TYPES AND PROPERTIES OF DRILLING FLUIDS USE IN MYANMA OIL AND GAS ENTERPRISE

DR. ZAW HTET AUNG
LECTURER
DEPARTMENT OF PETROLEUM ENGINEERING
MANDALAY TECHNOLOGICAL UNIVERSITY, PATHEINGYI TOWNSHIP,
MANDALAY, MYANMAR

ABSTRACT

Most rotary drilling methods require the use of drilling fluids. Drilling fluids perform several functions. The prime functions are to clean, cool and, lubricate the bit and continuously remove cuttings from the borehole. But with progress came sophistication, and more was expected from the drilling fluids. These functions mostly depend upon the types and properties of drilling fluids. Four basic properties that determine the behavior of the mud as a drilling fluid are viscosity, density, gel strength, and filtration. Several other properties, especially if problems are anticipated or encountered, are sand content, pH (alkalinity or acidity), and calcium content. And the author also analyzes each property, and its influences on drilling operations.

INTRODUCTION

The term “drilling fluid” properly includes gases as well as liquids and liquids with solids in suspension. But there are only two types of drilling fluids: namely water base drilling fluids and oil base drilling fluids. Drilling fluids perform numerous functions. The objective of a drilling operation is to drill, evaluate and complete a well that will produce oil and/or gas efficiently. To drill the well successfully and efficiently, it mostly depends upon the properties of the drilling fluids. The properties of the drilling fluids depend upon the specific well condition [1].

In this paper, only Shale Base Mud, XP-20 Spersene Mud and Lime Base Mud are discussed because Myanma Oil and Gas Enterprise uses only these three types of drilling fluids. And I deeply analyzed the properties of drilling fluids in Nyaungdone Gas Field under M.O.G.E [2].

GEOLOGY OF NYAUNGDONE GAS FIELD

Nyaungdone Gas Field is located at about 34 miles West North-West of capital Yangon. It also lies at about 27 miles, South of Apyauk Gas Field. It lies in the Ayeyarwady Delta Basin which is known to be proven hydrocarbon province. Total coverage area is about 360 square miles [3].

In 1999 April, the first exploration well 1 was discovered in onshore Block ‘G’ by MOGE. It was drilled at a depth of 10650 ft. It is bounded by East longitude 95 degrees, 39 minutes, 32.32 seconds and North latitude 10 degrees, 53 minutes, 54 seconds. Production has incepted since April 1999 with a daily initial production of 4.24 mmcfd of gas with 69 bbl condensate from 8050 ft sand (H-40) of Nyaungdon Well one. Afterward, MOGE extended exploratory and appraisal wells drilling in the area and found a major discovery. A total of 25 wells has been drilled in the Nyaungdon Gas Field 17 wells were found to be commercially productive whereas three wells were tested dry. The daily production of Nyaungdone Gas Field is 920bbls condensate and 99.001mmcfd of gas from 12 wells [4].

TYPES OF DRILLING FLUIDS USE IN MYANMA OIL AND GAS ENTERPRISE

There are only three types of drilling fluids use in Myanma Oil and Gas Enterprise. They are:

(i) Shale Base Mud
(ii) XP-20 Spersene Mud
(iii) Lime Base Mud

The constituents of the additives for 100barrels of Shale Base Mud is:

No.	Additives	lb/barrel (or) gal/barrel	Sack/barrel
1.	Shale	80/120 lb	75 sacks
2.	Bentonite	20/30 lb	40 sacks
3.	CMC	60 lb	5 sacks
4.	Caustic	1.2 lb	1 barrel
5.	Factory Oil	42 gal	5 barrels
6.	Water		100 barrels

Depending upon the reservoir condition, the following procedures should be followed to convert Shale Base Mud to XP-20 Spersene Mud.

(i) Reduce water loss to 3 cc
(ii) Increase Viscosity to 60 to 65 sec:
(iii) Mix the following additives to get 1barrel of XP-20 Spersene Mud.
  (a) XP-20 - 4lb
  (b) Spersene - 8lb
  (c) Bentonite - 8lb
  (d) Caustic - 2lb
  (e) Factory Oil - 8 to 10% (2gal)

Depending upon the reservoir condition, the following procedures should be followed to convert Shale Base Mud to Lime Base Mud [5].

(i) Treat the Viscosity Value to 50 to 60 sce:
(ii) Mix the following additives to get 1barrel of Lime Base Mud.
  (a) Cutch - 1 to 2 lb
  (b) Caustic - 2 to 4 lb
  (c) Lime - 6 to 8 lb
  (d) Starch 'K' - 3 to 4 lb
  (e) Factory Oil - 10 to 12%

ANALYSIS ON PROPERTIES OF DRILLING FLUIDS USE IN M.O.G.E

After conducting the laboratory test, it was found that the specific gravity and yield of local bentonite and local barite were lower than the commercial bentonite and barite. To get the desirable limit, more solids must be mixed. Excessive solids can:

(1) cause wear on pumps, bits and drill strings:
(2) retard penetration rates:
(3) cause a thick filter cake to be deposited on permeable formations:
(4) cause fluids loss to the formation:
(5) cause unnecessary work for the pump, having to push unwanted weight in the circulating fluids.

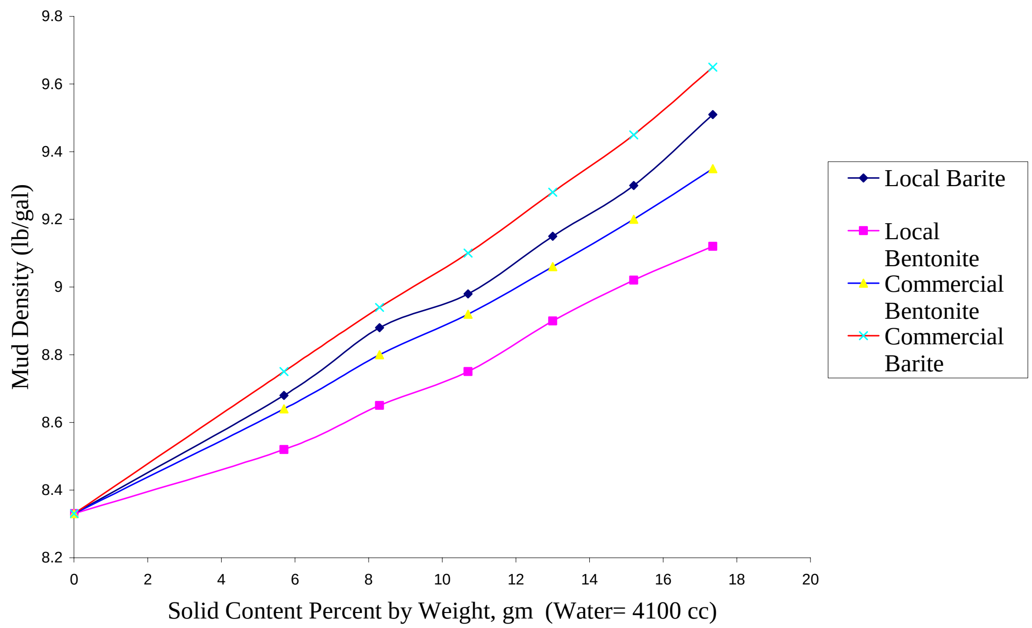

Figure 1. Solid Content Test

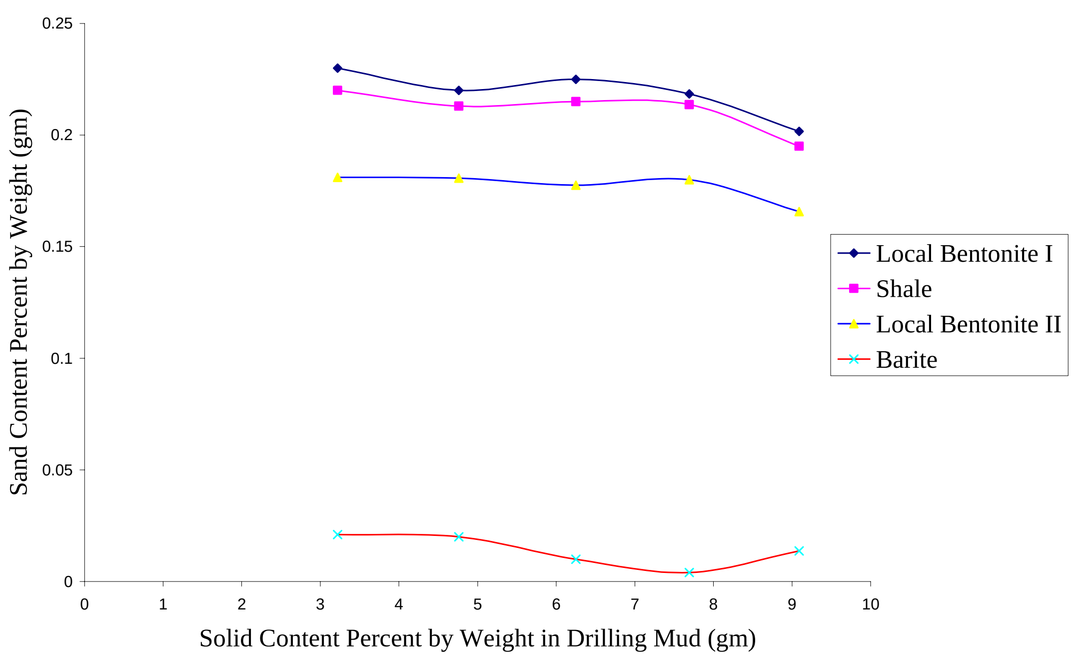

Figure 2. Sand Content Test

Table 1. Comparison of Commercial and Local Bentonites

	Commercial Bentonite (API)	Local Bentonite
Specific Gravity (lb/gal)	2.4 – 2.7	2.1 – 2.3
Sand % (%)	2%	6.2%
Gel (bbl/ton)	49	27

Table 2. Comparison of Commercial and Local Barites

	Commercial Barite (API)	Local Barite
Specific Gravity (lb/gal)	4.3 – 4.6	3.8 – 4.4
Sand % (%)	2%	2.07%

Thick filter cake can cause the pipe stuck. Salt may be added to increase mud weight without adding solids, and is a very effective method of increasing mud weight in most conditions. Sand can be produced as a result of drilling a sandy formation or can come from the bentonite being added to the mud. Sand is a naturally occurring contaminate in bentonite deposits. In local bentonite, sand content is seven percent volume, as shown in Figure 2. and Table 1. To meet API specifications, sand must be four percent or less quality bentonite should have a sand content of two percent or less to avoid problems. Table 2 shows the specific gravity and sand content of barite.

When analyzing the Nyaungdone mud at laboratory, the average density of mud is about 13.77 lb/gal. Hydraulic fracturing is initiated and lost circulation occurs when some critical fracture pressure is reached or exceeded. The desirable limit of mud density is nine lb/gal. Table 3 is the comparison of standard mud and local mud properties.

Table 3. Comparison of Standard mud properties and Local mud properties

	Standard Mud (API)	Local Mud (Nyaungdone Field)
Density (lb/gal)	9	13.77
Sand (%) by Volume	2	7.5
Viscosity (sec)	32-38	72
pH	8.5-9.5	10.65
Mud Cake Thickness (mm)	2	3.5
Gel (lb/100bbl)	8.33	5
Filtrate (cc)	5	9.3

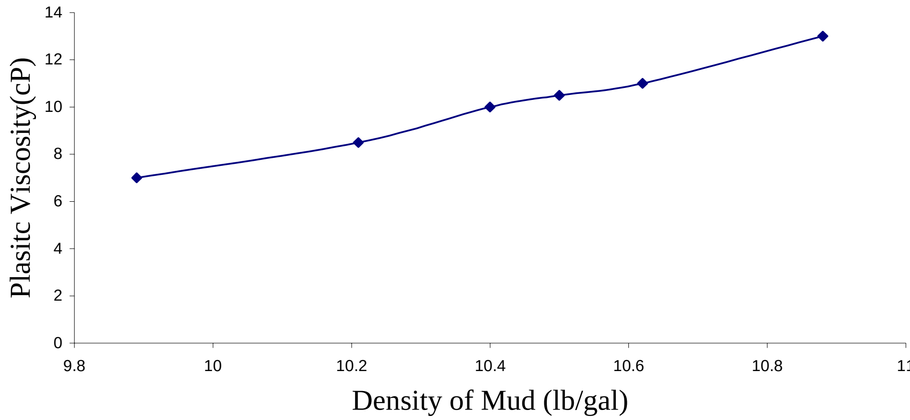

Figure 3. Plastic Viscosity Test at Suction Line

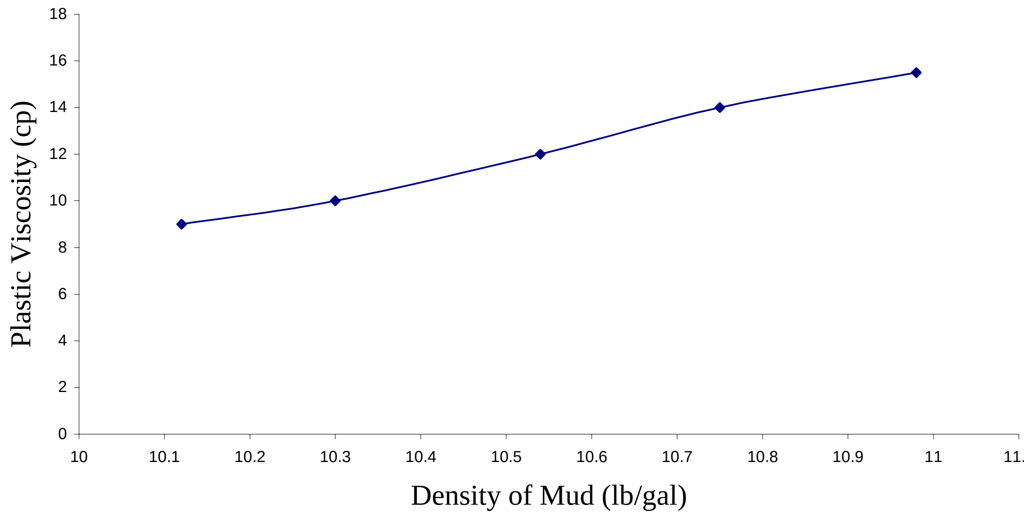

Figure 4. Solid Content Test at Suction Line

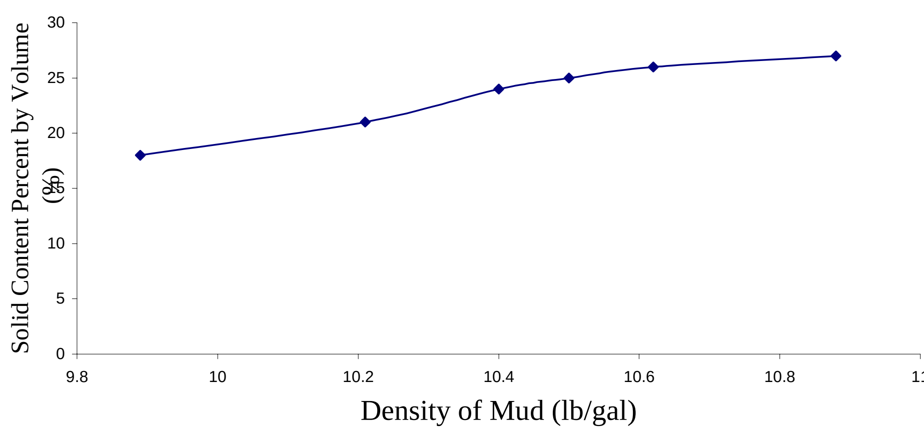

Figure 5. Solid Content Test at Flow Line

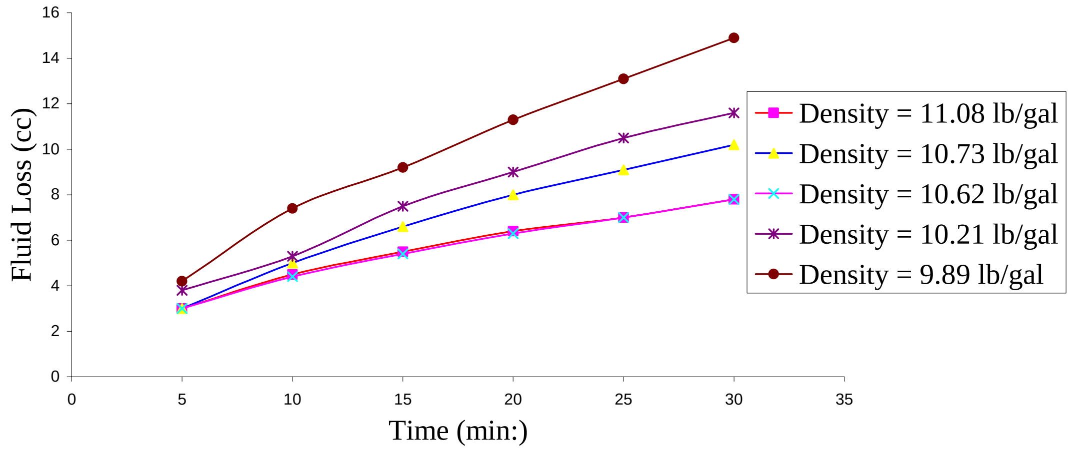

Figure 6. Fluid Loss Test at Suction Line

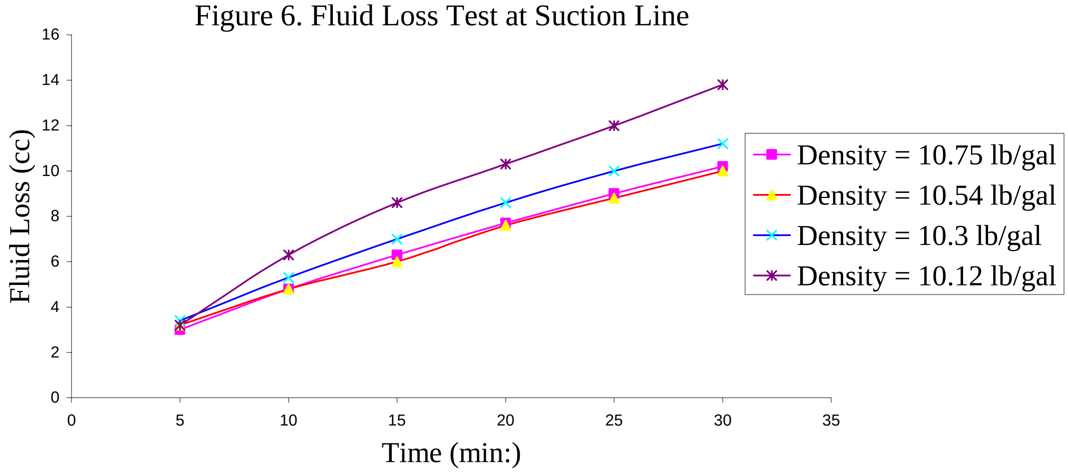

Figure 7. Fluid Loss Test at Flow Line

Figure-3 to Figure-7 are the comparison of plastic viscosity, solid content and fluid loss properties of Nyaungdone Mud. Between 3410ft to 5030ft, in Yaw Formation is essentially composed of dark gray shales and flay locally carbonates with thinly bedded sandstones. In Pondaung Formaiton, between 5030ft to 6000ft composed of sandstone with grits and conglomerates. According to experiences found in Nyaungdone Well 9 and 12 losses of circulation can be expected during drilling through Yaw and Pondaung Formation. So mud engineer gradually increase the mud density from 17lb/gal to 20lb/gal from 3400ft. From the point of mud properties, lost circulation is mainly caused by excessive mud density or increasing mud density too fast, excessive viscosities and gel strength and raising and lowering the pipe too fast, as shown in Table 4.

Table 4. Comparison of Mud Densities caused by Surge Pressure and Fracture Pressure

Depth (ft)	Mud Density Caused by Surge Pressure (lb/gal)	Equivalent Mud Density to Fracture Pressure (lb/gal)
2515	10.4549	16.544
3412	18.74	18.764
5000	19.378	19.24
5597	19.71	19.23

Table 5. Comparison of Actual Mud Density and Mud Density Equivalent to Fracture Pressure

Depth (ft)	Actual Mud Density (lb/gal)	Mud Density Equivalent to Fracture Pressure (lb/gal)
2515	10.43	16.544
3412	17.645	18.764
5000	19.25	19.24
5597	19.25	19.23

In NDN-16, mud is lost at five intervals. When analyzing these intervals, mud imposed pressure is not exceed the formation fracture pressure, nearly equal, as shown in Table 5. Mud loss can also occur to fissures or fractures in wells where no coarsely permeable or cavernous formations exist. These fissures or fractures may occur naturally, or may be extended by hydraulically imposed pressures; losses can occur at unsealed fault boundaries. Cavernous or vugular zones are usually associated with low-pressure carbonate (limestone and dolomite). In limestone, vugs are created by the previous continuous flow of water that dissolved part of rock matrix, creating a void space. When these vugular formations are drilled, the drill string may fall freely through the void zone and a rapid loss of mud can occur. Hydrostatic pressure is not also exceed the formation fracture pressure. But mud viscosities is extremely exceed (about two fold) the normal mud viscosity.

Causes of pipe stuck can be grouped into:

(1) Settled cuttings
(2) Thick filter cakes
(3) High-solid muds
(4) High-density muds

Table 6. Comparison of Slip Velocity of Cutting and Mud Annular Velocity

Slip velocity of cutting sample (ft/sec:)	Annular velocity of the mud (ft/sec:)
0.4807	1.78
0.3718	1.728
0.353	1.728
-0.71126	1.984
-0.8162	1.984

Table 7. Comparison of Hydrostatic Pressure of Mud and Pressure of Adjacent Formation

Hydrostatic pressure of mud (psi)	Pressure of adjacent formation (psi)
390.37	363.63
1509.39	1294.095
1653.95	1400.58
3921.98	1887.43
4792.79	2226.42

Pipe stuck caused by settled cuttings usually occurs when the drill string is moving. And differentially stuck pipe caused by thick filter cakes, high-solid muds and high-density muds usually occurs when the pipe is stationary. Cuttings sample from Nyaungdone Oil and Gas Field have been analyzed in water and mud. But cutting slip velocities cannot dominant the annular velocity of the mud, as shown in Table 6. By laboratory results, cutting sample cannot descend when the mud densities are greater than the densities of the cutting sample. But the hydrostatic pressure acting upon drill pipe is greater than the pressure of the adjacent formation, as shown in Table 7. So, differential sticking can occur while the pipe is stationary during a connection or when taking a survey.

Reduce the overbalance pressure by keeping the mud weight as low as good drilling practices allow. Excessive mud weights increase the differential pressure across the filter cake and increase the possibility of differentially sticking the pipe. Reduce the area of contact between the well bore and the pipe by using minimum length of drill collars needed for the required length of bit weight. Reduce the area of contact by using the small, spiral, square and helical drill collars. Reduce the filter-cake thickness. Thick filter cakes increase the contact area between the pipe and side of the hole, which efficiently reduces well bore diameter. Filer-cake thickness can be reduced by lowering the filtration rate and drill solids contact. The average mud cake thickness is about 3.5mm. The standard mud cake thickness is two mm. So the mud cake thickness of NDN-16 is more thick than the standard mud cake thickness. which can promote the differentially stick the pipe. The pH of water is a measure of how acidic or alkaline the water is. bentonite will mix best if the pH of make up water is adjusted to be between eight and nine. In NDN-16, the average pH of drilling mud is about 10.65. pH will effect mud mixing, viscosity, water loss and hole stability.

CONCLUSION

To fulfil this paper, the three months duration was spent in Nyaungdone Gas Field and Leppando Oil and Gas Field. Mud samples, drilling data and geology data were collected from these fields. And these mud samples were tested in laboratory to obtain results. These tests are for mud density, solid content, oil content, water content, mud viscosity, filtration, gel of mud and differential sticking tendency. These tests had been repeated to get reliable results based upon mud densities. Unfortunately, the chance to obtain the mud sample which was circulating at the time of lost circulation was missing but the data related to that lost circulation could be collected.

It was found that the muds used in M.O.G.E are too much in sand and solid content, too high in viscosity. Higher solid concentration and viscosity leads to adverse effect on drilling operation. It is very difficult to know accurate geological conditions of the formation being drilled. Actually, they have no chance to use proper raw mud materials and additives. The equipments used in mud treating system are lack of proper and regular maintenance. Although they have no favour to use commercial class mud materials, they should use good processed mud materials. If they used good processed mud materials, most drilling problems can be eliminated.

In conclusion, there is no perfect drilling fluid or method of application but a better understanding gives the researchers near perfection.

REFERENCES

[1] Dresser Magcobar. 1968. Mud Engineering. HOUSTON, TEXAS: Division of Dresser Industries, INC.

[2] Min Naing, U.2005. Drilling Data of Nyaungdone Gas Field. Myanma Oil and Gas Enterprise, Ministry of Energy.

[3] Anonymous.2005. Depth Data and Drilling Policy. Myanma Oil and Gas Enterprise, Ministry of Energy

[4] Kyi Soe, U.2001. History of Nyaungdone Well-1. Myanma Oil and Gas Enterprise, Ministry of Energy.

[5] Anonymous.1992. Millpark Drilling Fluids. HOUSTON, TEXAS. U.S.A.: A Barker Hughes Company.