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PREPARATION OF DRILLING FLUID FOR UNDER BALANCED DRILLING FROM OVER BALANCED DRILLING FUILD,WITH THE USE OF A CHEMICAL(HGS)

ABSTRACT

The project mainly concentrate on preparing drilling fluid for under balanced drilling from overbalanced drilling fluid, with the use of a chemical (HGS) – Hollow glass spheres added in to overbalanced drilling fluid there by reducing the over balanced drilling fluid density. Bringingdown the density so that it can be used for underbalanced operation by making the specific gravity less than or equal to 0.8 which is satisfied by IADC drilling fluid classification. All variation in the fluid properties like Rheological properties, Specific Gravity and pH are observed and evaluated during the percentage increase in the addition of the HGS.

This project also brings out the better understanding of all the techniques and operation of bothover and under balanced drilling which can be used in future purpose for comparing and takinga proper drilling practice for particular reservoir.

INTRODUCTION

Drilling is a process in which a hole is made or enlarged in a solid material. In petroleum industry the solid material is earth's surface or earth formation. Creating and enlarging hole according to specification through the formation to the traps in the reservoir rocks down in thesubsurface to obtain hydrocarbon. Drilling process has been continuing for several years. The growing number of depleted reservoirs around the world and increase in need to recover largehydrocarbon more effectively has been forcing petroleum industry to improve its drilling technology in all its ways. Some of the drilling technique like casing drilling, directional drilling etc. In that one such technique is called under balanced Drilling (UBD).

Under balanced drilling (UBD) is drilling practice in which drilling is done by keeping hydrostatic pressure less than the formation pressure there by permitting the well to flow whiledrilling proceeds. Keeping Underbalanced condition throughout the drilling process is the success of Underbalanced drilling operation mainly by avoiding the formation damage and other drilling related problems like differential sticking, LOC (Lost circulation) etc. So Controlling and maintaining this Underbalance condition is actually a challenge for the engineers, many research and also technological developments are going on in this topic.

Drilling fluid is the one which is used to control the pressure during the drilling operation. In Underbalanced drilling, drilling fluids used are Gasified, Foam type, Mist type which are usedto keep the well underbalanced during the Underbalanced operation. These has got some limitation, Gasified fluid operation does not help to maintain the underbalanced condition throughout the drilling operation, thus compressed gas through annulus is required which is not very effective in deviated wells and even at larger depths, chance of down hole fire, corrosion in down hole equipment's. Foam stability is also a very important issues. Poor holecleaning, fluid invasion, lost circulation issues and loss of underbalance control require a stablelow gravity fluid formation so water type drilling fluid is preferred.

Main aim of this project is to study about a new chemical called HGS (hollow glass sphere) and to prepare a water based drilling fluid which could be used in UBD, Prepared by adding HGS in to the standard sample and reducing the density till meeting the requirements of IADC,and studying how all the drilling fluid properties i.e. its density and rheological properties, varies on the addition of HGS.

LITERATURE REVIEW

A survey of the available literature pertaining to under balanced drilling and its importance forthe enhancement in production and ways to decrease mud density is given in this chapter.

2.1

D.B. Bennion, B.Lunan, 1996, The journal of Canadian petroleum technology, Underbalanced Drilling and completion Operations to minimize Formation damage- Reservoir screening criteria for optimum application, Vol 1, pp. 75-96. In this it is clearly mentioned about variousdrilling and completion operation to decrease the formation damage during under balanced drilling process.

2.2

A Case Study in Changing Economics Using Underbalanced Drilling for Bitter weed South (Caballos) field Settled vertical UBD Wells, Pecos County, Texas produced at twice the rate as OBD wells with UBD IP's 10 times higher than OBD wells.

2.3

Paper presented at the International Underbalanced Drilling Conference, The Hague, October 1997 of Alberta Canada, Harmattam Elkton Pool field On Production since 1967, vertical OBDwells typically produce 1.5 – 2.5 MMcf/d. UBD wells drilled 30 years later on in-field locations flowed 22 MMcf/d while drilling and produced at restricted rates of 9 MMcf/d without stimulation.

2.4

A new technology for reducing the density of drilling fluids, Arnold wong and M.J Arco Oil and gas industry technical brief, in this he clearly states HGS when added to drilling fluid density gets reduces, can survive down hole condition, can help reduce formation damage , reduce friction of drilling fluid and are reusable. This reducing capability of hollow glass sphere can be used for under balanced drilling fluid because for under balanced operation we need low density drilling fluid which can be prepared by using this chemical.

UNDER AND OVER BALANCED DRILLING

History of Drilling

Conventional Drilling

In earlier days holes were dug in to the earth for water, protection, for building houses or to escape from enemies. Those who spend for digging and spending their lives underground weredeveloping various tools like adaptation of claws and feeds, jaws, heads, etc. Early man, those having no usable claws, found it very necessary to use hand tools such as sticks, bones and naturally shaped stones which were been used as digging tools where it found needed. After many years of evolutionary and development process, man finally learned to shape sticks andpoles to make them more effective digging tools. He was then capable to dig more and more vertical wells of deeper depths with these tools which they made and bringing the cuttings to the surface.

About 600 B.C In China, Confucius wrote of wells drilled for brine and its depth were deeper than hand dug wells before. During the late 1700s and early 1800s, most families in America were moved with the early explores westward and settled in areas like western Pennsylvania, western New York and other places. A rural economy was created that required daily

commodity necessary like sodium chloride (NaCl) salt. This started the collection of brine bythe early human hunters. They started digging shallow pits or holes on the seepage areas, started accumulated brine, and concentrating it by boiling on one chamber and then the salt isprecipitated off.

Joseph Ruffner brothers one of the business people carried on their fathers brine business withhand dug pits. After some time, the demand exceeded their supply for their luck unlike their expectation. They got the idea of drilling a hole into the earth to match the source of the brine,and thus increasing the supply and then obtaining a more concentrated liquid which then on processing sodium chloride (NaCl) was early made. Between 1805-1808, they actually completed the first well drilled in America for the purpose of brine. It was about 58feet deep.

After the success of the Ruffner drilling well, many others were drilled succeeding it for 50 years or more for brine from which salt (NaCl) could be precipitated out of it. The Ruffner brothers developed the earliest American well boring tool for the purpose of bringing brine to the surface. William drake developed on their technique and then by introducing a steam engine to power the developed process and drilled for the purpose of producing oil and gas forcommercial use in 1859 at Pennsylvania.

The Drake well which was drilled in 1859 for 69.5 feet was the first in America drilled for petroleum production in commercial quantity very widely. Soon after the next 40 years, several other wells were drilled in many other countries including Canada, Europe, the Middle East and other countries. During this time in America, cable tools drilling equipment were developed from the crude rigs machinery and this became the very standard cable tool drillingequipment's that was used across countries until 1925 and so on. Wooden drilling rods were very famous with percussion tool drilling prior to 1860. American operators tried changed to a place called manila drilling cable after 1860 and to steel cable in the early 1900s. Rods werebecome the standard on European rigs very fast, the wood in the lighter rigs, and steel or wrought iron on big hole tools.

In 1880s the Baker bothers developed a fluid circulating rotary rig for drilling shallow water wells in the unconsolidated formations. The Texas oil field was discovered during the 1890s and the cable tools could not be used in that because the formation was soft and unconsolidatedformations. The new rotary rig technique that were drilling water wells of comparable formations was then applied in this field about 1895 and by 1900 several hundred wells were drilled along the Gulf Coast regions. The new rotary rigs were moved to many soft formationareas where cable tool had failed because of its inability for the tool to get to required depths in soft unconsolidated formations.

With the rotary rigs it was difficult problems situation with drilling through hard rock formation were encountered during the later stages. In 1909 Howard Hughes designed a new roller cutter consisting of replaceable rolling cutters and it was successful. The roller cutters were developed and improved over the years until for about 1930. In addition the combinationof rotary rig was equally developed still as a result of the problems were encountered by the rotary rigs in drilling hard formations or very hard rocks. They were erected in areas where such conditions were known or expected.

By 1930 a new rotary drilling rig was developed and started. This equipment's had a greater depth capacity per ton of weight drilled quickly and faster holes and was very reasonably trouble free compared with the one replaced older one. As further years passed many improvements had made one of it like the drilling feed control based on weight on the bit in 1935 which was a great development for petroleum industry.

1946 was considered to be a very important year for petroleum drilling business in the petroleum industry because as the war got ended the foundries, forgers, lathes and many otherof the oil field equipment manufacturers were cleared off military hardware as quick as possible and was replaced with machinery, tools and equipment required for drilling wells for production of hydrocarbon. Many of the new designs which were ready including equipment to be built into power rigs of greater capacity. Pumps were actually redesigned to meet the new requirements of new drilling practices to meet the requirements of new drilling practices and even also to meet the requirements of higher pressure drilling fluids than before. Down hole tools were been also made improvements. Basically the roller cone cutters and even body of the tools. In addition diamond set type bits was also developed as cutting tools. They are nowone of the principal form and most important cutting

tools in hard formations. Considerable improvements were also took place in the instrumentation application in these years and specifically in 1969. There were instruments that indicate the instant value of any given drilling factor gave cumulative values and recorded these values which were easily obtained on the monitor and could be recorded.

under Balanced Drilling

The Concept of drilling process with low pressure circulating fluid was first patented in the United States. Early applications of under balanced drilling process used compressed air technology to drill the hole. As the technology developed over the years passed, gas internal systems with stable foams, mist and aerated fluids and other types were introduced for specific drilling condition. The great technique called flow drilling was developed in south Texas, China. It was used for redevelopment of felids where depleted pressure type was an important concern in some fields. During the 1990s underbalanced drilling was very successfully used in both onshore and offshore drilling operation throughout Europe. Currently underbalanced drilling operation is the most exciting development in the area of drilling engineering which is a challenging thing for engineers to do. Together with horizontal drilling and multi-lateral drilling techniques, it holds value for drilling more cost effective.

Advancement in Drilling.

Conventional Drilling

Different advancements in conventional drilling.

Chinese Bamboo Drilling technique.

Earlier evidence of the wells in china comes from the era when humans first turned todo agriculture in this region some 7000 years ago. Oliver added that about 4000 years ago the Chinese boiled sea water to produce salt and as the need for salt increased withincrease in population they needed to go underground and started digging for brine (salt) to meet up with the demand or the requirements of salt. He pointed out that the first and successful recorded salt well in china was dug in Sichuan province that was inchina around 2150 years ago. Around 2000 years ago there was a change from the useof hand and shovels dug wells to percussively drilled ones. The drilling technique usedis still seen today in China and several parts of it in the rural places. Basically some ofthe drill bit is made of iron and also the pipe bamboo. He added that the rig was constructed from bamboo one or more men stood on a wooden plank lever like a child'sseesaw and this would lifts up the drill stem up to about 1m. The pipe was allowed to drop down with one man holding it and then ensuring that it goes straight in to the direction needed in to the well. As it crashes into the rock formation, it pulverizes, andcrushes it and slowly the drilling progresses till it reaches target depth. This might takedays or months or years in most cases. Solid bamboos pipe was replaced by thin, light, and flexible bamboo. This made allowed for deeper and deeper wells to be drilled as well as it lowered the total weight that needed to be lifted from the surface. By the1700stime wells as deep as 300 meters to 400 meters deep were drilled and in 1835 shanghaiwell was the first one in the world to exceed 1000 meters in depth. About that time in the United States, the deepest wells were around 500 meters in depth. This drilling method on its own was very impressive, especially when it was compared to what the rest of the world had to offer about that time period.

Fig 3.1 Ancient Chinese drilling method recreated

Cable Tool Drilling

Cable tool started 4000 years ago in china. It was the earliest drilling method and has been in continuous use. The Chinese people used tools constructed of bamboo. Wells of this depth often took years to complete drilling wells. Cable tool rigs are sometimescalled walking beam rigs. They actually operate by raising and lowering heavy and large string of drilling tool in to borehole. The drill bits crushes the rocks and its formation into many fragments.

Drilling is mainly done by continuously or repeatedly raising and lowering a heavy string of drilling tool into the borehole with the drill bit crushing consolidated rocks into small fragments. Vast improvements in the technique have been made to the basic Chinese bamboo drilling technique. The old spring pole originally operated by the weight and brawn of three or four men being replaced with the modern all steel rig powered with an internal combustion engines, electric motors, or steam engines. Each driller has got his own peculiar and technique in operating cable tool drilling technique the good driller differentiated from the poor one by the footage he makes in a given period of time.

Cable tool operates much like a seesaw with a powered walking beam mounted on a derrick. Penetration is commonly achieved by repeatedly lifting and dropping of heavy and large iron string and a curious variety of drill bits on the borehole, with a chisellingeffect of the drill bits on the rock which crushes consolidated rock into small fragments.The length of cable is adjusted so that on the down stroke. The tools stretches the line as the rock crushes consolidated rock into small fragments. The length of cable is adjusted so that on the down stroke. The tools stretch the line as the bit hits the bottomof the hole, striking with a sharp and pointed blow and immediately retracting it. The drilling process has to be stopped at intervals to get rock cutting off the borehole and water is added either by the driller or flows in from the formation to do this. Water mixes with the crushed rock particles and then turns it into slurry that settles down at the bottom of the borehole. At a point at where the slurry can accumulates to a particularquantity that begins to reduce the penetration to an unaccepted level then drilling is to be stopped and the slurry is removed by a component bailer of the drill string. The bit is reinstalled properly into the hole and drilling continues after each stage of removingslurry from it.

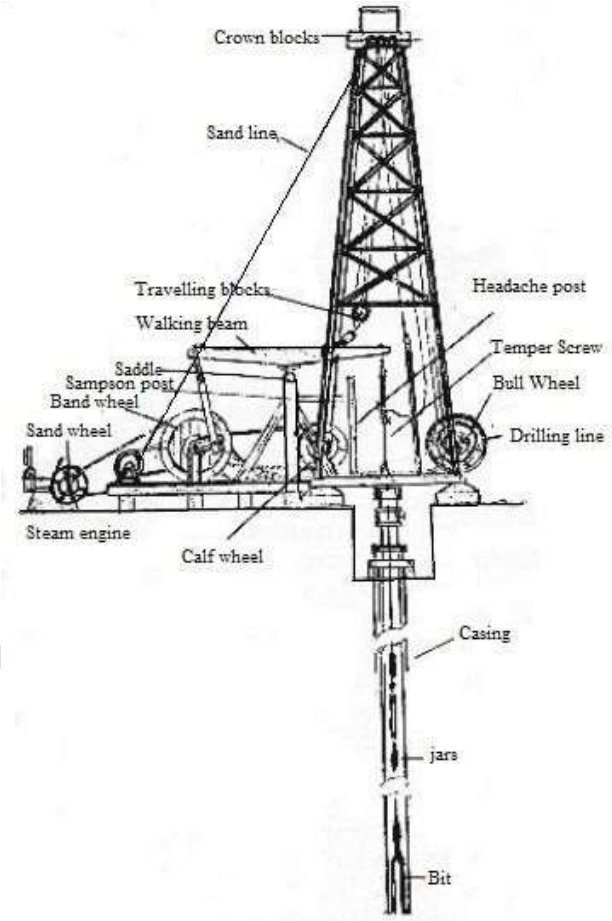

Fig 3.2 Cable tool drilling

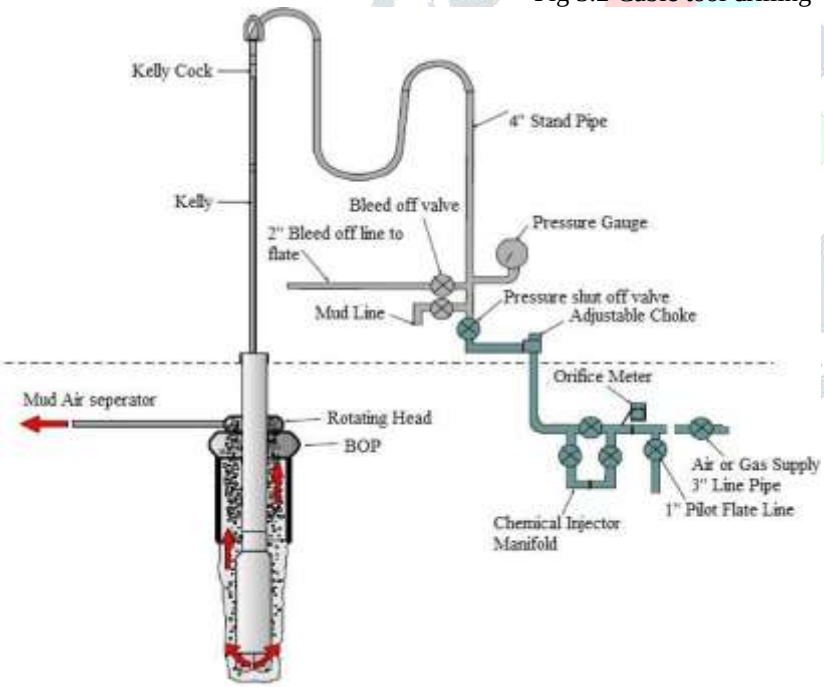

Fig 3.4 Injection through Standpipe

Gas injection through Parasitic String

Problem in aerated fluid is that they are not stable. In foam type drilling fluid it has some additive which binds both the gas and liquid, in some cases there will be a increase in pressure during tripping and connection of drill pipe and the underbalance atmosphere is loosed. There is a special technique in which gases are added before connection of drill pipe and finally enabling the reduction of pressure to maintain the underbalance condition

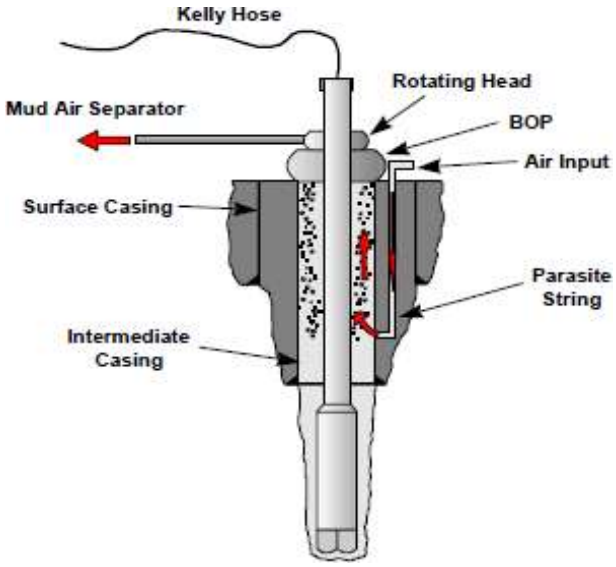

Fig 3.5 Injection through Parasitic string

a. Graph showing property variation.

1. HGS% Vs Specific Gravity

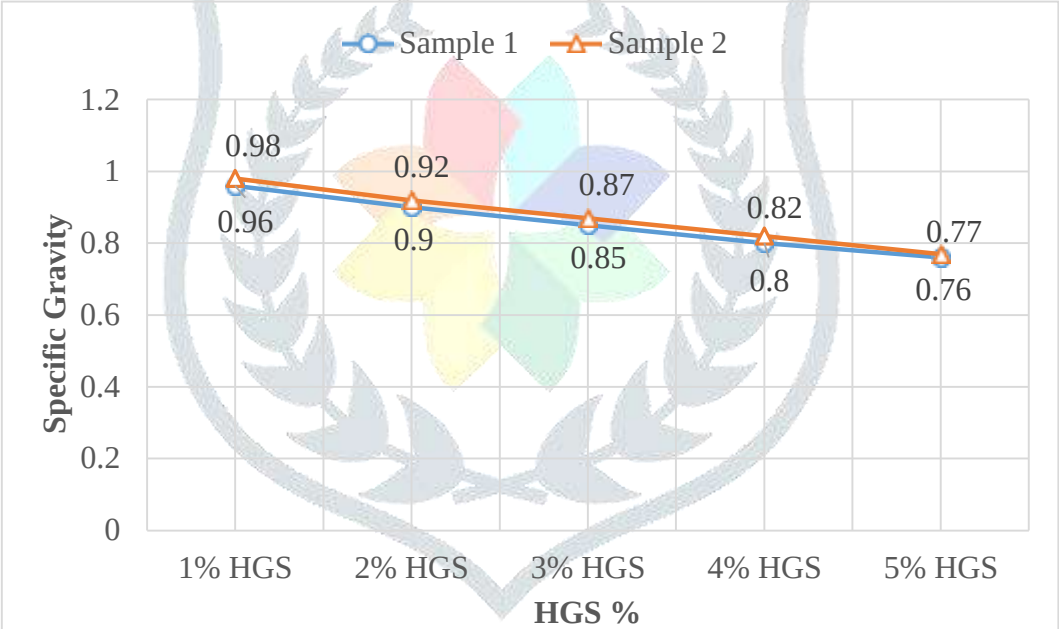

Fig 5.1 HGS% Vs Specific Gravity

2. HGS% Vs AV (Apparent Viscosity)

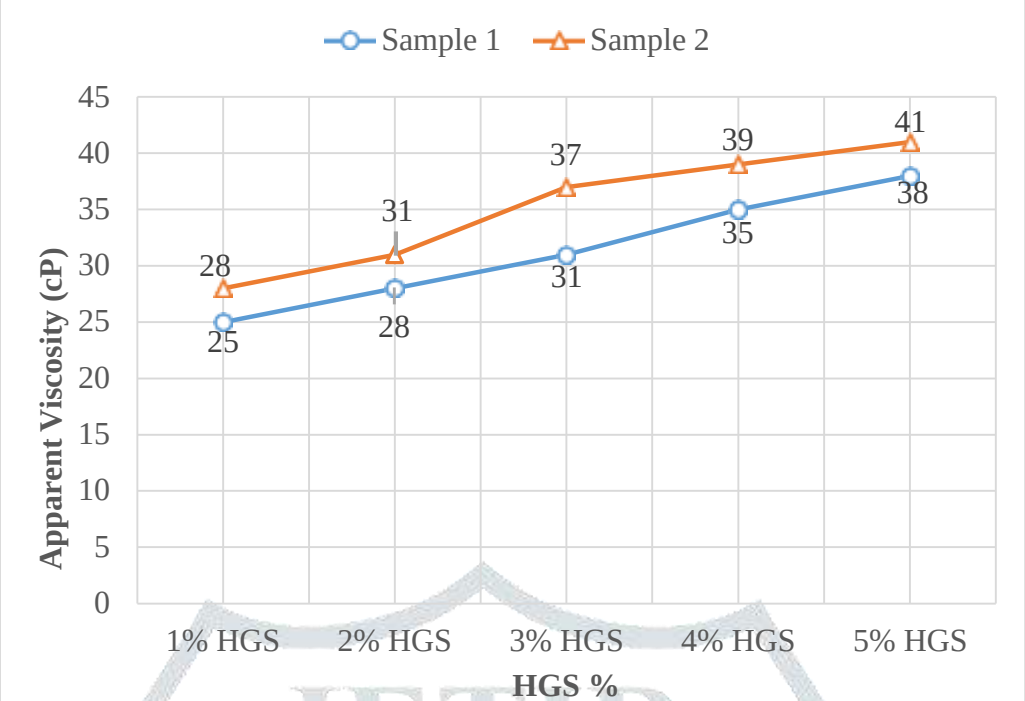

Fig 5.2 HGS% Vs AV (Apparent Viscosity)

3. HGS% Vs PV (Plastic Viscosity)

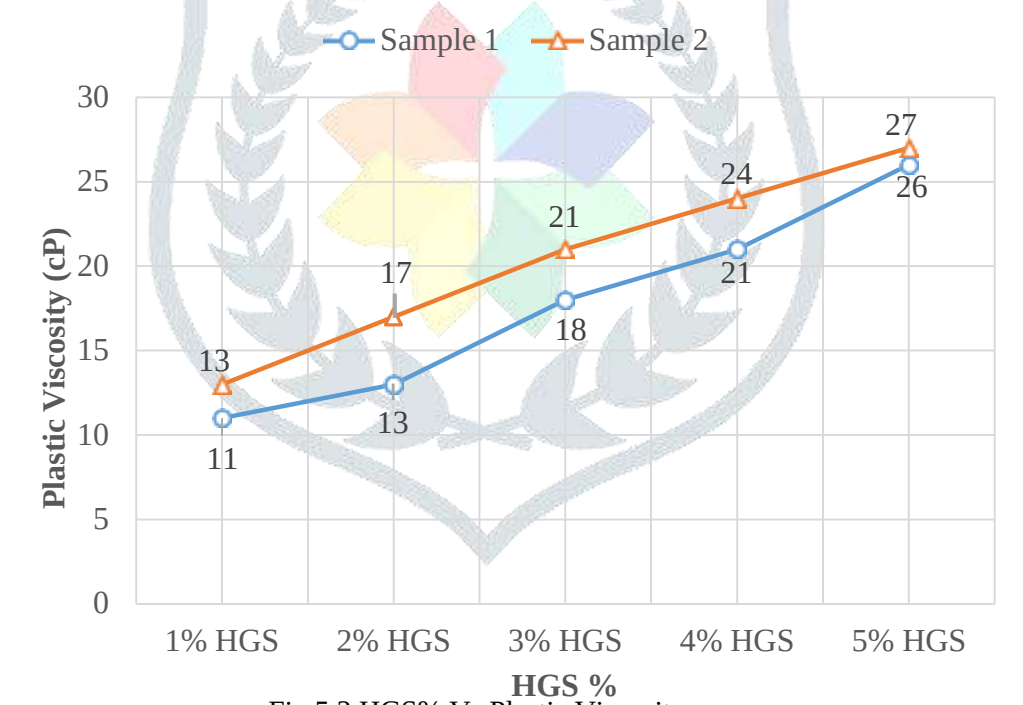

Fig 5.3 HGS% Vs Plastic Viscosity

4. HGS% Vs YP (Yield Point)

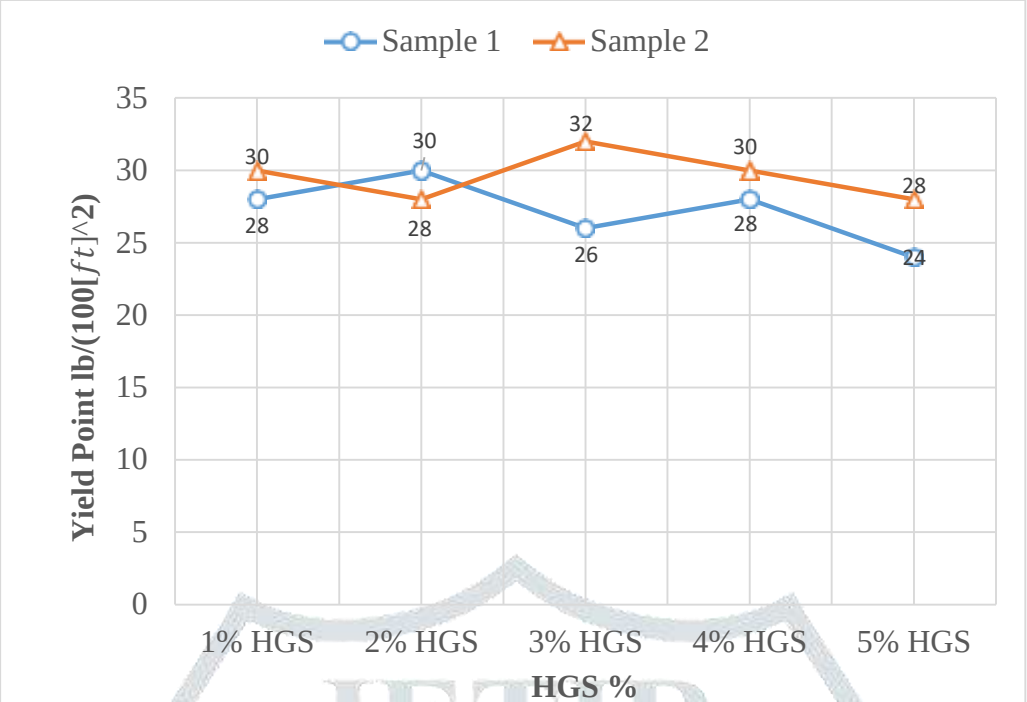

Fig 5.4 HGS% Vs Yield Point

5. HGS% Vs Gel Strength

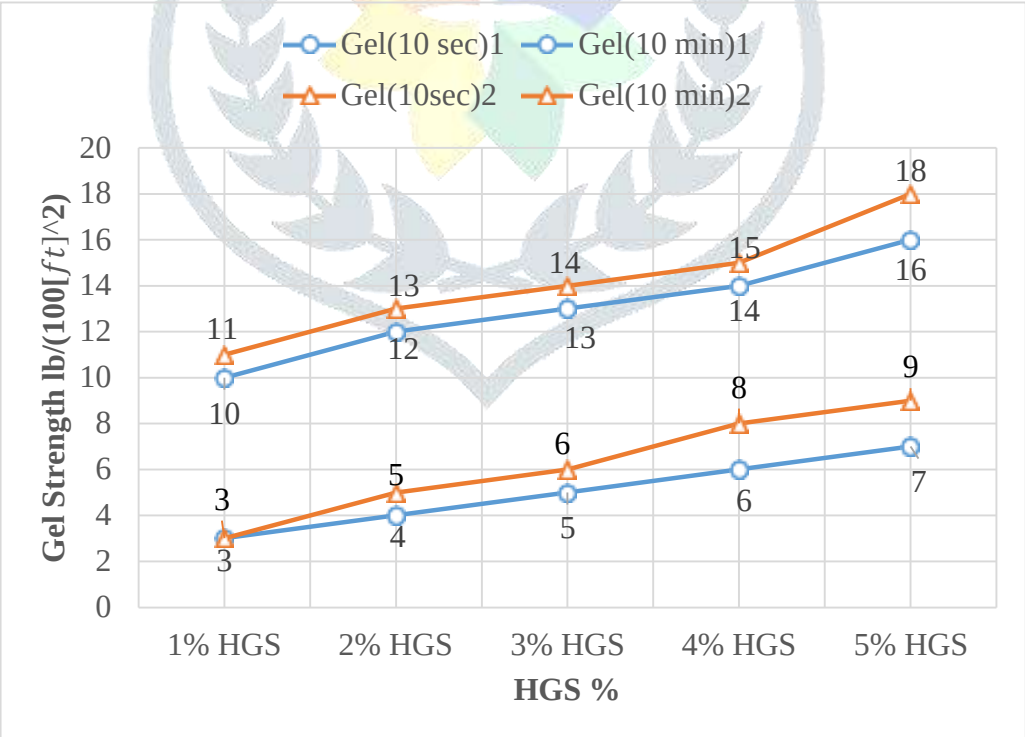

Fig 5.5 HGS% Vs Gel Strength

b. Comparing Experimental and theoretical values using material balance equation.

i. First Sample

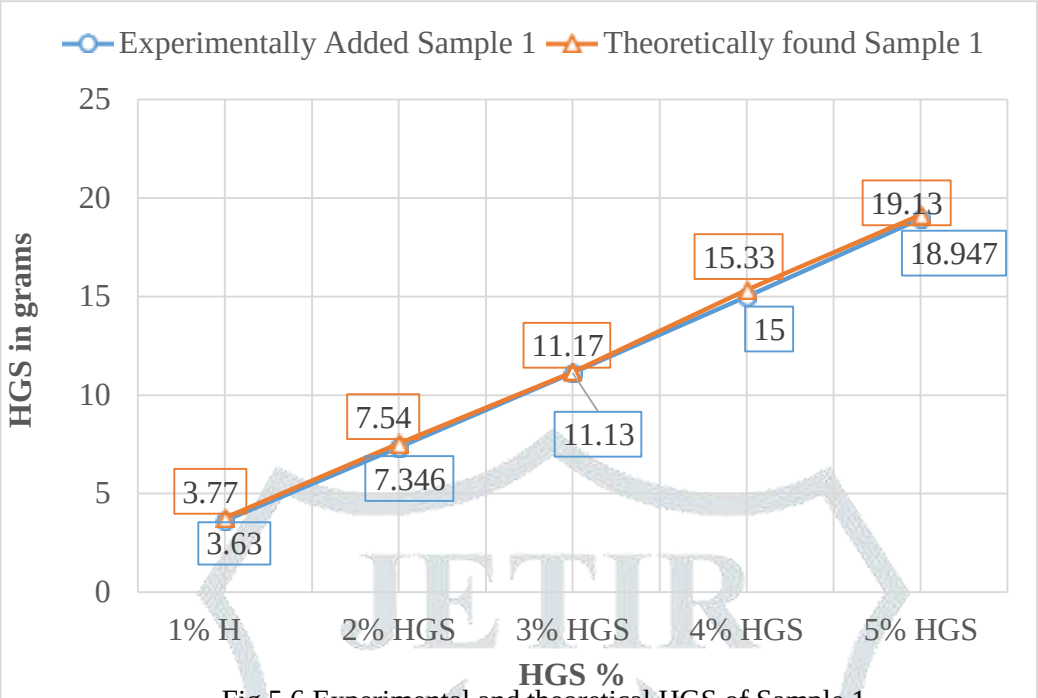

Fig 5.6 Experimental and theoretical HGS of Sample 1

ii. Second Sample

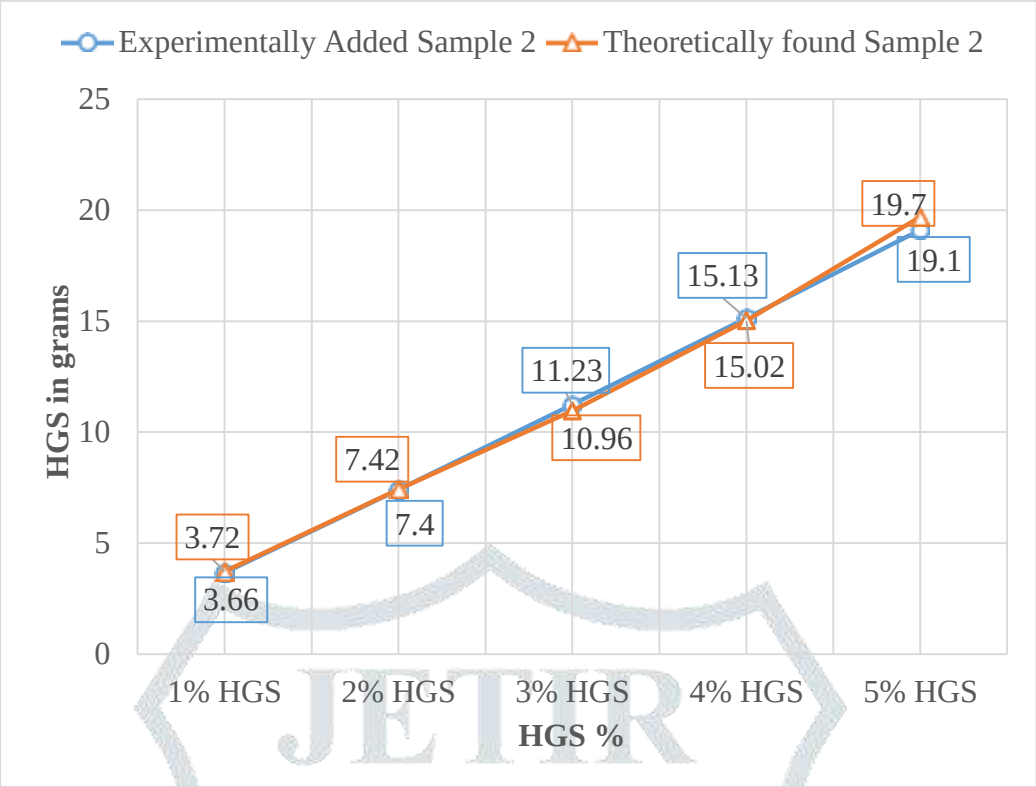

Fig 5.7 Experimental and theoretical HGS of Sample 2

CONCLUSION AND RECOMMENDATION

Though the technology is used to reduce the potential formation damage in the pay zone area, every time under balanced drilling condition cannot be maintained, for keeping the well in control some measures have to be taken.

Underbalanced drilling is mainly recommended for the candidates where the formation damage is the major concern in Conventional drilling. Underbalanced drilling is mainly employed in depleted or matured fields. Non production time is main factor for the economics of any field extraction. The place where the lost circulation problems and sticking problems chance is high, the non-productive time increases, this may deviate the well plan and also cause high operating cost. The underbalanced drilling is used for such situation for economic consideration. Fluid system for UBD are air or gas drilling and mist drilling and foam drilling. This selection is made on the wellbore stability and also the air or gas volume needed for cutting and cleaning in drilling process. The formation where well bore stability is limited to air or gas drilling, water type fluid with polymers which are used.

In this project a basic water type drilling fluid is taken in to consideration and then an additive called HGS (Hollow Glass Sphere) is used to reduce the drilling fluid density, reducing densitytill it becomes satisfiable to IADC classification.

Experiment is done and the results are evaluated, variation in all properties on addition of chemical are studied and plotted in Graph. On addition of special addictive called HGS (Hollow Glass Sphere), Decrease in mud density has been obtained, making the drilling fluid density less than particular value which could be used for underbalanced drilling operation. Variation in properties are noted down in tables. Experimental and theoretical values are also compared.

Further experiment can be done with the same fluids by increasing its temperature to the particular down hole temperature and then studying its variation in its properties. It need an Instrument called Roller Oven.

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