Impacts of Polyanionic Cellulose Polymer (PAC-LV) on Drilling Fluids Properties

Abusabah.E.Elemam[1], Rashid.A.M.Hussien[2], Ahmed.A.Ibrahim[2], Sumya.A.Mohamed[2]
[1]College of Water and Environmental Engineering, [2]College of petroleum Engineering and Technology, Sudan University of Science and Technology (SUST).
abusabah@sustech.edu

Received: 28/06/2014
Accepted: 10/08/2014

***ABSTRACT* -** This study aims at the assessment of the effect of Polyanionic Cellulose Polymer (PAC-LV) into water base drilling fluids Properties. Laboratory investigations of physical properties of raw material (clay) show that the clay is near to class Ca Bentonite. Adding PAC-LV increases viscosity and decreases filter loss. Drilling fluids need huge amount of PAC-LV to meet American Petroleum Institute Standards (API). The study concludes that the PAC-LV is an expensive drilling fluids properties improver, not recommended to be used.

Keywords: *Drilling Mud, PAC-LV, Clay, Physical Properties.*

المستخلص – هدفت هذه الدراسة إلي تقييم تأثير البوليمر من نوع (PAC-LV) علي سائل حفر مائي القاعدة محضر من بنتونايت محلي. النتائج المعملية للخواص الفيزيائية للطينة أوضحت أنها تقع بالقرب من البنتونايت الكالسي. أدت إضافة البوليمر لزيادة اللزوجة وتقيل فاقد الرشح. بغرض الوصول لمواصفة معهد البترول الأمريكي القياسية لجودة البنتونايت فأنه قد إتضح من التجارب المعملية أن العينات تحتاج إلي كمية كبيرة من هذا البوليمر الشيء الذي يعد مكلفاً إقتصادياً وبالتالي أوصت الدراسة بعدم إستخدام (PAC-LV) كمحسن لخواص سائل الحفر المحضر من بنتويايت محلي.

INTRODUCTION

In oil and gas industry, drilling is complicated operation and an expensive compared with other activities in well program [1]. Drilling fluids are considered important components of drilling wells using rotary drilling method used and date back to 1900[2,3]. Water based fluidsare the most widely used in drilling operations because they are available, minimal environment impact and low cost. More than 80% of wells drilled using water based drilling fluids [4, 5]. Water based fluids can be classified into three categories that are: inhibitive, non-inhibitive and polymers fluids [6].

All drilling operations depend directly on the properties of the drilling fluids [2]. If the drilling fluids properties are uncontrolled, there will be very serious risks and hazards in terms of economic and safety [6]. The rheological properties of the drilling fluid are of great importance of the drilling fluid, where it affects in bottom hole cleaning of the well and the pressure drop in the drilling bit [7]. Rheology is defined as “the study of fluids in motion” [6].

The aim of this study is to investigate the impact of PAC-LV in water base drilling fluids properties. Untreated Sudanese clay fails to match American Petroleum Institute (API) Specifications for bentonite quality [8]. For this study purposes, the Sudanese bentonite treated using different concentrations of PAC-LV 5%, 10%, 15%, 20%, and 25% by weight of bentonite.

MATERIALS and METHODS

Four boreholes were drilled in Umm Ali region to extract samples for these study purposes [14, 15].

Table 1: Boreholes Elevations [15].

Borehole No.	Elevation (m)
1	359
2	373
3	370
4	373

The determination of the liquid limit value for all samples was carried out according to the cone penetration method in BS 1377: Part 2:1990 CL 4. The tested samples were sieved through a BS No 40 (0.425 μm).After sieving the sample (about 300g) was mixed with distilled water using two palette knives for at least 10 minutes to make a homogenous paste. A portion of paste pushed into a cup, the penetration of the cone in (mm) was recorded from the dial gauge reading, and the corresponding moisture content of the sample then obtained. The relationship between the moisture content and the penetration was plotted as the best straight line fitting the plotted points. The liquid limit (LL) is equal to the moisture content as a percent corresponding to a cone penetration of 20 mm. The results are shown in Table (2) to (5).

The plastic limit is taken as the moisture content at which a sample of soil begins to crumble when rolled into a thread (about 3 mm or 1/8 inch dia.) under the palm of the hand. The method of testing is specified in BS 1377: Part 2:1990 CL 5.3. A sample of soil (passing sieve No 40 BS sieves) was taken and rolled with the palm of the hand on a glass plate into a thread of about 3mm in diameter. The moisture content of the crumbled sample is then determined and the average moisture content of two samples is taken as the plastic limit, The plasticity index is calculated as the difference between liquid and plastic limits, the values of the plastic limit and plasticity index for all samples are summarized in Table (2) to (5).

A six speed rotational viscometer type (ZNN-D6) is used to quantify the rheological properties of the drilling fluids at room temperature and atmospheric pressure.

Figure 1: Raw samples before crushing

Figure 2: ZNN-D6 viscometer

A filter press instrument type (ZNS-4) was used to investigate filtrate volume of drilling fluids under a pressure of 100 psi and 30 minutes period. All drilling fluid tests were carried out in accordance to American Petroleum Institute (API) standards [9, 10, and 11].

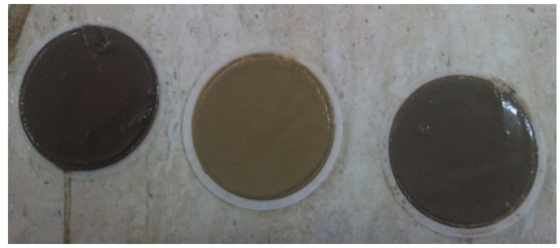

Figure 3: filter paper & Mud Cake

RESULTS AND DISCUSSIONS

The laboratory investigations revealed various descriptions for the soil strata in each borehole. For instance, borehole (1) showed a variation in the group symbol from being clayey sand (***SC***) between depths 2.0 m to 4.0 m; and clay of high plasticity (***CH)*** between depths 4.0 m to 6.0 m.

As for borehole (2) clayey sand (***SC***) represented the first meter of soil as well as depths between 3.0m to 4.0m. Depths from 2.0 m to 3.0 m have had clay of low plasticity (***CL*)**, whereas from depths 4.0 m to 6.0 m the encountered non-plastic types included silty sand (***SM***), and clayey silt of low plasticity (***ML***).

Clay of low plasticity (***CL***) dominated down to 5.0m of borehole (3). Remaining investigation depth (down to 8.0m) conveyed clay of high plasticity (***CH***) soil group. Notwithstanding the previous results, borehole (4) demonstrated clayey sand (***SC***) for depths down to 3.0m, clay of low plasticity (***CL***) for depths between 3.0 m to 4.0 m, clayey silt of low plasticity (***MH***) for depths between 4.0 m to 5.0 m, and silty clay of high plasticity (***CH***) for depths over 5.0 m.

The Atterberg Liquid Limit for the natural clay at Umm Ali site area found to range between 26 to 90. Such values, with the range of Na bentonite and Ca bentonite, are considered very law as referenced to the British Geological Survey standards [12]. The effects of PAC-LV on rheological and filtration properties on water base drilling fluids prepared from Umm Ali bentonite were investigated. Five different concentrations of drilling fluids were prepared to construct Figures 5 to 7.

As expected, the filtrate volume decreases as the PAC-LV concentration increases as shown in Figure 5. Filter volume do not meet the API standard at PAC-LV concentration 10% except for the samples of borehole one and dark at borehole three.

It is clear that the plastic viscosities considerably increase with increasing PAC-LV concentration Figure 6. The results achieved for viscometer dial reading at 600 rpm for samples, there is an improvement in the reading; this is evident in the graph plotted in Figure 7. All samples investigated satisfy the API standard for viscometer dial reading at 600 rpm at PAC-LV concentration 25% (5.625gram) which is very high amount of additive and costly.

CONCLUSIONS AND RECOMMENDATIONS

In this study, the effects of Polyanionic Cellulose Polymer (PAC-LV) on water base drilling fluids were studied. From the results:-

- The raw clay from study area is near to Ca bentonite.
- Adding PAC-LV improved water base drilling fluids in different degrees of efficiency.
- The drilling fluids reach API specification for filter loss at PAC-LV concentration 15% for all samples.
- The drilling fluids reach API specification for viscometer dial reading at 600 rpm at PAC-LV concentration 25% for viscometer dial reading at 600 rpm.
- The drilling fluid needs a high amount of PAC-LV to meet API specification for drilling fluid properties.
- Depending on economical consideration the study not recommend to use PAC-LV as drilling fluid improver for Umm Ali Bentonite.

REFERENCES

[1] H. Basarir et al (2014), Penetration rate prediction for diamond bit drilling by adaptive neuro-fuzzy inference system and multiple regressions, Engineering Geology 173, Elsevier, pp. 1–9.

[2] Baroid Drilling Mud Data Book (1954), Baroid Division, National Lead Co., Houston, Texas.

[3] Rashid .A. M. Hussein (2014), Rheologyical Properties Evaluation of Sudanese Bentonite with Different Additives, SUST Journal of Engineering and Computer Science (JECS), Vol. 15, No. 1, pp. 34-41.

[4] J. Hermoso et al (2014), Influence of viscosity modifier nature and concentration on the viscous flow behaviour of oil-based drilling fluids at high pressure, Applied Clay Science 87, pp. 14–21.

[5] Reza Khanpour et al (2014), Removal of contaminants from polluted drilling mud using supercritical carbon dioxide extraction, J. of Supercritical Fluids 88, pp. 1–7

[6] Steve Deverux (1999), Drilling for oil and gas, Penn Well Corporation pp. 145-167.

[7] XianghaiMeng et al (2012), Effects of carbon ash on rheological properties of water-based drilling fluids, Journal of Petroleum Science and Engineering 100, pp1–8.

[8] Rashid.A.M.Hussein et al (2014), Assessment of the Effect of Increasing Local Bentonite Concentration on Drilling FluidsRheology and Filtration Properties, SUST Journal of Engineering and Computer Science (JECS), Vol. 15, No. 1, pp 26-34.

[9] American Petroleum Institute (API) (2006) Specification 13A, Specification for Drilling Fluid Materials.

[10] American Petroleum Institute (API) (2003) Specification 13B-1, Recommended Practice for Field Testing Water-base Drilling Fluids.

[11] American Petroleum Institute (API) (2009) Recommended Practice 13D, Recommended Practice Rheology and Hydraulics of oil-well Drilling Fluids.

[12] SDJ Inglethorpe et al, (1993). Bentonite, Industrial Minerals Laboratory, Manual British Geological Survey.

[13] Mowia K. Omer (1983), the Geology of the Nubian Sandstone" Geological and Minerals Resources Department, the Ministry of Energy and Mining (SUDAN).

[14] Abusabah. E. Elemam (2013), Optimizing Sudanese Bentonite Properties for drilling applications, unpublished thesis. Sudan University of science and technology (SUST).

[15] Abusabah. E. Elemamet al (2014), an improving Rheological Properties and Filter Loss of Water-Base Drilling Fluids Using Carboxymethyle Cellulose (CMC). Online International Interdisciplinary Research Journal, Vol. IV, May 2014 Special Issue.

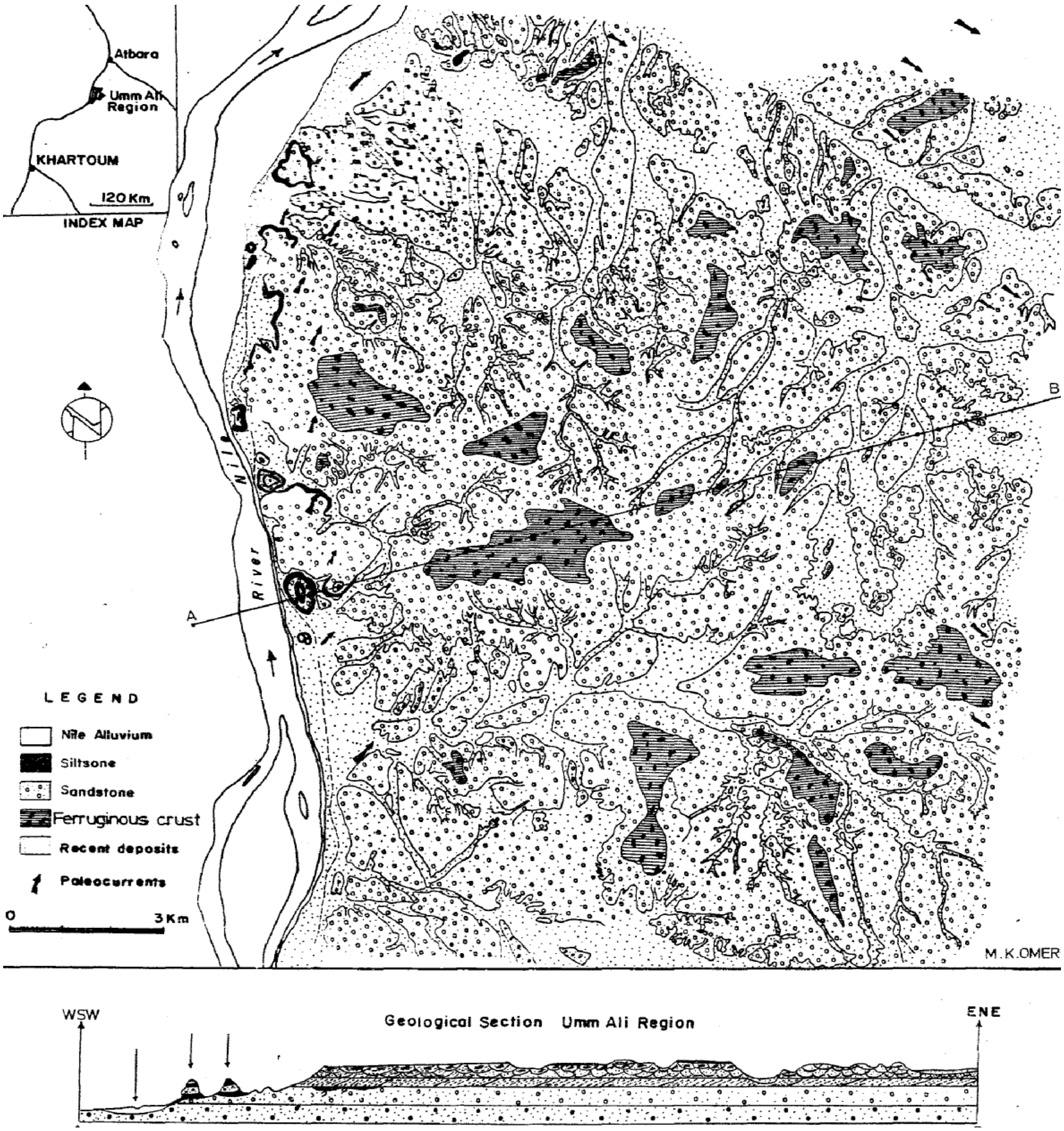

Figure 4: Geological Map of Jebel Umm Ali Region [13]

Table II: Physical Properties of Umm Ali Clay B.H#1#

Depth (m)	Group Symbol	Atterberg Limits L.L %	Atterberg Limits P.L %	Atterberg Limits P.I %	%pass sieve #200
1.0	SM	Non - Plastic			21
2.0		34	17	17	35
	SC				
3.0		45	19	26	39
4.0		59	19	40	60
5.0	CH	73	19	54	85
6.0		51	16	35	86

Table III: Physical Properties of Umm Ali Clay B.H#2#

Depth (m)	Group Symbol	Atterberg Limits L.L %	Atterberg Limits P.L %	Atterberg Limits P.I %	%pass sieve #200
1.0	SC	27	16	11	39
2.0	CL	31	17	14	54
3.0	SC	29	20	9	44
4.0	SM	Non – Plastic			30
5.0		Non – Plastic			63
	ML				
6.0					

Table IV: Physical Properties of Umm Ali Clay B.H#3#

Depth (m)	Group Symbol	Atterberg Limits L.L %	Atterberg Limits P.L %	Atterberg Limits P.I %	%pass sieve #200
1.0		38	19	19	58
2.0		42	20	22	64
3.0	CL	26	18	8	53
4.0					
5.0		68	24	44	97
6.0		85	33	52	96
	CH				
7.0		79	29	50	97
8.0					

Table V: Physical Properties of Umm Ali Clay B.H#4#

Depth (m)	Group Symbol	Atterberg Limits L.L %	Atterberg Limits P.L %	Atterberg Limits P.I %	%pass sieve #200
1.0		24	15	9	40
	SC				
2.0		25	15	10	41
3.0	CL	37	16	21	93
4.0	MH	90	40	50	92
5.0		74	30	44	90
	CH				
6.0		72	28	44	94

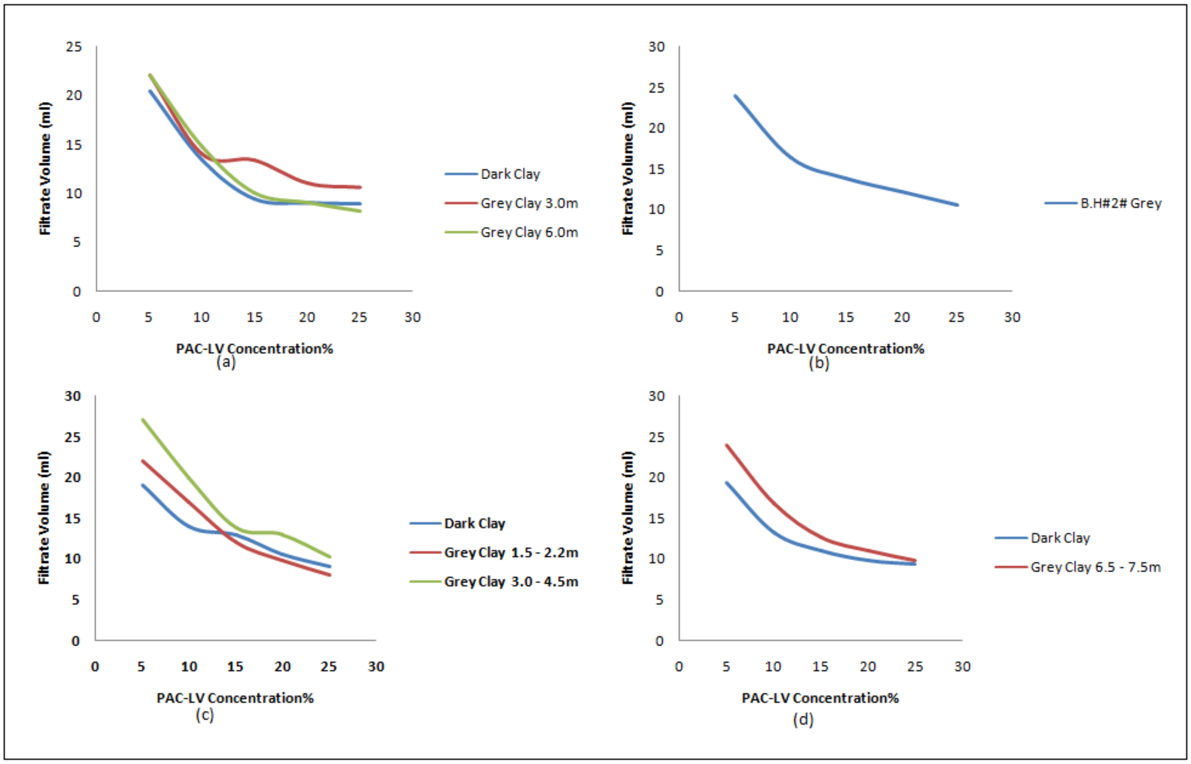

Figure 5: PAC-LV concentration vs Filter loss

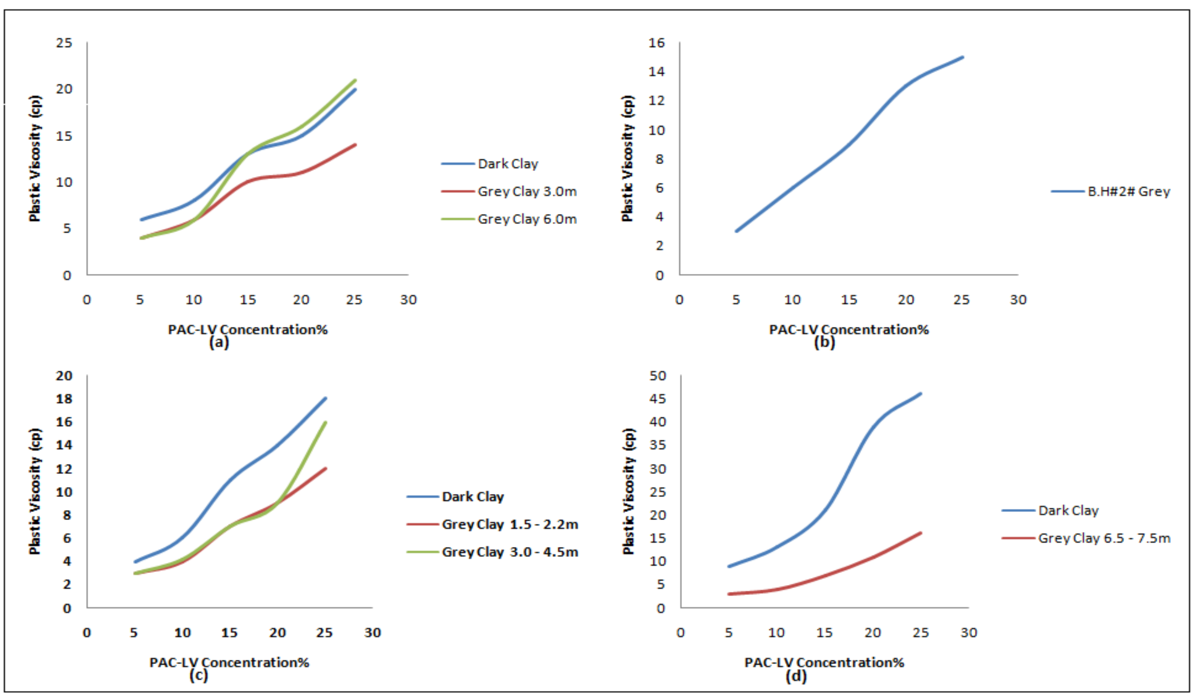

Figure 6: PAC-LV concentration vs Plastic Viscosity

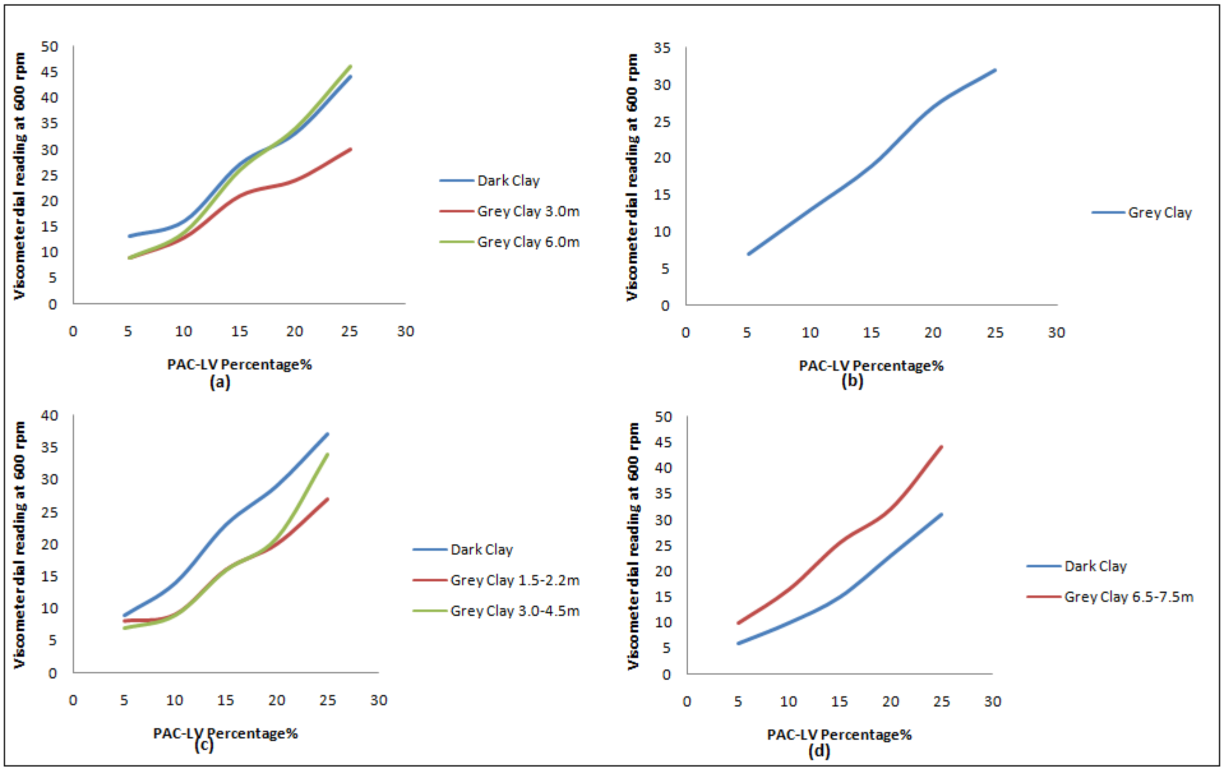

Figure 7: PAC-LV Concentration vs Viscometer dial reading at 600 rpm