

## The research of sapropels as the drilling fluids in dispersed phase (Lake Kirek)

R R Sagitov<sup>1,2</sup> and K M Minaev<sup>1,3</sup>

<sup>1</sup> Department of Well Drilling, Institute of Natural Resources, National Research Tomsk Polytechnic University, 30 Lenin Ave., Tomsk, 634050, Russia

E-mail: <sup>2</sup> sagitov\_r@bk.ru, <sup>3</sup> minaevkm@bk.ru

**Abstract** This research describes the application of Kirek Lake sapropel as a drilling fluid in dispersed phase which could replace traditionally used clay powders in drilling fluids. Sapropel is century-old bed silt of freshwater lakes of more than 12 000 years, i.e. Holocene. It consists of natural organic and inorganic substances and chemically is a complex multicomponent biogenic genesis system. Humic complexes and wulfonic acids, polysaccharides, carbonic and protein polymers comprise sapropel suspension texture. This article introduces formulations and laboratory research of sapropel suspensions and thermal activation.

### 1. Introduction

Oil and gas drilling development has a century and a half history. This was a time of significant changes- automated technological operations and processes and increasing well-bore depths and lengths. Further, drilling flushing fluids have become more complicated and are multicomponent systems, fine dispersed emulsions and suspensions, aerated fluids. Clay powders are applied as gelling agents. High-quality and yield bentonitic powders containing clay mineral montmorillonite of 70% are applied [1]. Hydromicaceous and palygorskite clay powders are used in the cases of drilling intervals of combined or artesian horizons with salt-saturated fluids [2]. Low-quality and yield kaolinic clay powder is used as weighting up in drilling high formation pressure intervals.

Due to drilling complication conditions and resource potential exhaustion more and more investigations are conducted in clay raw materials activation, quality improvement, increasing drilling fluid yield [3]. Platform drilling requires salinity resistant drilling fluids [4]. Clay powders should be substituted due to the absence of high-quality productive deposits, especially, in the Russian Federation. Such a potential substituting material could be sapropel [5]. Sapropels are freshwater bottom sediments(sea / lake) accumulating under anaerobic conditions as a result of physico-chemical and biological decomposition of decayed aquatic vegetation, debris, planktons and oil humus particles. Mineral and organic components of terrigenous discharge influence deposit composition. Another factor in deposit formation is flowage [6].

Near sapropel as dispersed - phase drilling fluid possesses good colloidal properties. Sapropels include all necessary minerals and organic elements, biopolymers and natural surfactants providing high aggregative stability of sapropel suspensions [7].

Both in Russia and abroad sapropel is being investigated. The application domain of various sapropel – products is diverse: fertilizers, sorbents and raw materials for chemical industry, production of forage additives and biostimulants, medical industry. In the Tomsk Oblast the geological resources



(comparable highly mineralized difference) were estimated to be 3,98 billion tons [8]. Tomsk Oblast is situated in quite a favourable climatic zone furthering the formation of large sapropel deposits. However, today sapropels are poorly studied and are used in limited spheres as in the medical industry and as fertilizers. Putting on production unutilized subsurface resources is promising, which, in its turn, predetermines the necessity of overall geological research of sapropel deposits for further licensing and development [8].

One of the most significant estimated deposits situated in Tomsk Oblast is Kirek Lake deposit. The lake area is approximately 0.49 km<sup>2</sup>, length -1.45 km, width – 0.4 km, average depth – 2.7 m, elongating N-E southward. The lake water is alkaline, salt composition includes hydrocarbonates with mineralization of 0.2 g/dm<sup>3</sup>. Sapropel deposit type is calcareous, organic-ferruginous, peaty, thickness of 0.2-8.5 m [8]. Sapropel resources in null contour is 2242.6 ths. m<sup>3</sup>. Kirek Lake sapropel is finely-ground and weakly alkaline medium of pH 7-7.6. The deposits are potential for geological survey and commercial deposits for future development and application.

## 2. Sapropel suspension formulation

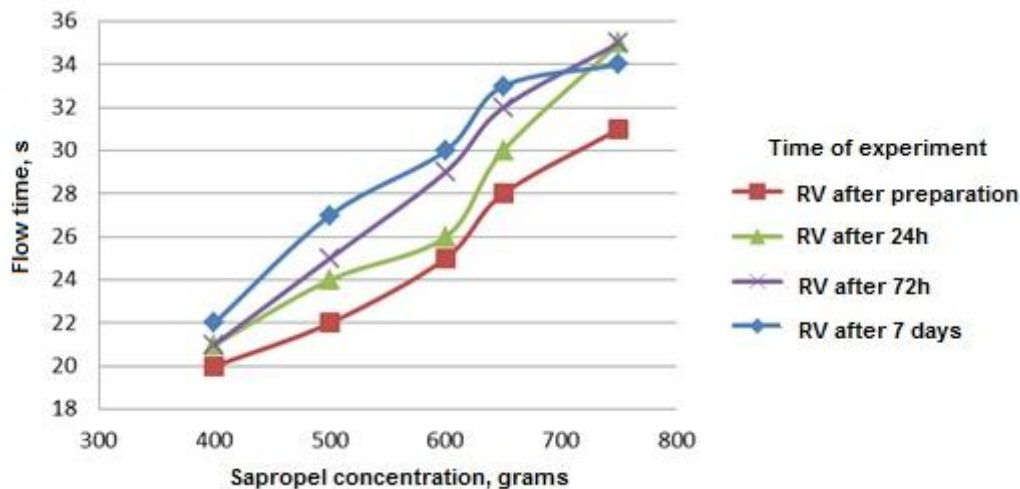
Sapropel suspension based on Kirek Lake raw materials as drilling fluid has not been analyzed. Sapropel formulation has been developed and sapropal, an alternative aqua-gel, as dispersed-phase drilling fluid was analyzed in Wash & Cement Drilling Slurries Lab., Drilling Department, Tomsk Polytechnic University. Preparation technique of sapropel suspensions involves the following: a wet sapropel sample of a particular mass and of various concentrations of sodium hydroxide (NaOH) was placed into 0.6 dm<sup>3</sup> water and mixed at rotation frequency of 10,000 revolutions per minute for 10 minutes. All experiments were based on standard API tests. Rheological properties were determined by a viscometer OFITE 800. Filtration quality properties were determined by filter press OFITE. Density was measured by a beam balance OFITE.

In the first experiment stage different sapropel concentrations were used (table 1). The experiment aim was to determine the optimal sapropel concentrations which would correspond to the industrial applied clay powder, according to TS 39-0147001-105-93 “Clay powder for drilling fluids.” Besides, the chosen formulation should have minimum solid phase content.

**Table 1.** Technological properties of experimental suspensions.

Sapropel concentration g/cm <sup>3</sup>	$\rho$ , g/cm <sup>3</sup>	Relative viscosity, s	Filtration, sm <sup>3</sup> per 30 min	Plastic viscosity, sP	Dynamic shear stress, lb/100ft <sup>2</sup>
400	1.07	20	39.4	13	2
500	1.07	22	38	14	5
600	1.07	25	36	17	6
650	1.08	28	32	18	9
750	1.08	31	28	19	12

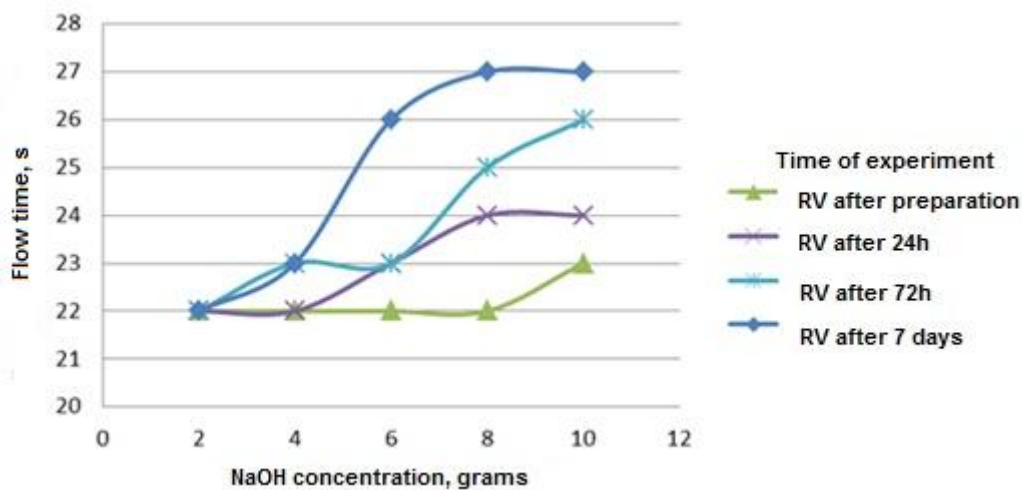
Technological properties of prepared suspensions were measured during the period of 7 days. The maximal alteration is observed for relative viscosity (figure 1). The increase of relative viscosity is due to flocculation of sapropel particles. As a result, effective area of dispersed phase is reduced, negatively affecting drilling fluid quality.



**Figure 1.** Relative viscosity (RV) of suspension with different sapropel concentrations.

To produce high quality drilling fluid from sapropel, the effect of alkali on suspension was examined. Experimental suspension with sapropel concentration of  $500\text{g/dm}^3$  was chosen, sapropel moisture was 64%, respectively, drilling fluid yield was up to  $8\text{m}^3$ , which corresponds to clay powder “PBMG”, according to TS 39-0147001-105-93 “Clay powder for drilling fluids”.

The results of the experiment are represented in figure 2. The alkali concentration increase does not result in relative viscosity increase. Moreover, in alkaline medium organic and inorganic elements interact which promotes drilling fluid quality and its yield.



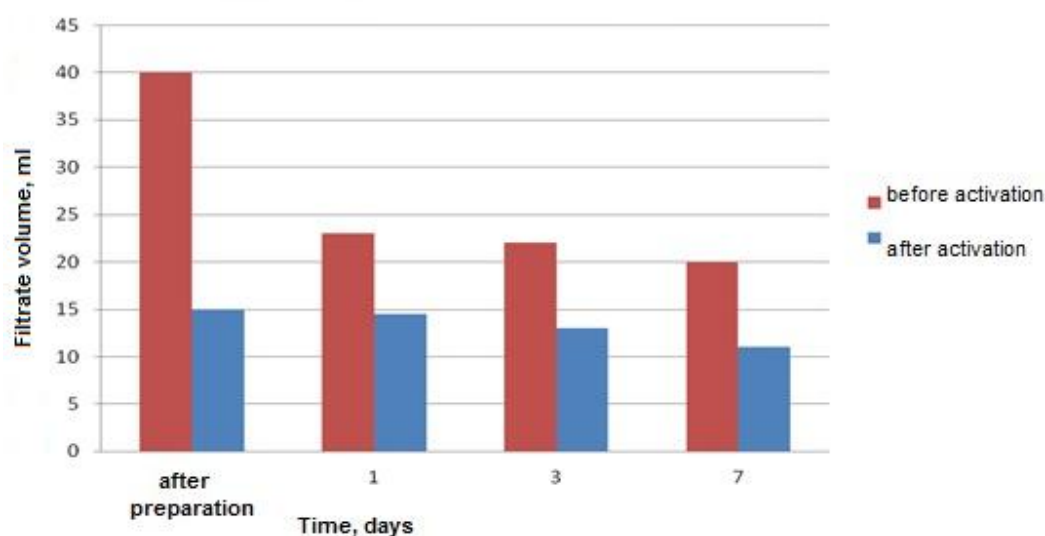
**Figure 2.** Relative viscosity (RV) of suspension with different concentrations of sodium hydroxide (NaOH).

### 3. Thermal activation of sapropel suspension

Produced suspension possess high filtration indexes. To improve the coefficient thermal activation of suspension was carried out (table 2). Suspension with 300g of sapropel, 6g content of NaOH and 600g water was heated to  $90^\circ\text{C}$  and mixed at this temperature for 60 minutes. After the thermal processing the filtration index decreases twofold (figure 3).

**Table 2.** Technological properties of experimental suspensions.

Properties	Before thermal processing	After thermal processing
Relative viscosity, s	22	22
Plastic viscosity, sP	16	17
Dynamic shear stress, lb/100ft <sup>2</sup>	3	1
Filtration, sm <sup>3</sup> per 30 min	40	15
PH	12.5	13.5

**Figure 3.** Filtrate volume after thermal activation.

#### 4. Conclusion

The research showed the potential application of sapropel as dispersed phase drilling fluid. In the future the research of suspensions based on sapropel will be continued, as well as their modification and activation, as well as the development of formulations of drilling fluids based on low-moisture sapropels. It would be necessary to study the features of dispersion structure formation, depending on their dryness, solid phase concentration, chemical additives and other factors.

#### References

- [1] Garrett Rodney L 1987 *Mining Engineering* **11** 1011–15
- [2] Galán E 1996 *Clay Minerals* **4** 443–53
- [3] Sarrafi A and Schaffie M 2015 *Research on Chemical Intermediates* **5** 2823–31
- [4] Uti L O and Joel Ogbonna F 2013 *37th Nigeria Annual International Conference and Exhibition – To Grow Africa's Oil and Gas Production: Required Policy, Funding, Technology, Techniques and Capabilities, NAICE 2013: Proceedings of a meeting held (Victoria Island, Lagos; Nigeria, 30 July – 1 August 2013)* **2** 988–97
- [5] Lishtvan I I, Lozhenitsyna V I, Lerman, A S, Lobov A I and Artamonov V Yu 1989 *Journal of Engineering Physics* **4** 1123–27
- [6] Topachevsky I V 2011 *Geology and Mineral Resources of the World Ocean (Ukraine)* **1** 66–72
- [7] Belyaeva L A 2010 *Management of Natural Resources: Ecology, Economics, Technology. Materials of International Scientific Conference: Proceedings of a meeting held (Minsk, Belarus, 6–8 October 2010)* 26–30
- [8] Kudashev I G 2004 *Sapropel of Tomsk Region: Geology, Genesis, Resources and Prospects of Use: avtoref. dis. ... kandidata geologo-mineralogicheskikh nauk (Tomsk)* p 23