

INVESTIGATION OF THE POSSIBILITY TO UTILIZE SALT CRYSTALS AS BRIDGING AGENTS IN POROUS MEDIA

S.O. Liashenko

LLC "Geosynthesis engineering"

ABSTRACT: Topicality of the utilization of drilling fluids with water-soluble particles as bridging agents are shown. Main difficulties in the preparation of such fluids are revealed. Results of laboratory tests conducted in order to evaluate the possibility of utilization of salt crystals for the colmatation of porous medium are given.

The main objective is set for any drilling fluid during either drilling-in or workover operations is preservation of reservoir properties. Acid- and water-soluble bridging agents are used in common drilling muds for creating an insulating layer on the productive formation.

Acid-soluble agents based on calcium carbonate are among the most commonly used ones. In case of proper selection of the fractional composition, bridging agent particles wedge into pores and create the basis of future filter-cake surface. Previously it was found that, the combination of carbonate bridging agents with resilient organic materials allows the formation of virtually impermeable insulating barrier [1]. This screen can be almost entirely removed after acid treatment. However, in some cases at the bottomhole area there are zones inaccessible to the contact of acid with resilient particles. It leads to deterioration of reservoir permeability.

It is possible to use water soluble bridging whose removal can be performed with the help of well circulation with either process or brackish water [2, 3]. Thereby, there is no need in acid treatment. Utilization of fluids saturated with such bridging agents is a well-known practice, however, it needs a more detailed research regarding its utilization in mining and geological conditions of Ukraine.

Elaboration of a flush fluid recipe with the utilization of salt crystals as a blocker requires giving solutions to the following problems: 1) to choose salt type which would be used as a bridging agent; 2) to choose correct concentration of salt (bridging agent) in suspension in flushing system for creating an impermeable filter-cake; 3) to achieve stable grading of salts particles after thermostating.

The research was held with the utilization of water-based and oil-based systems. As a water-based system clay-less biopolymer system Biocar® was chosen, and as an oil-based fluid invert emulsion Witer-II, elaborated in Petroleum Institute (Krakow, Poland), was chosen [4].

In the conditions of Ukraine, where minimal well depth is 3000 m, it is essential to conduct a research with mandatory sample heating up to not less than 100°C. In order to maintain constant particle size of salt bridging agent in the flushing system, special conditions such as

minimal increase of salt solubility with increasing of temperature is needed. Sodium chloride meets the above requirement which was used as a basis of a bridging material (Fig. 1). Sodium chloride availability and its low cost is an important factor.

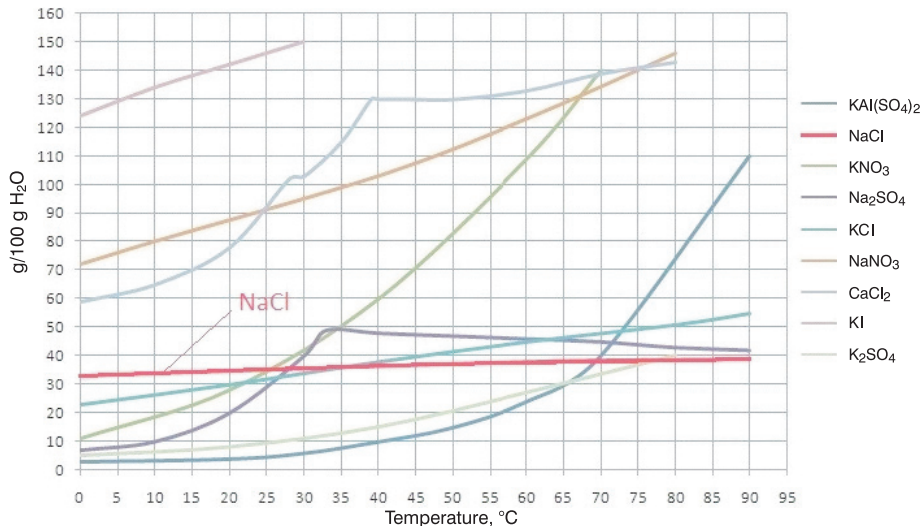


Fig. 1. Dependence of salt solubility on temperature

Ground salt crystals whose size do not exceed 200 μm, were added to the clay-less biopolymer system Biocar®, previously mineralized by sodium chloride until the limit of solubility (Fig. 2). The amount of bridging agent was determined to give minimal filtration index through non-cemented sand filter of a particular grade [1].

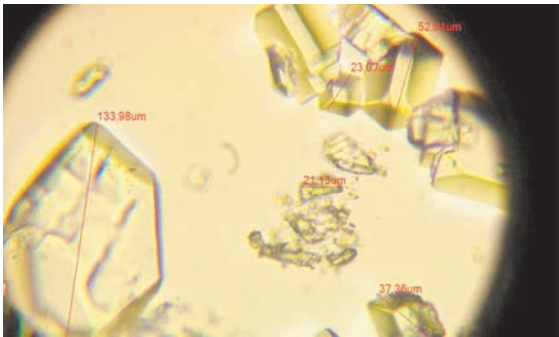
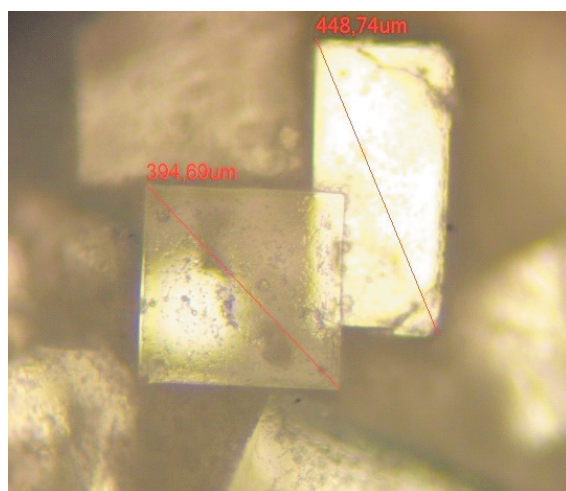


Fig. 2. Photo of saturated salt crystals in a mineralized brine (400× zoom)

It was experimentally proven that adding 15% of saturated salt to the system leads to zero filtration. However, after fluid samples were heated with subsequent cooling, deterioration of bridging properties was registered alongside with almost doubling of the salt crystals size (Fig. 3). This effect was partly avoided by the utilization of special water repellent agents in order to avoid further growth of salt crystals. Organic-mineral agent Alevron® was also added for consolidation of the salt filter cake (Tab. 1).

Table 1. Result of the utilization of salt as bridging agent in clay-less biopolymer system Biocar®

Fluid composition	Filtration loss through the sand filter [cm ³ /30 min]	Filtration loss through the sand filter (after heating under 120°C) [cm ³ /30 min]
Biocar® without bridging agents	immeasurable	immeasurable
Biocar® with a complex of organic and carbonated fillers	0	0
Biocar® + 15% salt bridging agent	0	84
Biocar® + 15% salt bridging agent + + 2% water repellent agents	0	25
Biocar® + 15% salt bridging agent + 2% water repellent agents + + 1% Alevron®	0	5

**Fig. 3.** Photo of sized salt crystals in the clay-less biopolymer system Biocar® after thermal regulation and subsequent cooling (100× zoom)

It is possible to conclude that the utilization of salt as a bridging agent in a biopolymer fluid can be possible with the utilization in a system of agents that prevent the increase of salt crystals in size after temperature and making filter cake harder. Among the disadvantages of the utilization of salt in the water-based flush system is rather high minimum density of the mud that is the result of full sodium chlorine mineralization up to 1.20 g/cm³.

Utilization of salt blocker in oil-based fluids has shown better results. Ground sodium chloride was added in the different amount to the invert emulsion fluid. Received samples were sequentially subjected to thermostating during 8 hours under certain temperatures. The samples were subsequently cooled. Basic parameters and salt particle sizes in a system were measured with the help of a microscope.

Received recipe, having 20÷25% of saturated salt in its composition, showed zero filtration through the sand filter even after a series of heating up to 170°C (Fig. 4).

Results of the research have shown that bridging properties do not change after thermostating (Tab. 2), and electro stability index ranges within appropriate limit (> 200 V). Photos of fluid samples with ×100 zooming allowed to see that sizes of particles in a system remained unchanged (Fig. 5). Thereby, it can be concluded that saturated salt can be used in invert emulsion fluids for a wide temperature diapason without alternations in its fraction composition.



Fig. 4. Photo of salt crystals in inert emulsion fluid Witer II after thermostating (100× zoom)

Table 2. Results of testing of invert emulsion fluids with the addition of salt as a bridging agent after consecutive heating with (8 hours each)

Fluid composition/ Temperature of thermostating	ρ [g/cm ³]	T [s]	FI [cm ³ / 30 min]	Gel [dPa]	PV [cP]	YP [dPa]	ES [V]	Fluid loss through sand filter [cm ³ /30 min]
Witer II	0.97	10	2.5	19/19	17	67	1260	immeasurable
Witer II + 25% salt colmatant	1.10	11	3	29/29	26	62	484	0
After 85°C	1.10	15	4	34/34	34	53	525	0
After 120°C	1.10	15	4.5	40/40	33	86	605	0
After 150°C	1.10	15	5	44/44	30	91	570	0
After 170°C	1.10	25	6	77/77	33	168	456	0

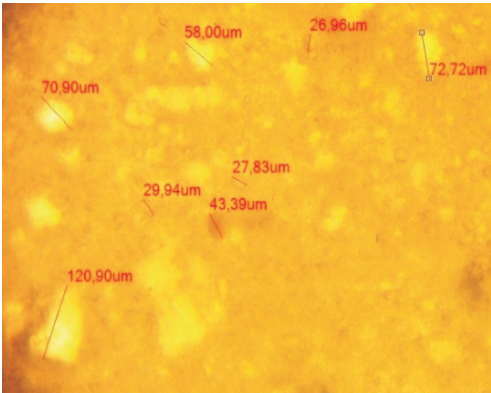


Fig. 5. Filter cake after filtration cake testing through the sand filter under 0.7 mPa of pressure fluctuation. Lower part of sand filter is dry

Test results have shown that utilization of salt as a bridging agent in a clay-less biopolymer fluid is possible in combination with special water repelling agents that shall prevent the increase in the size of salt crystals, as well as agents for filter cake tightening. Achieved recipe of invert emulsion fluid, containing 20÷25% of saturated salt, demonstrated zero filtration indexes, even after many cycles of heating. The research confirmed the possibility of the utilization of water-soluble salt as blockers, and will be conducted further.

Literatura

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tytuł rosyjski?

СОДЕРЖАНИЕ: Показана актуальность применения промывочных жидкостей, имеющих в качестве регентов-кольматантов водорастворимые вещества. Рассмотрены основные сложности при получении таких жидкостей. Предоставлены результаты лабораторных исследований, направленных на изучение возможности применения кристаллов соли для кольматации пористых сред.

Recenzent:

dr inż. Małgorzata Uliasz

