UDC622.276.344

***Nalyvaiko O.I.**, PhD, Associate Professor*
ORCID 0000-0001-5513-9868 Nalivayko.60@ukr.net
***Melnikov O.L.**, senior lecturer*
ORCID 0000-0002-2569-1827 melnikovpntu@gmail.com
***Nalyvaiko L.G.**, senior lecturer*
ORCID 0000-0002-8782-2394 Nalivayko.60@ukr.net
***Petrash R.V.**, PhD, Associate Professor*
ORCID 0000-0002-5812-4044 Petrash.R@ukr.net
***Khivrenko V.N.**, senior lecturer*
Poltava National Technical Yuri Kondratyuk University

APPLICATION OF HYDROPHOBIC CEMENT SLURRIES «RAN-M» OF «RAMSINKS-2M» GROUP TO AVOID FLUID KICK

Laboratory studies of cement slurry and cement stone is established that hydrophobic cement slurry «RAN-M» consists of NTPha additives for well cements PTC-1-100 and «Ramsinks-2M». In the laboratory confirmed the technical parameters of the newest hydrophobic cement slurries (mobility, density, separation, pumpability, etc.) according to the standard requirements in the respective devices. Done such works as: implementation of the selection of formulations of cement slurries with different rate of strength development for different temperature integrals.

***Keywords**: permeability, well, technical condition, cement, Water-repellent, behand column overflows.*

***Наливайко О.І.**, к.т.н. доцент*
***Мельніков О.Л.**, ст. викладач*
***Наливайко Л.Г.**, ст. викладач*
***Петраш Р.В.**, к.т.н., доцент*
***Хівренко В.М.**, ст. викладач*
ПолтавськийнаціональнийтехнічнийуніверситетіменіЮрія Кондратюка

ЗАСТОСУВАННЯ ТАМПОНАЖНИХ ГІДРОФОБНИХ РОЗЧИНІВ «RAN-M» ГРУПИ «RAMSINKS-2M» ДЛЯ УНИКНЕННЯ ФЛЮЇДОПРОЯВІВ

Лабораторними дослідженнями тампонажного розчину і цементного каменю встановлено, що тампонажний гідрофобний розчин «RAN-M» складається з добавки НТФк до тампонажного цементу ПЦТ-1-100 і «Ramsinks-2M». У лабораторних умовах підтверджено технічні параметри новітніх гідрофобних тампонажних розчинів (рухливість, густина, водовідділення, прокачуваність тощо) згідно зі стандартними вимогами на відповідних приладах.Виконано таку роботу, як здійснення підбору рецептур тампонажних розчинів з диференційованим темпом набору міцності для різних температурних інтегралів.

***Ключові слова**: проникність, свердловина, технічний стан, гідрофобізатор, міжколонні перетоки.*

Introduction. The urgency of the creation of newest cement slurries is due to the need to improve the quality of isolation of the formation at different stages of the completion and operation of wells. With the growth of the depths of oil and gas wells, reservoir temperatures and pressure are increased, resulting in complicated work on the separation of layers in the wells.

An analysis of the industrial statistical material on gas, oil and water inflow in the fields of the Dnipro-Donetsk depression (DDd) in the course of the completion and operation of wells shows that at the fields from 10% to 50% of oil and up to 60% of gas wells have interplanetary flows and in the connection to this well is partially or completely ineffective for efficient operation.

Cementing of wells, especially deep ones, is the most crucial phase of their construction. The value of cementing works is due to the fact that they are the final process, and failures in their execution can minimize the success of the previous work up to the loss of the well, so to improve the quality of wells construction, and especially at the final stage of work – well casing. One of the main causes of these phenomena is poor-quality boreholes, in particular in the zone of production formation.

An overview of the latest sources of research and publications. Scientists from Russia, Ukraine, the USA, England and other countries, whose names are known in oil companies around the world, made a significant contribution to the development of modern ideas about cementation in general and its various aspects [1]. Domestic scientists and engineers are more familiar with famous works of scientists working in this field in Russia, Ukraine and Azerbarijan. A significant contribution to the development of such issues as accident prevention, fastening, cementing, cement slurries were made by V.F. Abubakirov, M.O. Ashrafyan, V.S. Bakshutov, A.I. Bulatov, Yu.M. Basarigin, V.P. Detkov, Ya.S. Rybchicha, M.A. Myslyuk, Ya.S. Kotskulich, Ye.M. Solovyov, V.M. Svetlitsky and others [2].

Analysis of literary sources and production and construction data indicates that the success of cementing wells is determined by the technique and technology of the processes of cementing, the quality of preparatory work, the cement material and the completeness of replacement of the mud with cement slurry [3].

Selection of previously unsolved parts of the general problem. The analysis of special literary sources and production and construction data shows that the materials used today for the separation of layers do not always correspond to reservoir conditions of deep wells and do not provide reliable sealing of the cement ring [4]. The success of cementing wells is determined by the technique and technology of the processes of cementing, the quality of preparatory work, the cement material and the completeness of replacement of the mud with cement slurry [5].

Existing cement slurries (for example, PTC 1-100) according to their physical, mechanical and physical and chemical properties do not fully meet the requirements of the quality of cementation of operation wells [6]. With prolonged storage, especially in the autumn-winter period, the properties of the portland cement deteriorate: the cement breaks down, the timing of seizing the cement slurry is extended, the viscosity is increased, the mechanical strength of the cement stone is decreased. Prolonged storage in wet conditions sometimes leads to the conversion of all cement, which is in a normal paper bag, into a stone-like body [7].

The purpose of this work is to create the latest hydrophobic cement slurries with a differentiated rate of strength to prevent fluid kick in the waiting on cement (WOC) in the temperature range from 0° C to 180° C, which will ensure a high quality of isolation of formations during the operation of wells.

Main material and results. Experimental and industrial testing of cement slurries with the addition of NTKa was carried out in relation to verification of the method of introducing a reagent into astringent, identifying the optimal amounts of the reagent, rational technology of

preparation and application of cement slurry with the addition of NTKa, as well as identifying the possibility of transition to industrial use of cement slurries with the additive NTFK. The works were carried out in three programs: for bottom hole temperatures 50-65 °C; 75-90 °C and 100-130 °C.

The method of selection of correlations proposed by the authors of the latest cement slurries, consisting of cement PTC 1-100 and hydrophobic material «Ramsinks-2M» is developed. The ratio of PTC 1-100 cement and hydrophobic material «Ramsinks-2M» in laboratory conditions was 1: 0.001; 1: 0.002; 1: 0.003; 1: 0.005; 1: 0.008.

The use of PTC cement 1-100 is widely known. In more detail, we will consider the hydrophobic material «Ramsinks-2M».

The problem of steady stream flows today exists both in the wells of OJSC Ukrnafta and in the wells of the UkrhazvydobuvannyaSC, NJSCNaftogaz Ukraine.

The latest cement slurries will allow the use of such cement mixtures for the cementing of oil and gas wells in the zones of ANPT, which meets the criterion of industrial use.

Technological properties of the proposed materials are following:

– NTKa is nitrile trimethyl phosphonic acid which is a white crystalline powder, well soluble in water at any temperature, as well as in acids and alkalis. It is widely used in cementing wells for the purpose of regulating the tensile strength of cement slurries;

– «Ramsinks-2M» is a hydrophobic additive (water repellent), a complex silicone hydrophobic compound. The application of this additive in the manufacture of cement mixture «RAN-M» (hydrophobic additive «Ramsinks-2M» + cement PTC-1-100 + NTKa) increases the elasticity of the mixture, prevents the uneven concentration of fillers, as well as prevents the bundle of the mixture and increases the resistance to impact aggressive factors and increases their longevity. The high water resistance of the products with the additive is achieved with the appropriate composition of the cement mixture «RAN-M» by a thin decomposition of hydrophobic particles in the mixer SMN-20.

Test conditions:

– air temperature in the room 20 °C;

– atmospheric pressure 742 mmof mercury column

– humidity 78%;

– pressure in the autoclave installation A-2.00.000.IE 450 atm .;

– temperature in the autoclave installation A-2.00.000.IE 75 ° C.

The main indicators of the quality and effective use of the additive «Ramsinks-2M» are: hydrophobic effect (degree); water absorption of cements and slurries; strength; waterproof; plasticity, etc.

The autoclave unit A-2.00.000.IE in the complex with a special device for the installation of metal forms with samples, whose function is to prevent the destruction of samples, was used to form a cement stone from the cement mixture «RAN-M».

To determine the coefficient of open porosity, the Preobrazhensky method was used - the method of weighing samples after full saturation of pores with a liquid, chemically neutral with cement generating minerals. Experimental studies were conducted using kerosene. For this purpose, in a specially made metal forms, cylindrical samples of a cement mixture «RAN-M» 39.5 ~ 1.0 mm in length and 26 ~ 1.0 mm in diameter were formed for this purpose in the autoclave installation.

The method of determining the coefficient of open porosity is indicated in the following:

– preparation of samples formed in autoclave;

– blowing samples with air;

– drying of samples to constant mass in a drying cabinet at a temperature of 30-40 °C;

– weighing of dried samples in the air;

– saturation with samples of kerosene using a vacuum system;
– weighing of samples saturated with kerosene in the air;
– weighing of kerosene-saturated samples;
– determination of the coefficient of open porosity;
– processing of research results.

Selection of optimal ratios of PTC 1-100 and hydrophobic material «Ramsinks-2M» provides the required density of the cement slurry, the rate of strength at high operational parameters of the stone.

According to the authors, hydrophobic cement slurry due to the mechanical interaction of the hydrophobic material «Ramsinks-2M» with the structure of the cement PTC 1-100 will significantly improve the physical and mechanical and physical and chemical properties of standard cement slurry, which will ultimately lead to a significant improvement in the isolation of the productive formation on stages of completion of wells and their operation.

The determination of the hydrophobic effect was carried out by a laboratory test on the degree of hydrophobicity of the cement PTC 1-100 with the addition of «Ramsinks-2M» a sample of 200 grams of cement was taken, which was filled with water to obtain a normal density of the cement paste, leaving it at rest and marking the time absorption of water by cement.

The data obtained when tested with different values of «Ramsinks-2» as a percentage of cement weight (0.2, 0.25, 0.3%) are given in Table 1 below.

Table 1 – Effect of the amount of hydrophobic additive on the property of cement

Brand and type of cement	Mass of cement sample	Name of additive	Additive ratio (% of the mass of cement)	NDCP-normal densityof c/paste, ml	Degree of cement hydro-phobicity, min
PTC 1-100	200 g			95 ml	8
PTC 1-100	200 g	«Ramsinks-2M»	0,02	95 ml	11
PTC 1-100	200 g	«Ramsinks-2M»	0,025	95 ml	14
PTC 1-100	200 g	«Ramsinks-2M»	0,03	95 ml	17

According to the results of the laboratory test of the degree of hydrophobicity of the cement PTC 1-100 with hydrophobic additive «Ramsinks-2M» it was established that the degree of hydrophobicity of cement depends on the amount of additive «Ramsinks-2M» in percent (%) to the mass of cement.

The cement mixture «RAN-M» is used directly when performing cement works in the well. When mixing, an even-fitting cement slurry is formed.

In laboratory conditions, the following works were performed: the selection of formulations of cement slurrywith a differentiated rate of strength set for different temperature integrals. It is necessary to study their technological properties; study of the physical and mechanical properties of the cement stone in the temperature range from 20 to 80 °C. It is necessary to study the properties in the temperature range of 80-180 ° C; study of thermal stability of cement mixtures at temperatures up to 80 °C. It is necessary to continue the study of thermal stability at temperatures up to 180 °C.

The scheme of the selection of recipes with the necessary parameters and study of the physical and mechanical properties of the cement stone is standard and performed at temperatures of 70 °C, 100 °C, 130 °C, 160 °C and the corresponding pressures by aligning the ratio of PTC cement 1-100 and the hydrophobic material «Ramsinks -2M» for these conditions. Samples are stored in hydro-bacterial conditions for 1, 7 and 28 days.

Table 2 – Results of determination of absolute gas permeability on samples of cement stone from PTC-1-100 and hydrophobic additive «Ramsinks-2M»

№ of laboratory sample	Recipe of the sample	Gas permeability, a $\times 10^{-15}$ м^2
40443	Cement stone with PTC-1-100	0,15
40444	Cement stone with PTC -1-100, 0,2% additive «Ramsinks-2M»	0,15
40445	Cement stone with PTC -1-100, 0,25% additive «Ramsinks-2M»	0,10
40446	Cement stone with PTC -1-100, 0,3% additive «Ramsinks-2M»	0,05
40447	Cement stone with PTC -1-100, 0,35% additive «Ramsinks-2M»	0,04
40448	Cement stone with PTC -1-100, 0,4% additive «Ramsinks-2M»	0,04

In the laboratory, i have been conducting researches on the determination of absolute gas permeability according to samples of cement stone from PTC-1-100 and hydrophobic additive «Ramsinks-2M». The tests are performed according to GOST 26450.0-85 – GOST 26450.2-85.

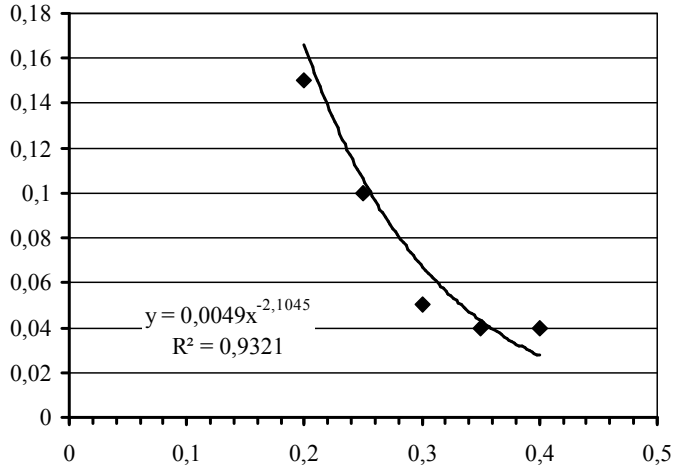

Figure 1 – Determination of absolute gas permeability by samples

This function proves that the gas permeability decreases with the application of different compositions of hydrophobic additives, but the best performance is achieved with a 0.3% additive of «Ramsinks-2M» in PTC-1-100 cement. A further increase in the percentage of quantity leads to a deterioration in the results.

The scientific novelty of the obtained results is that, due to the conducted research:

– the proposed technical solution in comparison with the existing ones will allow to get hydrophobic cement slurries with lower ranges of density of the cement slurry, high stability, good pumpability and high strength of hardened stone, guarantees the reliability of isolation of productive formation;

– to ensure the high quality of the separation of water and gas layers by improving the technology of cementing the operational wells in the «Ukrburgaz», the selection of hydrophobic cement slurries that best meet the mining and geological conditions of the wells of the Starosambirskfield;

– in particular, it is suggested to take hydrophobic materials from the group «RAN-M» to study.

Conclusion. After carrying out laboratory tests on the development of improved cement slurry for increasing their strength, according to the results of examinations of samples installed:

– cement = composition A - the best result with the admixture of NTFa to the cement of USCS 120 at B/C = 0,5 was equal to 5.4 MPa;

– oil-well cement = composition B – cement PTC-1-100 + 0,006 NTFa + 0,25% «Ramsinks-2M» (at B/C = 0,33) = 9,4 MPa;

– oil-well cement = composition C – cement USC 120 + 1.5% Stinol + 0.2% «Ramsinks-2M» + 0.3% foam gun Defoam (at B/C = 0.33) = 12.93 MPa.

The obtained results show that we have developed two newest compositions of oil-well cement B and V.

The use of «RAN-M» hydrophobic cement slurry will significantly improve the properties of cement materials, which in general should lead to the avoidance of overflow and make it possible to significantly reduce the migration of formation fluids.

References

1. *Селиханович А. П. Эффективность применения тампонажных растворов с добавкой НТФ / А. П. Селиханович, Р. И. Иимаков. – М. : РНТС Бурение, 1982. – С. 30 – 31.*
   Selihanovich A. P. Effektivnost primeneniya tamponazhnyih rastvorov s dobavkoy NTF / A. P. Selihanovich, R. I. Iimakov. – M. : RNTS Burenie, 1982. – S. 30 – 31.
2. *Наливайко А. И. Методы увеличения нефтеотдачи пластов и производительности скважин в условиях нефтяных месторождений / А. И. Наливайко, М. И. Рудый, Ю. А. Полевой // Вісник Дніпропетровського університету. Серія: Механіка. – Дн-к, 2005. – №12. – С. 15 – 21.*
   Nalivayko A. I. Metodyi uvelicheniya nefteotdachi plastov i proizvoditelnosti skvazhin v usloviyah neftyanyih mestorozhdeniy / A. I. Nalivayko, M. I. Rudyiy, Yu. A. Polevoy // Visnik Dnipropetrovskogo universitetu. Seriya: Mehanika. – Dn-k, 2005. – № 12. – S. 15 – 21.
3. *Наливайко О. І. Шляхи підвищення водонепроникності бетонів і ґрунтобетонів / О. І. Наливайко, М. Л. Зоценко, О. М. Панько. – К. : ДНДІБК, 2008. – Вип. 2. – С. 3 – 12.*
   Nalivayko O. I. Shlyahi pidvischennya vodoneproniknosti betoniv i gruntobetoniv / O. I. Nalivayko, M. L. Zotsenko, O. M. Panko. – K. : DNDIBK, 2008. – Vip. 2. – S. 3 – 12.
4. *Технічний звіт від 11 жовтня 2010 року про результати проведених лабораторно-виробничих випробувань дії гідрофобної водовідштовхуючої добавки «Ramsinks-2M» і її модифікацій щодо тампонуючих цементів БУ «Укрбургаз».*
   Tehnichniy zvit vid 11 zhovtnya 2010 roku pro rezultati provedenih laboratorno-virobnichih viprobuvan diyi gidrofobnoyi vodovidshtovhuyuchoyi dobavki «Ramsinks-2M» i yiyi modifIkatsiy schodo tamponuyuchih tsementiv BU «Ukrburgaz».
5. *Iken H. W. HandbuchderBetonprüfung: Anleitungen u. Beispiele / H. W. Iken, R. R. Lackner, U. P. Zimmer. – Düsseldorf: VerlagBau+Technik, 2003. – 380 P.*
   ISBN 3-7640-0317-0.
6. *Pat. US 7658794 B2 USA. Classification C04B14/24. Fibercement building materials with low density additives / Applicant(s): James Hardie Technology Limited, Dublin IE. Appl. № 10/414505, filed 15.04.2003; published 09.02.2010.*
7. *Пат. №2188215 РФ. Способ получения гидрофобного дисперсного материала / Наливайко А. И.; заявл. 19.11.2002.*
   Pat. №188215 RF. Sposob polucheniya gidrofobnogo dispersnogo materiala / Nalivayko A. I.; zayavl. 19.11.2002.

Received 03.10.2017