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LABORATORY RESEARCH ON MODIFIED BENTONITE PT-85 FOR HDD MUD DEVELOPEMENT**

1. INTRODUCTION

Horizontal Directional Drilling is a trenchless method used for installation of pipelines, air-pressured and gravitational ducts as well as cable installation. This drilling method is utilized on terrains with roads, highways, railway tracks, canals, rivers, and highly urbanized areas, where direct pit under the ground is impossible. Trenchless technologies such as HDD have more advantages than the traditional methods. Not only do they shorten time necessary for dig-up, but also the pipelines used during drilling can be placed in any desired position under any territorial barrier. In addition, HDD does not disturb public transportation and most importantly, does not devastate the environment, what makes it the commonly used technology in the construction industry.

Drilling muds that are used for HDD have to possess certain rheological qualities that will facilitate the process. Because of the relatively short distance for cuttings to fall, drilling fluids should have higher yield point and be resistant to structural pressure. Rheological parametres of drillig mud have fundamental meaning for drilling proces. Technical and economic effects highly depend on these properties. Basic factor conditioning proper selection of drilling mud is adjustment of suitable rheological model to a given mud. Particularly it's most important in horizontal drillings – as in HDD technology.

Currently used mud are drawn up from bentonite base that is modified with polymers. These modifications are often made by using the hydrolyzed polyacrylamide.

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Unfortunately, such prepared mud often require an additional chemical adjustment during drilling, what in turn leads to worsening working conditions and drilling complications. The increasing demand in drilling technology calls for new solutions and innovations regarding to drilling fluids. Therefore, the Department of Drilling, Oil and Gas at AGH - University of Science and Technology in Cracow has conducted the research that closely analyses bentonite modification with use of both synthetic and natural polymers. This study has been carried out to complement the HDD procedure and to look at qualities of new kinds of drilling fluids [1].

This paper presents the laboratory research that used OCMA grade bentonite [4] modified with biopolymer PT-11 (described into [1]) and synthetic ampholytic polymer (patented for UST-AGH [2]). So modified OCMA bentonite is marked as PT-85.

In order to determine the rheological properties of researched mud, rheological models was prepared. In this research "Flow-Fluid Coef. v.2.2+" from Drilling, Oil and Gas Faculty UST-AGH was used [3].

Most important parameter of drilling mud is resistance for mono- and multivalent salts contamination, which is a condition of technological parameters stability and effectiveness of mud in changing hole conditions. This as well as lubricity of PT-85 bentonite-based mud was researched too.

2. EXPERIMENT

Preliminary research

In first stage preliminary research was conducted. The aim of the research was to verify the usefulness of PT-85 modified bentonite applied to the HDD technology. Field experience shows that drilling mud should have the following parameters: plastic viscosity of max. 15 cp, the relation of yield point to plastic viscosity as a proportion of YP/PV=1, and the lowest flirtation possible. In addition, we expected the examined drilling fluid to obtain desired technological parameters after 15 minutes of stirring all the components and the parameters to be maintained over time.

The research was done on PT-85 bentonite which was added to water with five different concentrations: 2 - 4% without any other chemical additives. These mud were stirring for 15 minutes and then examined. In order to measure the drilling mud parameters, we used the Chan 35 viscometer and followed the measurements with the American Petroleum Institute [5]. See Figure 1 for results.

The results show that as concentration of PT-85 bentonite is increased, rheological parameters increases as well. The most important for HDD mud is fact that the tested mud reaches stable parameters after 15 minutes of stirring. It means that substantially shorter time is needed for its preparation.

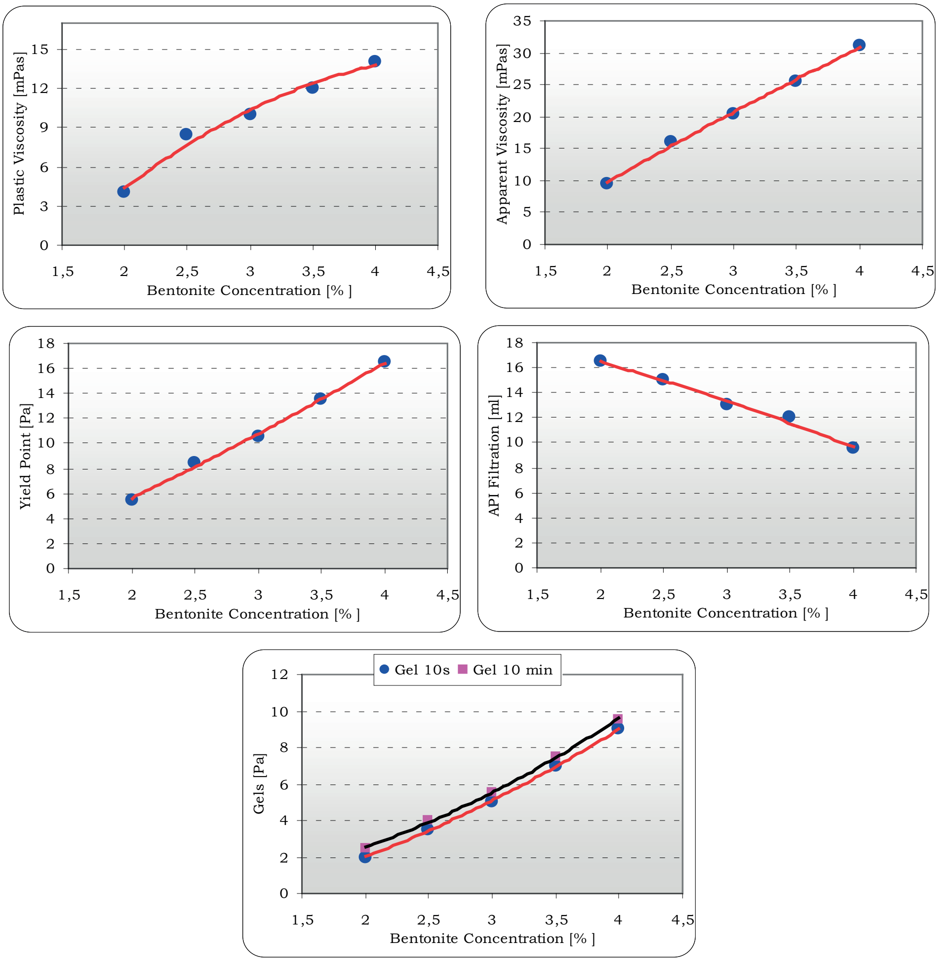
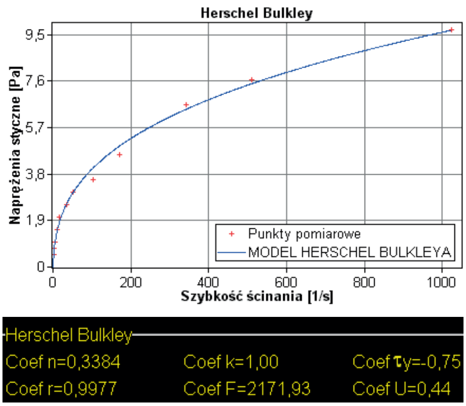


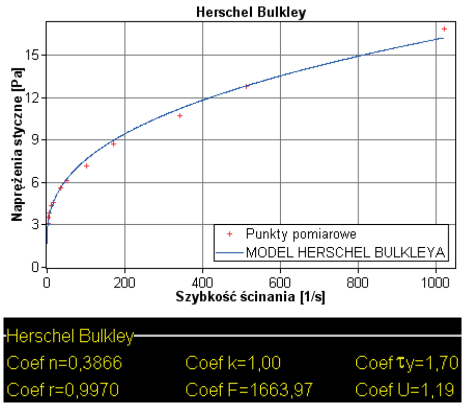
Fig. 1. Preliminary research. Rheological parameters of mud vs PT-85 bentonite concentration

3. RHEOLOGICAL MODEL

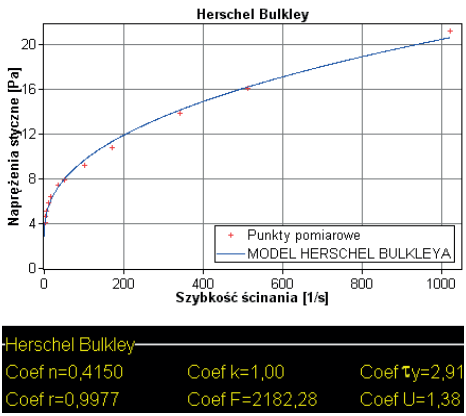
Determination of rheological models for researched mud was conducted with Chan 35 viscosimeter use. Test results were worked out in research “Flow-Fluid Coef. v.2.2+” from Drilling, Oil and Gas Faculty of UST-AGH [3]. This program enables selection of rheological models for tested mud, including technical parameters of viscometer (rotary speeds, configuration of cylinders: rotor-bob and kind of spring). After tests data were loaded, on the ground of statistical coefficients (Pearson’s Linear Correlation Coef., Fischer-Sneadecor Coef., Least Squares Method) the best rheological model was matched. Graphical panel allows presentation of rheological curve that approximates measurements data. See Figure 2 for results.



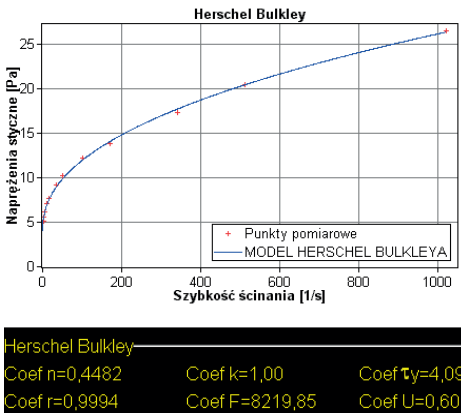
PT-85 concentration: 2 %



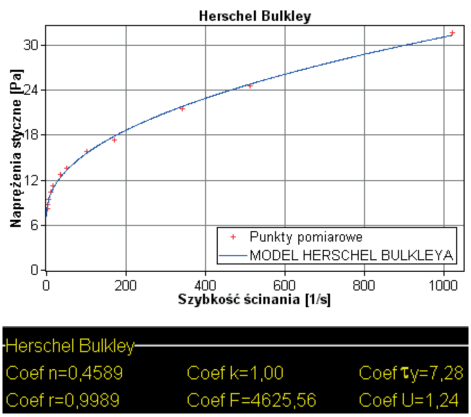
PT-85 concentration: 2,5%



PT-85 concentration: 3%



PT-85 concentration: 3,5%



PT-85 concentration: 4%

Fig. 2. Rheological models for PT-85 bentonite mud

Conducted research shows that Herschel-Bulkley model is the best for PT-85 bentonite mud irrespective of bentonite concentration.

4. SALTS CONTAMINATION

In next stage PT-85 bentonite-based mud resistance for mono- and multivalent salts was researched. In order to succeed with this research of sodium chloride and calcium chloride influence onto PT-85 bentonite was conducted. PT-85 bentonite mud with concentrations 2,5% and 3,5% was used. See Figures 3 and 4 for results.

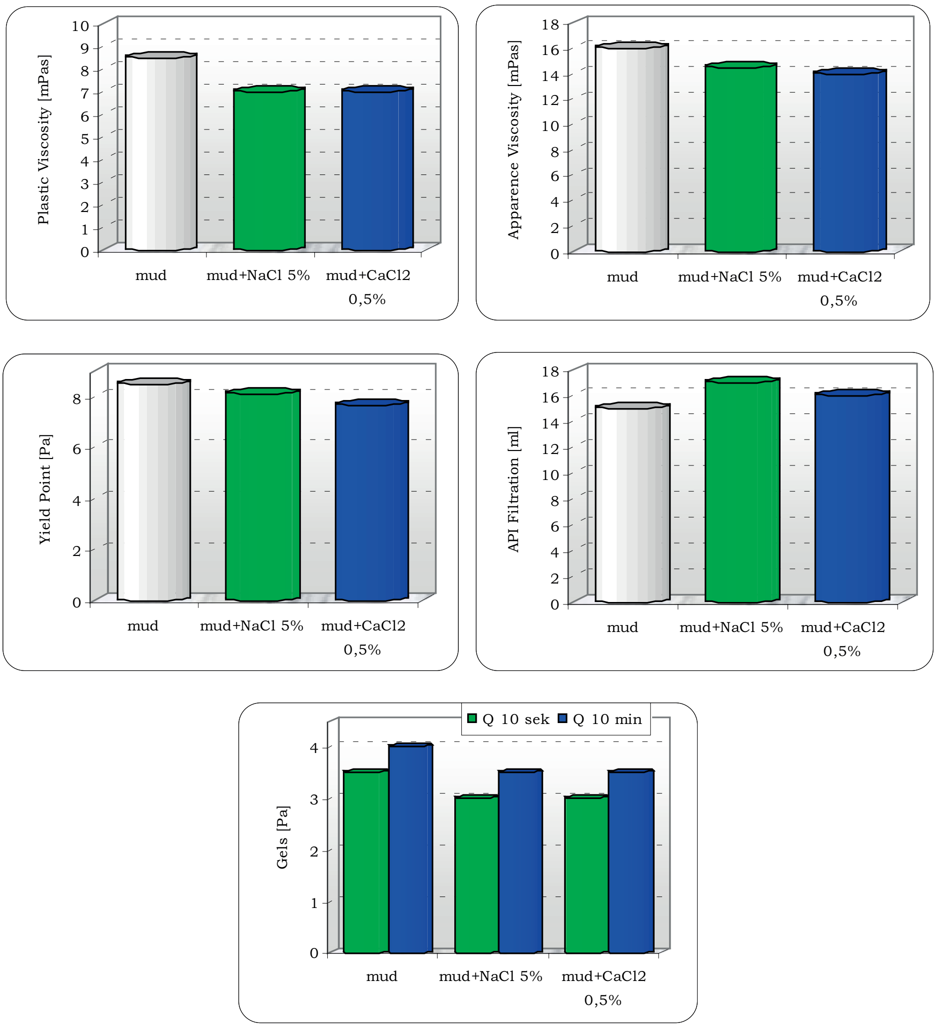


Fig. 3. Resistance of 2,5% PT-85 bentonite mud for salts contamination

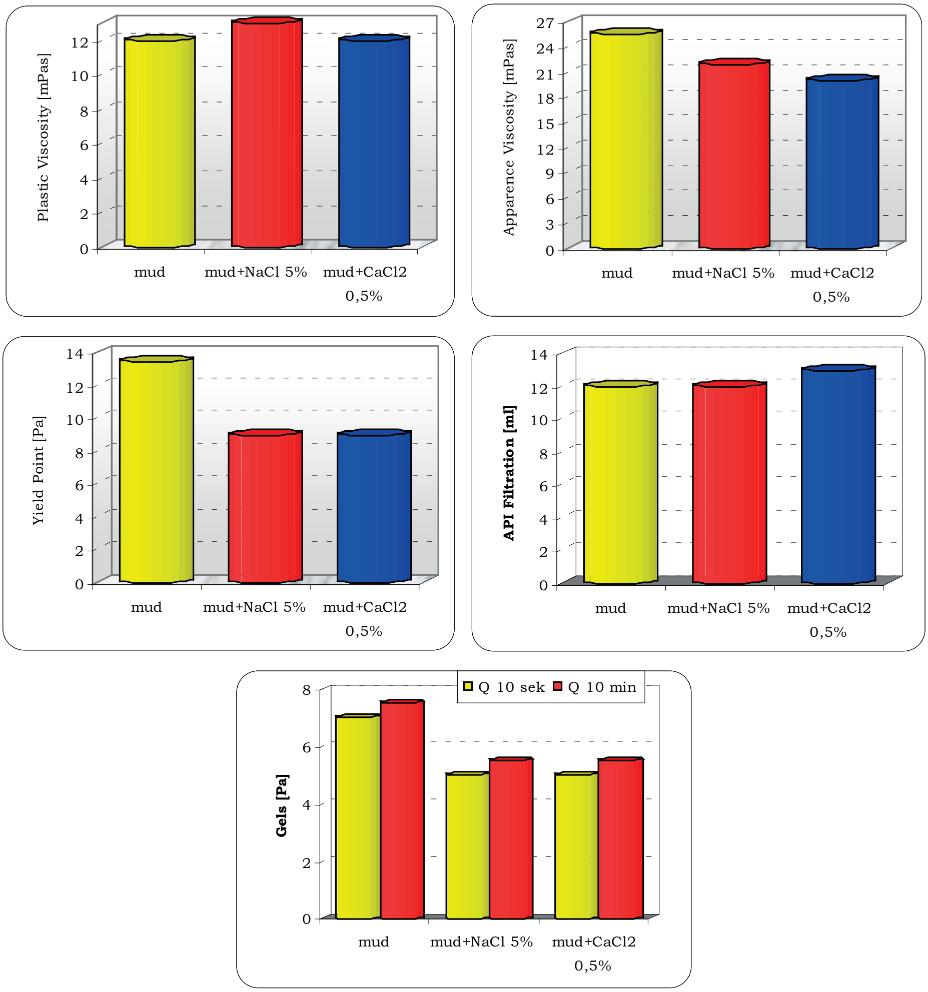


Fig. 4. Resistance of 3,5% PT-85 bentonite mud for salts contamination

As you can see in Figures 3 and 4, technological parameters of PT-85 bentonite-based mud in salts conditions are only slighty lower than in fresh water. The drilling mud that were composed are stable for mono- and multivalent salts contamination.

5. LUBRICITY

In order to determine of lubricity properties of tested mud, lubricity coefficient was researched. In measurements Lubricity Tester was used. Suspensions of PT-85 bentonite with concentrations 2 – 4% was researched. To compare measurements for “Zębiec” bentonite (3% suspension) and fresh water was conducted. See Table 1. for results.

Table 1

Lubricity measurements

	water	PT-85 bentonite mud	Zębiec bentonite 3% suspension
Lubricity coefficent [-]	0,34	0,27 – 0,32	0,44

The results show that lubricity coefficient of PT-85 bentonite-based mud with different bentonite concentrations (2 – 4%) are similar to fresh water and significantly better to "Zębiec" bentonite (3% suspension).

6. CONCLUSIONS

The conducted study showed that the composed PT-85 bentonite-based mud reaches its optimal parameters after 15 minutes of stirring, what plays important role when using HDD technology. The technological parameters of the examined mud barely changed as time went on, what made us believe that this composed drilling fluid can be used for most industrial HDD development. Another important quality is the fact that the researched muds are resistant to mono- and multivalent salts contamination and show good lubricity.

REFERENCES

[1] Boniecki Ł., Dyndor D., Wysocki S., Dubiel S.: *"Clay modyfications with biopolymer PT-11 for HDD muds"*; AGH Drilling, Oil, Gas (im press)

[2] Bielewicz D. i in.: "Środek inhibitujący hydratację skał ilastych oraz płuczka wiertnicza do przewiercania skał ilastych"; patent nr P-360 512, 2008

[3] Wiśniowski R., Skrzypaszek K.: *"Komputerowe wspomaganie wyznaczania modelu reologicznego cieczy – program Flow-Fluid Coef"*; NTTB, 2-3, 2000

[4] American Petroleum Institute Specification 13A (SPEC 13A: Drilling Fluid Materials) 17th Edition, Section 11. OCMA Grade Bentonite; 2006

[5] American Petroleum Institute Specification 13B-1 (RP 13B-1, Field Testing Water-Based Drilling Fluids) 3rd Edition; 2003