THE USE OF TAPIOCA AS A SUBSTITUTE FOR STANDARD VISCOSIFIERS

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INTRODUCTION

Drilling, the act of creating a hole by removing material with a drill gloss tool is also carried out in the petroleum industry, but this is done with the aid of a drilling rig for the creation of a wellbore (hole) with the sole aim of the recovery of petroleum resources(oil and gas in this case).

The drilling rig which is used to carry out this drilling operation is divided into 5(five) systems they include:

- **Hoisting system**: This is the part of the drilling rig the helps increment in the wellbore depth they includes the hoisting tower structure i.e. the mast and derrick, the substructure, the draw works(hoist), the derrick line and its accessories and finally the travelling and crown block.
- **Circulating system**: This is the path in which mud and cuttings pass through during the drilling process so as to enhance a better rate of penetration (ROP) by suspension of cuttings ensuring that bit cuts a fresh surface while rotating, they include the stand pipe, Kelly hose, the drill stem, the annulus, the mud return line, the shale shaker, the mud pit.
- **Rotary system**: This system aids in the rotary action which aids drilling, ensuring a better rate of penetration (ROP), they include the swivel, Kelly, rotary drive and rotary table
- **Power system:** This system provides all the necessary power to carry out the drilling work; this is basically the Gen set and any other power generating equipment.
- **Well control and monitoring system**: this system basically helps to monitor the drilling operation, drilling a well is very dangerous, because the pressure in the reservoir could be significant high, which normally about couple thousands psi. The main part of this system is the blowout preventer(BOP)

Drilling operation on the rig is carried out with the aid of drilling mud, the need for drilling mud in drilling operation cannot be over emphasized, and some of the uses of drilling mud include:

- Suspension/removal of cuttings from well,
- Control formation pressure,
- Seal permeable formations,
- Maintain wellbore stability,
- Minimize formation damage,
- Cool, lubricate, and support the bit and drilling assembly,
- Transmit hydraulic energy to tools and bit,
- Ensure adequate formation evaluation,
- Prevent inflow of formation fluid thereby preventing a kick, etc

But the properties of drilling mud is dependent on the formation parameters, a drilling mud with a density of 8.5ppg despite being the API standard can't be used to drill a formation of 10ppg else caving in of the wellbore would occur thereby causing destruction of equipments, waste of time, and the need for a remedial operation such as sidetracking to be done which would require more funds for the operation, therefore the drilling mud used at any depth should be dependent of formation conditions at that depth. The properties of the drilling mud can be altered via the use of drilling mud additives, depending on the property needed to be increased. The mud weight/density can be increased to meet the well depth condition with the addition of weighter, example of a weighters include Haematite, Barite, etc these additives would help increase the mud weight to the needed weight, likewise, if the PH of our drilling mud needs to be increased in a case where by we are drilling through an acidic formation, additives which increase the ph of mud (PH Enhancers) can be used, examples of PH enhancers are potassium hydroxide(KOH), Sodium Hydroxide(NAOH), etc, there are also other parameters of drilling mud that can be altered such as viscosity, filtration, Gel strength etc

Viscosity can simply be defined as fluid resistance to flow. The higher the viscosity the lesser the tendency of a fluid to flow, take for example water will flow faster than gum under the same conditions, thereby indicating that gum has a higher viscosity than water.

Viscosifiers in the petroleum industry are substances which we add to our drilling mud with the aim of increasing its resistance to flow. Some common examples of viscosifiers are Drispac, C.M.C (carboxyl-methyl-cellulose), H.E.C (hydroxyl ethyl cellulose), etc. The need to increase the viscosity of drilling mud can occur for various reasons, some of the common instances when the viscosity of the drilling mud used is increased include:

- Suspension of cuttings, as too little viscosity will allow cuttings to settle below in the slurry and be deposited behind the drill bit and thereby leading to stuck pipe.
- Mud cake formation
- Reduce water loss, etc

Tapioca is the starch extracted from the cassava root. Cultivation of the cassava plant is common throughout South America and Africa, while culinary use of tapioca has become popular throughout the world. Tapioca has a neutral flavor and strong gelling power, making it highly useable as a thickening agent in both sweet and savory foods. Unlike corn starch, tapioca can withstand a freeze thaw cycle without losing its gel structure or breaking down.

Traditional uses for tapioca include tapioca pudding, bubble or boba tea, and other candies and desserts. Tapioca's thick, chewy texture is fun to eat, making it prime for desserts, gummy candies, and other fun foods. With the industrialized food revolution, tapioca has seen many new uses. Tapioca is often added to soups, sauces, and gravies to create body and thickness because it has more thickening power and is less expensive than flour and other thickeners. Tapioca is also often added to doughs, especially gluten-free products, to improve the texture and moisture content.

The Petroleum Industry Bill that was proposed seeks to achieve the ‘promotion of the development of local (Nigerian) content (both personnel and resources) in the oil industry’ as one of its major goal, with this in view the need for the development of local additives as substitute for foreign additive is paramount, thereby the possibility of the use of Tapioca in place of C.M.C or H.E.C due to the availability of cassava in excess in Nigeria is being explored.

MATERIALS AND METHOD

Tapioca

100g of process tapioca from Warri, Delta state, Nigeria which has been processed via a natural convention solar dryer as against the open-air uncontrolled sun drying which is commonly used so as to avoid contamination via rain, dirt, dust, rodents etc. This 100g of processed Tapioca is then grounded with the aid of a clean hand mill**,** until powdery form is obtained.

Drilling mud

Mid-viscous water based mud was prepared for the purpose of this experiment illustrated in table 1 below, 21g (gram) of Bariod bentonite was measured with 350ml measured with a measuring cylinder meeting the API standard for a mid-viscous drilling mud**.**

Table 1: water based drilling month formation

Mud	Bentonite concentration (g)	Water volume (ml)
Low viscous mud	17.5	350
Mid-viscous mud	21	350
High-viscous mud	24.5	350

EXPERIMENTAL PROCEDURE

21g of Bariod bentonite is measured on a filter paper with the aid of a weighing scale, the weight of the filter paper(0.6g) was initially measured and noted down, then 21g plus the weight of the filter paper (0.6g) was then measured on the weighing scale, 350ml of clean water was measured with the aid of a measuring cylinder and then poured into the mud mixer, then 21g of mud was then added into the mud mixer, the mud mixer was covered and turned on, after thoroughly mixing for about 4 mins, the mud density of the formulated drilling mud is measured with the use of a mud balance and record, the ph of the mud is also measured with the use of a PH paper and the value is also noted down, the viscosity of the formulated mud is measured with a rheometer, the viscosity readings at 300RPM (revolutions per minute) and 600RPM is noted and finally the sand content with the aid of the sand content kit is recorded.

Another drilling mud is formulated just as before, using 21g of Bariod bentonite and 350ml of water and mixed in the mud mixer then, 0.1g of C.M.C (carboxyl methyl cellulose) was measured on a filter paper with the weighing scale, the weight of the filter paper was initially measured (0.6g) then, 0.1g plus the weight of the filter paper(0.6g) was measured on the weighing scale, and added to the formulated drilling mud in the mud mixer and mixed for about 6 minutes, the formulated drilling fluid is poured into a beaker and allowed for about 5 minutes, the mud weight is measured with the mud balance, the PH is recorded with the PH paper, the Viscosity is measured with the rheometer, and the sand content is measured. And these procedures are repeated with 0.2g of C.M.C, 0.3g of C.M.C, 0.4g of C.M.C and 0.5g of C.M.C, 0.6g of C.M.C, 0.7g of C.M.C, 0.8g of C.M.C and 0.9g of C.M.C and the properties of the formulated drilling fluid in each formulation is recorded just as before.

The same process is repeated again, drilling mud is formulated but instead of C.M.C, Tapioca is used in its place 0.1g of tapioca is added to a mixture of mid-viscous drilling fluid and thoroughly mixed, allowed for some time and the mud weight, Ph, viscosity and sand content is recorded. And these procedures are repeated with 0.2g of tapioca, 0.3g of tapioca, 0.4g of tapioca, 0.5g of tapioca, 0.6g of tapioca, 0.7g of tapioca, 0.8g of tapioca, 0.9g of tapioca.

RESULT AND DISCUSSION

For the mixture of drilling mud C.M.C the results are as follows

Blank (21g of bentonite +350ml of water)

Mud density – 8.6ppg (pounds per gallon)
PH- 9
Sand content 0%
Rheology @ ϴ300 – 12.5cp (centipoises)
ϴ600 – 18.5 cp (centipoises)

21g of bentonite + 350 ml of water + 0.1g of C.M.C

Mud density – 8.6ppg (pounds per gallon)

PH- 9
Sand content 0%
Rheology @ ϴ300 – 14cp (centipoises)
ϴ600 – 22.5 cp (centipoises

21g of bentonite + 350 ml of water + 0.2g of C.M.C

Mud density – 8.6ppg (pounds per gallon)
PH- 9
Sand content 0%
Rheology @ ϴ300 – 18cp (centipoises)
ϴ600 – 26 cp (centipoises)

21g of bentonite + 350 ml of water + 0.3g of C.M.C

Mud density – 8.6ppg (pounds per gallon)
PH- 9
Sand content 0%
Rheology @ ϴ300 – 22cp (centipoises)
ϴ600 – 31 cp (centipoises)

21g of bentonite + 350 ml of water + 0.4g of C.M.C

Mud density – 8.6ppg (pounds per gallon)
PH- 9
Sand content 0%
Rheology @ ϴ300 – 26.5cp (centipoises)
ϴ600 – 34.5 cp (centipoises)

21g of bentonite + 350 ml of water + 0.5g of C.M.C

Mud density – 8.6ppg (pounds per gallon)
PH- 9
Sand content 0%
Rheology @ ϴ300 – 30cp (centipoises)
ϴ600 – 39 cp (centipoises)

21g of bentonite + 350 ml of water + 0.6g of C.M.C

Mud density – 8.6ppg (pounds per gallon)
PH- 9
Sand content 0%
Rheology @ ϴ300 – 33.5cp (centipoises)
ϴ600 – 43 cp (centipoises)

21g of bentonite + 350 ml of water + 0.7g of C.M.C

Mud density – 8.6ppg (pounds per gallon)
PH- 9
Sand content 0%
Rheology @ ϴ300 – 39cp (centipoises)
ϴ600 – 46cp (centipoises)

21g of bentonite + 350 ml of water + 0.8g of C.M.C

Mud density – 8.6ppg (pounds per gallon)
PH- 9
Sand content 0%
Rheology @ ϴ300 – 40.5cp (centipoises)
ϴ600 – 48.5cp (centipoises)

21g of bentonite + 350 ml of water + 0.9g of C.M.C

Mud density – 8.6ppg (pounds per gallon)
PH- 9
Sand content 0%
Rheology @ ϴ300 – 42cp (centipoises)
ϴ600 – 53cp (centipoises)

while the result for the formation of drilling mud with tapioca are as follows:

21g of bentonite + 350 ml of water + 0.1g of Tapioca

Mud density – 8.55ppg (pounds per gallon)
PH- 8
Sand content 0%

Rheology @ Ɵ300 – 14.5cp (centipoises)
Ɵ600 – 22.5 cp (centipoises)

21g of bentonite + 350 ml of water + 0.2g of Tapioca

Mud density – 8.55ppg (pounds per gallon)
PH- 8
Sand content 0%
Rheology @ Ɵ300 – 15.5cp (centipoises)
Ɵ600 – 24.5 cp (centipoises)

21g of bentonite + 350 ml of water + 0.3g of Tapioca

Mud density – 8.55ppg (pounds per gallon)
PH- 8
Sand content 0%
Rheology @ Ɵ300 – 17.5cp (centipoises)
Ɵ600 – 27cp (centipoises)

21g of bentonite + 350 ml of water + 0.4g of Tapioca

Mud density – 8.6ppg (pounds per gallon)
PH- 8
Sand content 0%
Rheology @ Ɵ300 – 18.5cp (centipoises)
Ɵ600 – 28cp (centipoises)

21g of bentonite + 350 ml of water + 0.5g of Tapioca

Mud density – 8.55ppg (pounds per gallon)
PH- 8
Sand content 0%
Rheology @ Ɵ300 – 20cp (centipoises)
Ɵ600 – 29.5 cp (centipoises)

21g of bentonite + 350 ml of water + 0.6g of Tapioca

Mud density – 8.6ppg (pounds per gallon)
PH- 8
Sand content 0%
Rheology @ Ɵ300 – 20.5cp (centipoises)
Ɵ600 – 30.5 cp (centipoises)

21g of bentonite + 350 ml of water + 0.7g of Tapioca

Mud density – 8.55ppg (pounds per gallon)
PH- 8
Sand content 0%
Rheology @ Ɵ300 – 21cp (centipoises)
Ɵ600 – 31.5 cp (centipoises)

21g of bentonite + 350 ml of water + 0.8g of Tapioca

Mud density – 8.6ppg (pounds per gallon)
PH- 8
Sand content 0.15%
Rheology @ Ɵ300 – 21cp (centipoises)
Ɵ600 – 32cp (centipoises)

21g of bentonite + 350 ml of water + 0.9g of Tapioca

Mud density – 8.5ppg (pounds per gallon)
PH- 7
Sand content 0.2%
Rheology @ Ɵ300 – 21.5cp (centipoises)
Ɵ600 – 33.5 cp (centipoises)

The table below shows the viscosity readings at 300RPM and 600RPM

Table 2 : viscosity readings for Tapioca and C.M.C at 300RPM

Tapioca and C.M.C conc. (g)	Drilling Fluid + Tapioca	Drilling Fluid + C.M.C
0.0	12.5cp	12.5cp
0.1	14.5cp	14cp
0.2	15.5cp	18cp
0.3	17.5cp	22cp
0.4	18.5	26.5cp
0.5	20cp	30cp
0.6	20.5cp	33.5cp
0.7	21cp	39cp
0.8	21cp	40.5cp
0.9	21.5cp	42cp

Table 3 : viscosity readings for Tapioca and C.M.C at 600RPM

Tapioca and C.M.C conc. (g)	Drilling Fluid + Tapioca	Drilling Fluid + C.M.C
0.0	12.5cp	18.5cp
0.1	22.5cp	22.5cp
0.2	24.5cp	26cp
0.3	27cp	31cp
0.4	28cp	34.5cp
0.5	29.5cp	39cp
0.6	30.5cp	43cp
0.7	31.5cp	46cp
0.8	32cp	48.5cp
0.9	33.5cp	53cp

Table 4: showing readings for both Apparent and plastic viscosities and yield point of Tapioca and C.M.C additives

Additive conc.	Ɵ300 (TAPIOCA) (cp)	Ɵ300 (C.M.C) (cp)	Ɵ600 (TAPIOCA) (cp)	Ɵ600 (C.M.C) (cp)	AV (TAPIOCA) (cp)	AV (C.M.C) (cp)	PV (TAPIOCA) (cp)	PV (C.M.C) (cp)	YP (TAPIOCA) (cp)	YP (C.M.C) (cp)
0	12.5	12.5	18.5	18.5	9.25	9.25	6	6	6.5	6.5
0.1	14.5	14	22.5	22.5	11.25	11.25	8	8.5	6.5	5.5
0.2	15.5	18	24.5	26	12.25	13	9	8	6.5	10
0.3	17.5	22	27	31	13.5	15.5	9.5	9	8	13
0.4	18.5	26.5	28	34.5	14	17.25	9.5	8	9	18.5
0.5	20	30	29.5	39	14.75	19.5	9.5	9	10.5	21
0.6	20.5	33.5	30.5	43	15.25	21.5	10	9.5	10.5	24
0.7	21	39	31.5	46	15.75	23	10.5	7	10.5	32
0.8	21	40.5	32	48.5	16	24.25	11	8	10	32.5
0.9	21.5	42	33.5	53	16.75	26.5	12	11	9.5	31

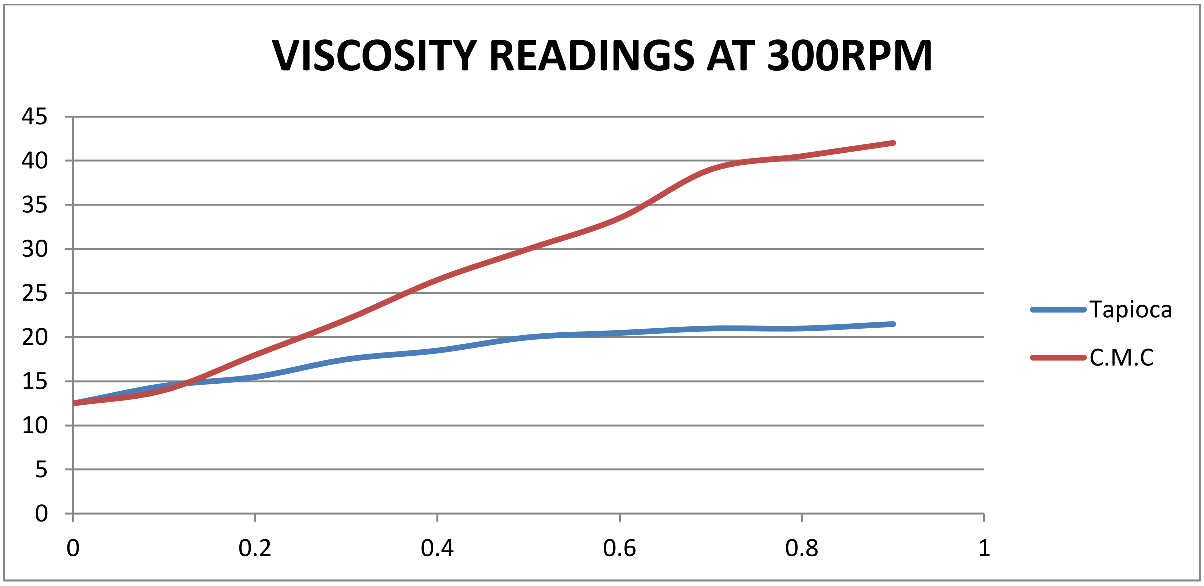

Chart 1: chart showing increase in viscosity at 300RPM for tapioca and C.M.C

At 300RPM the C.M.C is a far better viscosifier, when the revolutions being made during the drilling process is low C.M.C is a far better additive to achieve a better ROP (rate of penetration).

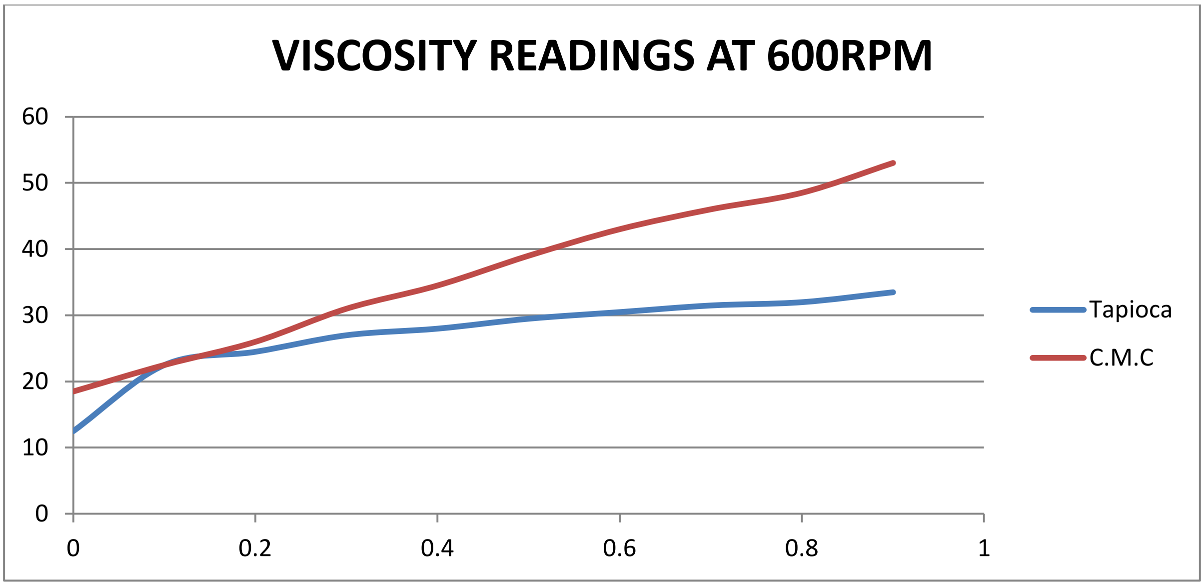

Chart 2: chart showing increase in viscosity at 600RPM for tapioca and C.M.C

At 600RPM although C.M.C still is a better viscosifier, Tapioca is not far behind and with a little increase in the quantity of Tapioca it can be used as a substitute for C.M.C

CONCLUSION

From the above viscosity readings, the noticed increase in viscosity indicates that Tapioca acts as a viscosifier on drilling fluid, although not as effective as the standard viscosifier in this case C.M.C, though one can further improvise by the mixing a percentage of Tapioca to C.M.C thereby reducing the amount of foreign content used thereby meeting the PIB requirement of using local content for drilling operations, although this hasn't been experimented on yet and it might or might not work out (maybe by not achieving a homogenous mixture) we can't rule out this possibility until its fully experimented on. There's also the issue of sand content in using the Tapioca although still within the API standard of less than 1% there is the possibility of abrasion on the drill string, the noticed reduction in PH is an indication that Tapioca mildly acidic and if it's going to be used in a large quantity for drilling, there is the need for a PH enhancer, a petroleum economist would thereby be needed to determine whether using Tapioca instead of our standard viscosifier is cost effective, the gel strength of the mud with the addition of Tapioca wasn't also considered in this experiment, the gel strength of drilling fluid is very important as it will help to determining if the drilling fluid can suspend cutting in a case where there is need to suspend drilling for one reason or the other. Further experiment is needed in order to conclude that Tapioca can effectively replace C.M.C as a viscosifier for the preparation of drilling fluid.

REFERENCES

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D) www.oil-drilling-fluids.co/viscosifiers