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Sławomir Wysocki*, Danuta Bielewicz*, Marta Wysocka, Damian Lewicki**, Joanna Wilaszek****

WEIGHTING OF NEW STARCH-POLYMER SALTED MUD WITH PT-23 POLYMER***

1. INTRODUCTION

Rheological properties of mud should assure high rate of penetration and supply maximal hydraulic power to the hole bottom. From this point of view drilling mud should have as little density and viscosity as possible and also minimal solid phase fraction. By the reason of the hole depth and geological conditions in the region it often occurs that maintenance of low density is impossible and drilling mud have to be treated with weighting materials. The process may cause change of mud rheological parameters and cause decrease of penetration rate. In case of weighted mud there is also a problem consisting in sedimentation of weighting material.

Suitability of chosen weighting material to drilling mud weighting contingents upon its physical and chemical properties: density, degree of fineness, hydrophilic as well as chemical and mineral composition. It also depends on abrasive properties, grain composition and content of residua of reagents used in flotation (e.g. surface-active agents).

Density is one of the main suitability indicators of weighting material, because solid phase fraction in the mud, rheological parameters and rate of penetration depends on it. There are three basic weighting materials groups:

– low density materials (2600 – 2900 kg/m^3) – carbonate materials: limestone, chalk, marl and others; their content in mud may be large, but they can cause significant increase of mud volume, which has big influence on technological parameters and density of weighted mud is lower than 1500 kg/m3

* AGH University of Science and Technology, Krakow, Poland

** AGH UST, Drilling Oil and Gas Faculty, Krakow, Poland – PhD Student

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– medium density materials (3800 – 5000 kg/m^3) – barite, iron ores of 45 – 55% iron content among others; they are basic weighting materials used in drilling fluid technology; they enable weighting mu up to 2300 kg/m^3
– high density materials (over 5000 kg/m^3) – for example iron ores with iron content higher than 55%, lead ores.

Weighting materials should not react with drilling mud components, they also should not dissolve themselves in mud or formation water in a wide range of pH values. Chemical inertness of weighting materials depends mostly on composition and additives content. Water-soluble salts, clayey materials, carbonate rocks and other compounds that have low thermical and chemical resistance are undesirable.

Properties of weighted mud depends also on degree of weighted materials fineness. Materials of low degree of fineness application may cause worsening of stability (sedimentation) and increase of abrasive properties of the mud. Excessive fineness may cause increase of colloidal particle content. It has negative impact on technological parameters and may contribute to silting-up of depositional area in case of mud used for well completion. On the basis of laboratory research and plant tests it was found that the most advantageous size of weighting materials particles are 2-44 μm.

Form of weighting material particles has a large impact on abrasive of weighted mud. Particles of materials that are characterized by the highest abrasivity: magnetite and hematite (fig. 1.), are in forms of rhombic cube and rectangle with sharpened corners and finned surface. Whereas particles of materials which has lower abrasivity, e.g. barite (fig. 2,3) and limestone are rounded.

Fig. 1. Hematite [3]

Fig. 2. Barite [4]

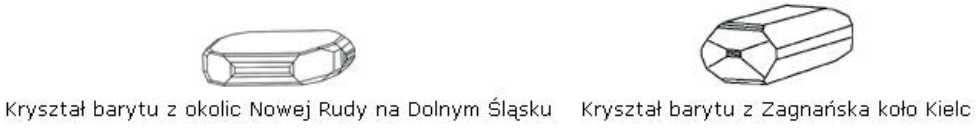

Fig. 3. Barite crystals

To ensure homogeneity and stability of water – dispersed drilling mud, surface of weighting materials should be hydrophilous. Usage of materials of low water-wettable surface can cause worsening mud parameters because of aerations, foaming and floccules formation. Hydrofobization of weighting materials particles surface is caused by chemical agents residua, which are used in flotation or by interaction of agents used in mud treatment (e.g. surface-active agents and lubricity agents).

A particular case of weighted drilling mud are mud used for well completion. They are composed of both weighted materials and bridging agents, these mud are often also salt saturated. In the case of mud used for well completion a large meaning has quality of used materials and their grain composition. Particularly undesirable are additives of clayey materials and indissoluble particles with colloidal size. They can penetrate rock pores and cause irreversible blocking of well-screen adjacent area and limit inflow of reservoir fluid. In extreme cases it may lead to total silting-up of depositional area.

During these project realization there was developed recipe of new mud for well completion with new PT-23 polymer. PT-23 polymer was synthesized in Polymer Technologies in Krakow. This is a synthetic polymer which in the side chains includes anion groups $–SO_3^-$, $-COO^-$ and nonionic amide groups. Their mole ratio is 1:1:1. The next step was testing of possibilities of weighting the mud with different weighting materials: barite with grain size lower than 75 μm, barite with grain size lower than 25 μm, commercial barite, hematite, bridging agent M-25. Barite with grain size lower than 75 μm and barite with grain size lower than 25 μm were conditioned in water, then wet separated into fractions.

2. EXPERIMENTAL PART

The first stage of research work was development of new drilling fluid on the basis of new PT-23 polymer. The mud was to be salt saturated and there should be possibility of weighting it up to 1,6 g/cm3. To reach this there were prepared six mud, which composition is shown in table 1. Next all rheological parameters were tested. All the research were made in accordance with Polish and international standards [6,7].

Table 1

Percentage composition of developed mud

	mud-1	mud-2	mud-3	mud-4	mud-5	mud-6
Skrobia:	2	2	3	2	3	3
PT-23:	0,2	0,05	0,2	0,05	0,05	0,05
XCD:	0,01	0,01	-	0,05	0,2	0,4
K_2CO_3:	2	2	2	2	2	2
NaCl:	30	30	30	30	30	30

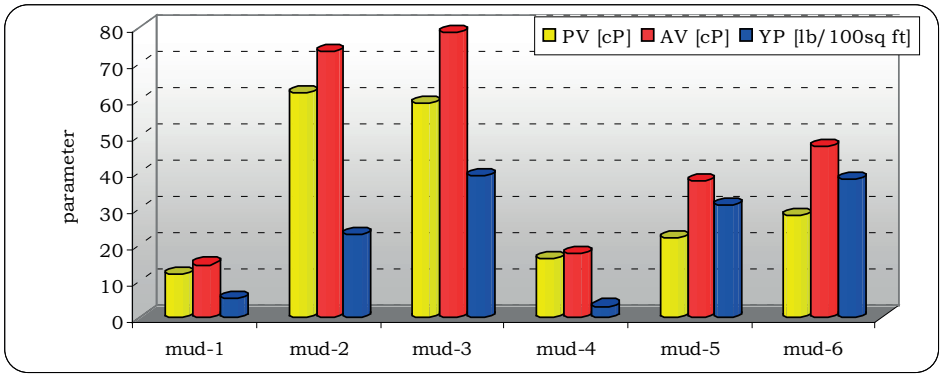

Fig. 4. Rheological parameters of mud with PT-23 polymer

On the basis of laboratory research, mud-6 was chosen to further tests. Its technological parameters are shown in table 2.

Table 2

Composition and technological parameters of mud-6

Mud-6 composition		**Parameter**	
Starch:	3%	Density:	1,19 [g/cm^3]
PT-23:	0,05%	Plastic viscosity:	28 [cP]
XCD:	0,4%	Apparent viscosity:	47 [cP]
K2CO3:	2%	Liquid limit:	38 [lb/100sq ft]
NaCl:	30%	Structural strength 10s/10min:	8/10 [lb/100sq ft]
		API filtration:	7,2 [ml]

The next stage was testing of weighting ability of the selected mud using different weighting materials: barite with grain size lower than 75 µm, barite with grain size lower than 25 µm, commercial barite, hematite, bridging agent M-25. The mud was weighted up to: 1,30; 1,45 and 1,60 g/cm^3. Next step was testing of technological parameters of all weighted mud. Test results are shown in the diagrams (fig. 5-12).

Technological parameters (apart from filtration, which decreases) increases along with density increase for all weighting materials that were used. During weighting mud-6 up to 1600 kg/m^3 there was relatively the least increase of parameters for mud weighted with hematite, the biggest increase was observed for mud weighted with commercial barite. In case of mud weighted up to 1300 kg/m^3 there are only little changes of technological parameters (they are relatively bigger for mud weighted with commercial barite).

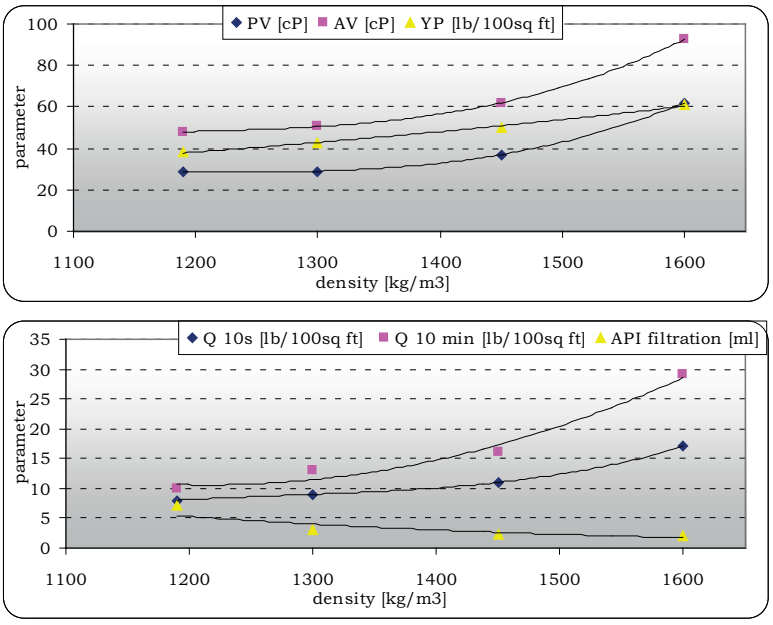

Fig. 5. Technological parameters of mud-6 weighted with barite with grain size lower than 75 μm depending on density

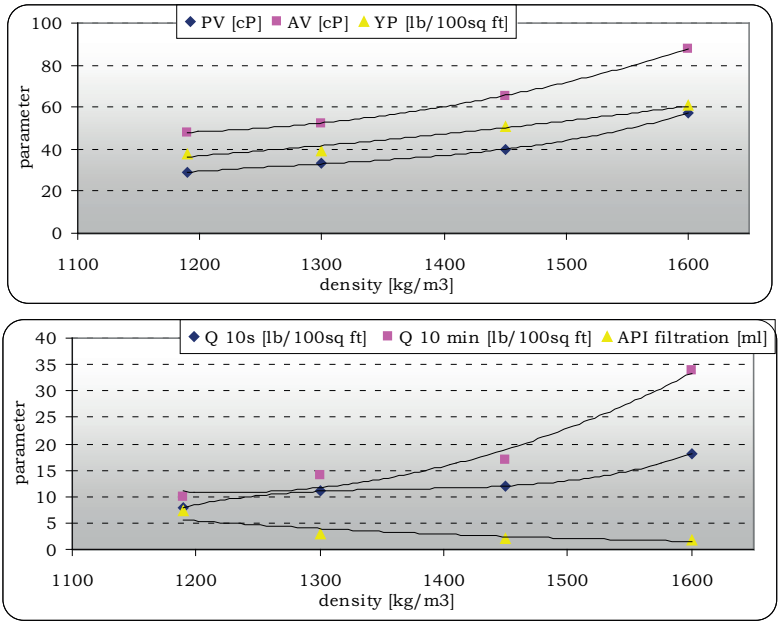

Fig. 6. Technological parameters of mud-6 weighted with barite with grain size lower than 25 μm depending on density

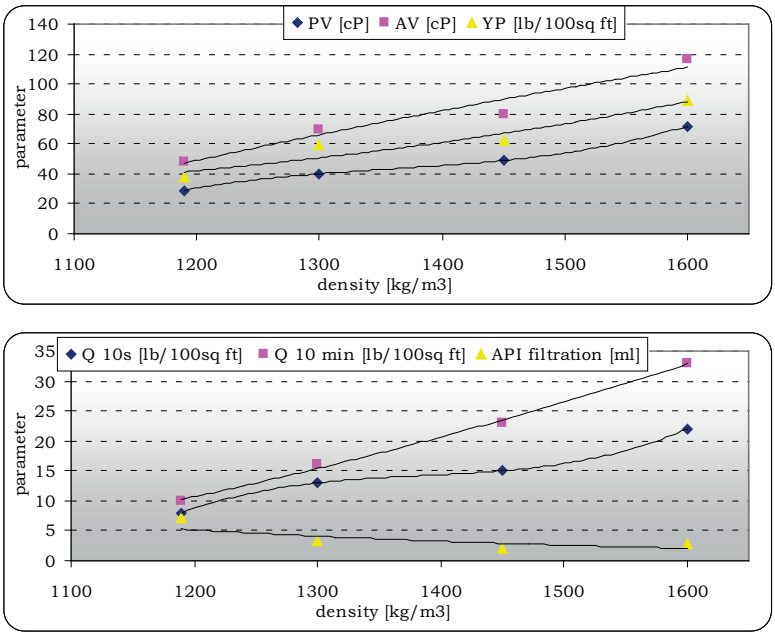

Fig. 7. Technological parameters of mud-6 weighted with commercial barite depending on density

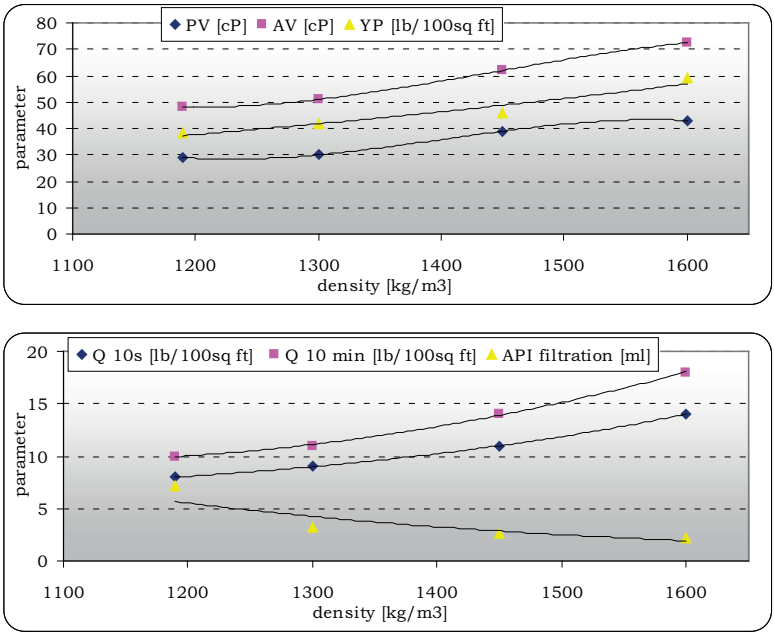

Fig. 8. Technological parameters of mud-6 weighted with hematite depending on density

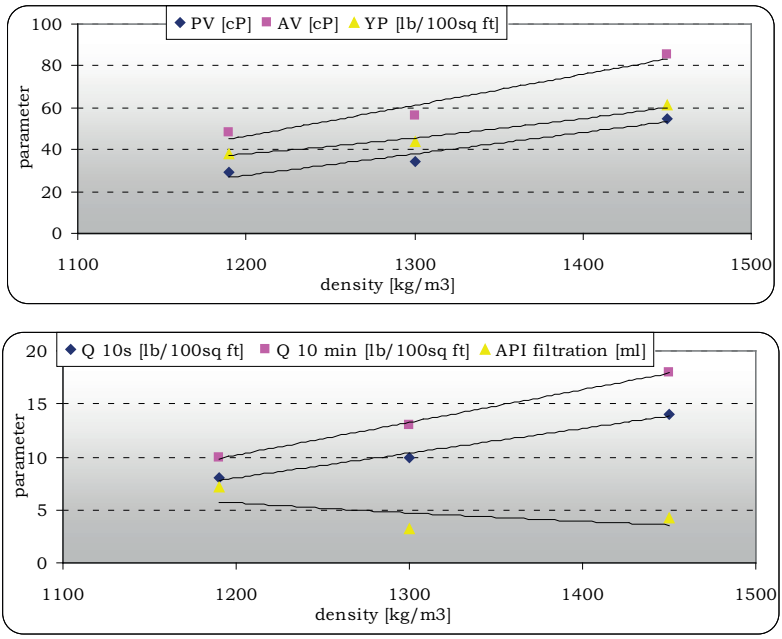

Fig. 9. Technological parameters of mud-6 weighted with carbonate bridging agent M-25 depending on density

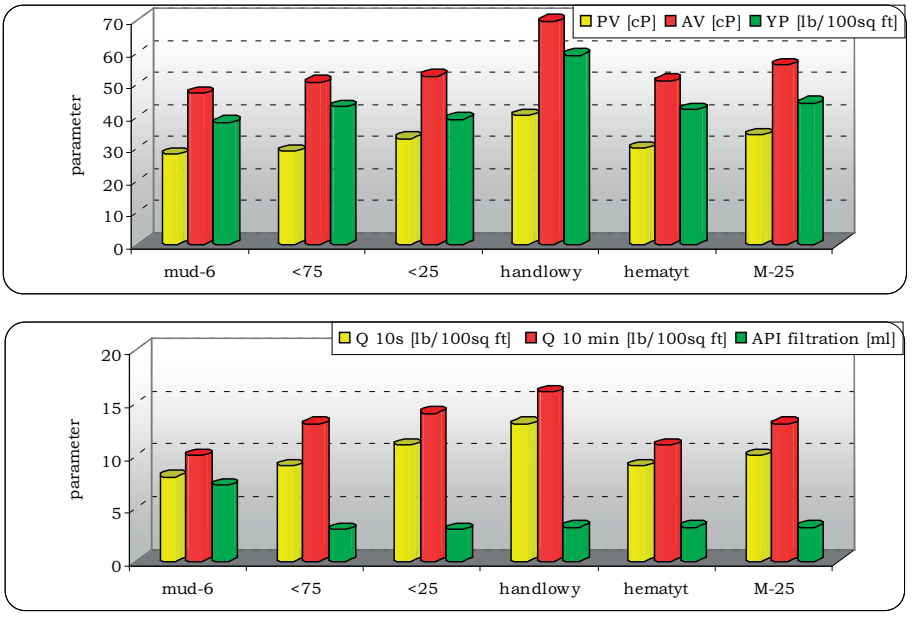

Fig. 10. Technological parameters of mud weighted up to 1300 kg/m^3

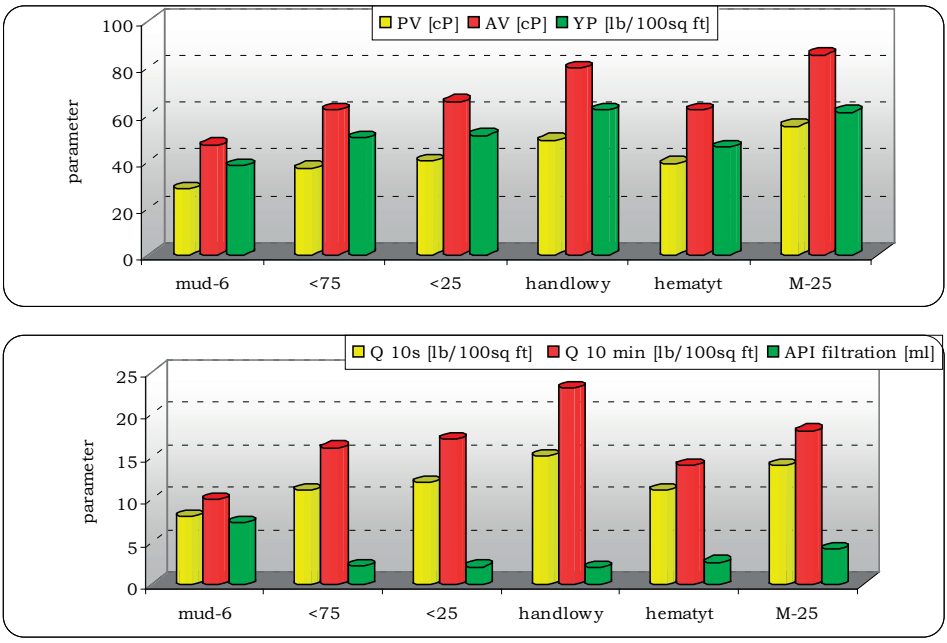

Fig. 11. Technological parameters of mud weighted up to 1450 kg/m^3

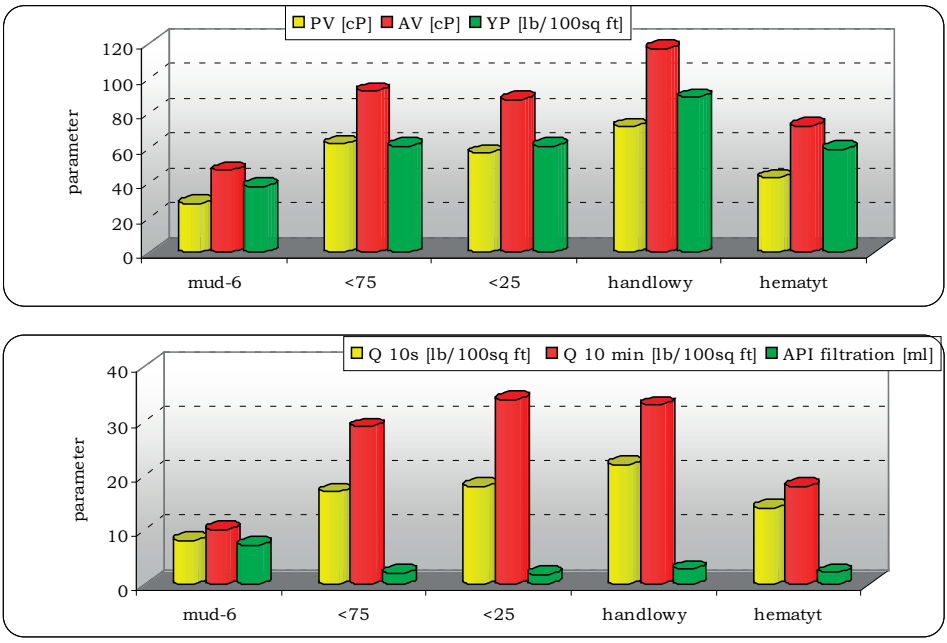

Fig. 12. Technological parameters of mud weighted up to 1600 kg/m^3

3. CONCLUSIONS

During the research work there was developed a recipe of new starch-polymer salt saturated mud, which technological parameters enable its weighting up to 1600 kg/m^3. There were also tested possibilities of weighting it with other weighting materials.

On the basis of research work it was found that the biggest changes of technological parameters are shown by mud weighted with commercial barite. In case of the other weighting materials parameters changes are comparability.

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