

## Range of Rheological Properties for Bentonite Drilling Muds

Ahmed S. Mohammed and C. Vipulanandan Ph.D., P.E. and D. Richardson<sup>3</sup>

Center for Innovative Grouting Material and Technology (CIGMAT)

Department of Civil and Environmental Engineering

University of Houston, Houston, Texas 77204-4003

E-mail: asmohammed2@uh.edu, cvipulanandan@uh.edu, Tel: 713-743-4278

<sup>3</sup>Program Manager- RPSEA, Sugar Land, Texas

**Abstract:** This study was focused on the statistical analyses of the rheological properties of Bentonite drilling muds with over 200 data collected from the literature. Analyses of the rheological properties of bentonite muds were done based on the minimum and maximum range, mean, standard deviation and coefficient of variation. The Cov varied from 65.5% to 208.7% for all rheological properties. Also the rheological properties of the drilling muds in the literature were compared with the experimental results from the ongoing studies at CIGMAT.

**1- Introduction:** Drilling mud properties such as apparent viscosity, plastic viscosity and yield point play an important role in designing efficient and optimized drilling operation. Drilling muds have three main functions (i) to transport drill cuttings out of the hole and to allow for separation of cuttings from the drilling fluids at the surface; (ii) to form a thin filter cake on the walls of the wellbore to prevent fluid loss and (iii) to prevent inflow of formation fluids into the wellbore (Falode et al. 2008). Bentonite suspensions are widely used in underground work because of their mechanical and rheological properties (Basqa et al. 2003). These properties allow them to stabilize the wall of the hole by forming a cake to clean the hole by evacuating the cuttings and to decrease the wear on tools.

**2- Objective:** The overall objective was to quantify the range of rheological properties (apparent viscosity, plastic viscosity and yield point) for bentonite drilling muds used in oil/gas well drilling.

**3- Results and Analysis:** Data on the apparent viscosity, plastic viscosity and yield point of bentonite drilling muds were collected from the literature. Based on over 200 data from the literature, the percentages of bentonite in the drilling mud varied up to 14%. Drilling mud with 6% and 8% of bentonite represented 21% and 15% of the data respectively as shown in Fig. 1.

**(i) Apparent Viscosity (AV):** Total of 42 data on apparent viscosity of bentonite drilling muds were used in this analyses. The minimum and maximum values of apparent viscosity for drilling mud with varying bentonite contents were 1.1 cP and 19.7 cP respectively and the mean, standard deviation and Cov (%) were 5.8 cP, 5.8 cP and 77.5% respectively as shown in Fig. 2. The average value of apparent viscosity was 7.4 cP. The experimental results on apparent viscosity of water-based drilling mud from the current study were well within the range of value as shown in Fig. 2.

**(ii) Plastic Viscosity (PV):** Total of 44 data on plastic viscosity of water based drilling fluid mud were collected from the literature, the average value of apparent viscosity was 5 cP and the mean, standard deviation and Cov (%) of drilling muds were 1 cP, 3.3 cP and 81.5% respectively as shown in Fig. 3. The experimental results of plastic viscosity drilling mud were compared

with data from literature in Fig.3. From the current study, PV of drilling fluid mud with 2%, 4% and 6% of bentonite content were 5 cP, 8 cP and 12 cP respectively as shown in Fig. 3.

**(iii) Yield Point (YP):** More than 50 data on yield point of water based drilling fluid mud were collected from the literature. The minimum and maximum values of the data were 0 and 79 lb/100ft<sup>2</sup> and the mean, standard deviation and Cov (%) were 6.6 lb/100ft<sup>2</sup>, 13.7 lb/100ft<sup>2</sup> and 208.7% respectively Fig. 4. The experimental results of yield point of drilling mud were compared with data from literature in Fig.4. The YP of drilling fluid mud with 2%, 4% and 6% of bentonite content were 10, 18 and 35 lb/100ft<sup>2</sup> respectively as shown in Fig. 4.

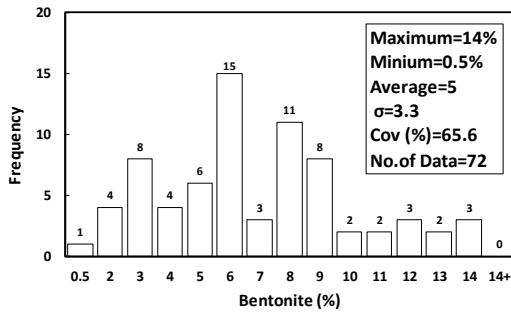


Figure 1. Histogram for Percent of Bentonite Used in Drilling Fluid Mud

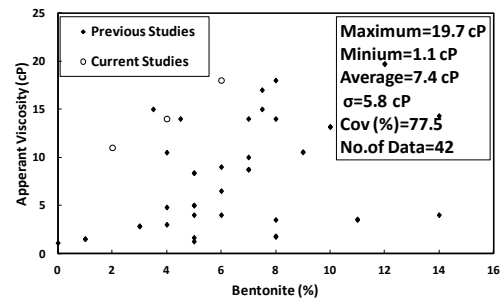


Figure 2. Variation of Apparent Viscosity with Percent of Bentonite in Drilling Fluid Mud

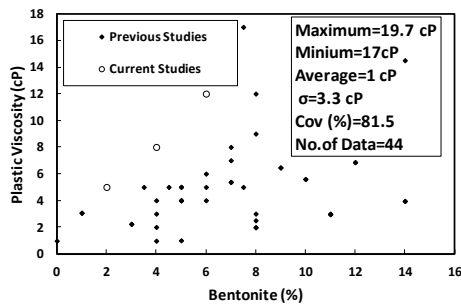


Figure 3. Variation of Plastic Viscosity with Percent of Bentonite in Drilling Fluid Mud

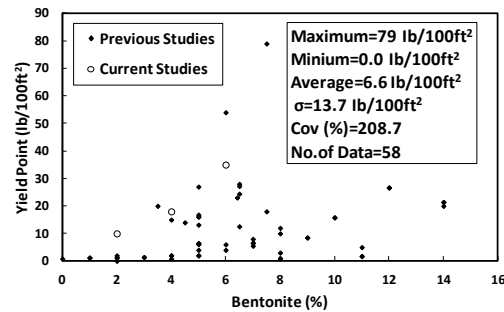


Figure 4. Variation of Yield Point with Percent of Bentonite in Drilling Fluid Mud

**4- Conclusions:** Based on the analyses of over 200 data from the literature following conclusions are advanced:

1. Bentonite used in drilling mud varied up to 14% and the most of the studies used 6% of bentonite.
2. The rheological properties of the bentonite drilling muds varied with bentonite content but also had notable variation within one bentonite content.

**5- Acknowledgements:** This study was supported by the Center for Innovative Grouting Materials and Technology (CIGMAT), University of Houston, Houston, Texas.

**6- References:**

- Besqa, C. Malfoyb, A. Pantetb, P. Monneta, D. Righib (2003). "Physicochemical Characterisation and Flow Properties of Some Bentonite Muds". Applied Clay Science, Vol.23, pp.275– 286.
- Falode, O.A., Ehinola, O.A. and Nebeife P.C. (2008) " Evaluation of Local Bentonitic Clay as Oil Well Drilling Fluids in Nigeria" Applied Clay Science, Vol. 39, pp.19–27.