1089	1197	1290	1394	1497	1572	1678	1711	1800	1912	2112
TEMP	26.225	26.775	28.95	32.425	36.15	39.6	40.025	40.85	43.35	46	48.975	52.225	54.925	57.25	59.85	62.425	64.3	66.95	67.775	70	72.8	77.8
vescosity(sec)	48	48	48	45	48	46	46	45	46	45	46	47	45	45	47	47	44	46	46	48	47	46

REFERENCES

[1].drilling engineering laboratory manual

[2]drilling reports from thi-qar oil company and drilling additions from basra oil company

[3].L. Robinson, “Drilling Fluid Processing Handbook”, ASME – Elsevier, 2005.

[5] A.O.A. Moses, and F. Egbon, “Semi-Analytical Models of the Effect of Drilling Fluid Properties on Rate of Penetration (ROP)”, SPE Nigeria Annual International Conference and Exhibition, Abuja, Nigeria, August 2011.

[6] H.C.H Darley and G.R. Gray, “Composition and Properties of Drilling and Completion Fluids”, Fifth Edition, 1988.

[7] G.V. Chilingarian, E. Alp, M. Al-Salem, S. Uslu, S. Gonzales and R. Dorovi, “Drilling Fluid Evaluation using Yield point-Plastic Viscosity Correlation” SPE General, 1983.

[8] L. Robinson, “Economic Consequences of Poor Solids Control”, American Association of Drilling Engineer (AADE), 2006.

[9] Edition Technip, “Drilling Mud and Cement Slurry Rheology Manual”, 1982.

[10] M.E. Baumert, E.N. Allouche and I.D. Moore, “Drilling Fluid Consideration in Design of Engineered Horizontal Directional Drilling Installation”, International Journal of Geomechanic, vol. 5, issue 4, pp. 339-349, December 2005

[11] J.C. Machado and P.F. Castilho, “Solid control and Low solids: Important Binary to Drill Deep wells”, Second Latin American Petroleum Engineering Conference, Caracas, Venezuela, March 1992.

[12] A.M. Paiaman, M.K. Ghassem and B. Salamani, B.D. Al-Anazi and M. Masihi, “Effect of fluid properties on Rate of Penetration”, NAFTA 60 (3) pp. 129-134, 2009.