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APLICATION OF LOCAL CEMENT FOR CEMENTING OIL WELLS IN THE SOUTH EASTERN REGION OF THE PANNONIAN BASIN

Bošković Zvonimir[1], Čebašek Vladimir[1], Gojković Nebojša[1]

[1]*Faculty of Mining and Geology Belgrade, E mail: vvnz55@yahoo.com*

ABSTRACT

Wells conditions are different in wide range of temperature and depth. Cement slurries in such conditions have to remain pumpable and after setting to stay homogenous in production well life. For cementing operations in wide range of temperature and pressure and to accommodate cement slurries for individual well requirements more than 50 additives are now used for various API classes of cement. Laboratory in NIS – National oil company of Serbia, provides cement analysis of dry cement, tests on cement slurries and cement stone in compliance with methods prescribed by API standard, whereby quality and type of equipment fully meet the requirements. Adaptation of the local cement to the well conditions had already been done by these additives and by numerous tests of pure cement and cement mixtures we developed a palette of typical cement mixtures for cementing oil wells in the south eastern region of the Pannonian basin.

Key words: *cement, aditives, lead and tail cement slurry, compresive strenght, casing*

INTRODUCTION

As a basis for the development of cement mixtures in NIS used API cement class E, F and G and the local cement. Adaptation of local cement with additives are made for the regulation properties of cement slurry and cement stone the world's leading service companies in the conductor, technical and production casing . Laboratory testing of cement, additives for cement and cement mixtures [1] are of great importance for the success of cementing casing. The test included testing the quality of the ingredients, mix design of cement, cement mixtures control samples being prepared. By linking the physical and mechanical values of cement slurry and cement stone within the recommendations of Standards [2] API – API Specification 10 – (thickening time, filtrate loss, free water, rheological parameters, the development of compressive strength) created several compositions based on typical local cements.

TESTS OF LOCAL CEMENT

Basic requirements [3] are set for the cement slurry based on local cements are: thickening time, filtrate loss, rheology, strength development of cement stone to the pressure, density, and the possibility of mixing special requirements (gas migration control, thixotropy, expansion, strong bonds with protection pipe and formation). All tests were performed according to the recommendations of standards API Specification 10 and with standard laboratory equipment, as defined in this specification.

Thickening time

Thickening time of cement slurry [2] is one of the critical elements in designing cement mixtures in general. Setting appropriate time densification cement mixtures based on local cements require a large number of laboratory tests and the appropriate selection of the retarder. Were used HTHP konzistometri Chandler Engineering, 8-25-10 and 7-1 models and Halliburton model 800.6605. Table tests have been formed with the recommendation of API standards and borehole data (temperature and pressure gradient, the type, density and characteristics of the working fluid, the type of case and the available equipment).
At the entrance of controlling local cement applied internal procedures for assessing the quality, which involves determining the time of densification at test temperature of 50 ° C to 90 ° C by applying standard retarder – lignosulfonate type, determining the optimum water-cement ratio, the determination of smearing and measuring the compressive strength of cement stone typical mixture . Table 1 shows the values of some physical quantities several typical cement mixtures based on local cements.

Table 1 Tipical cement mixtures with local cement and their aplication

Mixture	w/c	Density kg/m3	Smearing mm	Tickening time	Aplication
I cement, pozzolan and accelerator	0.50	1830	210	80'/50°C	Primary cementing conductor and technical casing
IIcement, puzzolan, plaster, retarder	0.50	1830	220	168'/50°C	Primary cementing technical casing and cement bridges
III cement, puzzolan, retarder, dispergator and filtration regulator	0.55	1770	240	136'/90°C	Primary cementing of production casing, squeeze cementing, "liner" casing cementing
IV cement, puzzolan, fly ash. dispergator and filtration regulator	0.68	1620	230	147'/90°C	Primary cementing of production casing (lead cement)
V cement, puzzolan, retarder, dispergator i filtration regulator	0.55	1750	240	110'/110° C	Squeeze cementing, cement plugs and bridges
VI cement, silica flour, retarder, dispergator, filtrate regulator and antifoam	0.50	1780	220	90'/125°C	Primary cementing of production casing, "liner"-s, cement pluggs and bridges

Filtrate loss

According to API Specification 10, filtrate loss for cement G class is not precisely defined, but it is recommended to apply approximate values depending on type of cementing operations:

- For cementing technical casing string up to 1000 ml/30min
- For cementing production casing string up to 500 ml/30min
- For cementing "liner" casing ≤ 100 ml/30min
- For gas wells cementing and cementing under pressure from 30 to 50 ml/30min

Excessive loss of cement slurry filtrate [4] is danger in cementing operation in pumping, displacement and waiting during the cure - WOC because it increases the density of the cement slurry, changing the rheological properties, thickening time, creates bridges dehydrated cementitious materials. By the chemical nature of the additives to control the filtrate loss of cellulose derivatives, synthetic polymers, asphaltenes, thermoplastic resins, bentonite., And work-related increase in viscosity of water, creating a polymer film on the filter cake particles and cement packing and particle size. Filtrate loss values typical cement mixtures based on local cement are shown in Table 2.

Table 2 Filtrate loss of tipical cement mixtures with local cement

Mixture	w/c	Δ P	Δ T	Temperature	Filtration
I	0.50	500 psi	-	50 ºC	600 + ml/30'
II	0.50	500 psi	-	50 ºC	500 + ml/30'
III	0.55	1000 psi	2.5 ºC	90 ºC	180 ml/30'
IV	0.68	1000 psi	2.5 ºC	90 ºC	300+ ml/30'
V	0.55	1000 psi	3.0 ºC	110 ºC	80 ml/30'
VI	0.50	1000 psi	3.0 ºC	125 ºC	45 ml/30'

Rheology

Rheology of cement slurries is of great importance for the design, construction and quality of primary cementing. Knowledge of the rheological properties is necessary to assess the possibilities for mixing and pumping cement slurries, determination of the relationship of pressure to depth during and after repression [5], return circulation to calculate the phase of "free fall", forecasts temperature profile during pumping a cement slurry design and capacity required for optimal suppression of cement puree. Chemical composition, specific surface supplied local cement, water-cement ratio is relatively high and the presence of additives with different chemical compositions for different purposes in the cement mixture influenced the rheological behavior of cement slurries (Table 3). Since the dispersant have an important role in setting the rheological properties, the local cement demanded the use of different chemical nature of the dispersant such as sulfonated polymer composite, lignosulphonates, salts of organic acids. Mixing and testing procedures of API specifications 10 were observed when measuring the rheological properties of cement slurries and rotational viscometers were used Chan 35 and Fann 35.

Table 3 Reology of tipical cement mixtures with local cement

Mixture	w/c	PV mPas	GT Pa	n'	K' $Pas^{n'}$	Gel MPa
I	0.50	47	11.0	0.75	0.3276	7.5/31.5
II	0.50	73	7.5	0.98	0.1550	5.5/8.5
III	0.55	39	5.0	0.90	0.0020	3.5/15.0
IV	0.68	31	5.5	0.79	0.5330	5.0/19.0
V	0.55	120	20.0	0.81	0.0870	3.5/7.5
VI	0.50	87	13.0	0.82	0.3400	5.5/15.0

The compressive strength

According to API specification section 7, Appendix D 10 specifications, procedures and tables for the determination of compressive strength, cement chamber maturation Chandler and Chandler Model 7-00 Model 19-90-10 with a tester for measuring the compressive strength of hardened cement Chandler Model 4207 made destructive methods, Table 4. We also use the UCA (Ultrasonic Cement analyzer). Its advantage is the elimination of a large number of classical tests, destructive method, continuously monitors and better determines the strength of the trend of development and thus would define WOC (waiting on cement hardening).

Table 4 Compresive strenght of tipical cement mixtures with local cement

Mixture	w/c	Temp. °C	Pressure MPa	Time h	Compressive strenght MPa
I	0.50	50	-	24	16.10
II	0.50	50	-	24	11.00
III	0.55	110	21	24	14.52
IV	0.68	110	21	24	6.80
V	0.55	127	21	16	10.40
VI	0.50	138	21	20	19.70

CONDUCTOR PIPE CEMENTING

In some oil fields [6] in the south-eastern part of the Pannonian Basin OD 355.6mm conductor is running in the borehole 444.5mm nominal diameter up to 20m. and the characteristics of its cement mixture are shown in Table 5.

Table 5 Cement mixtures for cementing conductor pipe

Mixture	w/c	Density kg/l	Tickening time min	Compresive strenght MPa	WOC h
Local cement + 2% CaCl2	0.50	1.83	start – 48 final - 64	14.95	16

INTERMEDIATE CASING CEMENTING

Some intermediate casing [6] ID 244.5mm are set up to 450m in hole bit size 311.15 mm and cementing the annulus from top to bottom. Since the temperature at the bottom of wells does not exceed 50 ° C using a local cement without additives, Table 6.

Table 6 Cement mixtures for cementing intermediate casing

Mixture	w/c	Density kg/l	Tickening time min	Compresive strenght MPa	WOC h
Local cement	0.50	1.78 – 1.81	start – 114 final - 123	7.2	24

PRODUCTION CASING CEMENTING

In some oil fields [6] in the south-eastern part of the Pannonian Basin, where the temperature at the bottom of the wells does not exceed 120 º C and pressure gradient layer fracturing of 0148 - 0.18 bar / m adaptation of local cements successfully performed cementing annulus between the production casing OD 139.7 mm and hole size 215.9 mm use of lead [7] and tail cement slurries, Tables 7 and 8.

Table 7 Lead cement slurry

Mixture	w/c	Density kg/l	Tickening time min	Compresive strenght MPa	WOC h
Local cement, weighting aditive, dispergator, retarder, fluid loss	0.70	1.59	start – 120 final - 129	10.15	24

Table 8 Tail cement slury

Mixture	w/c	Density kg/l	Tickening time min	Compresive strenght MPa	WOC h
Local cement, dispergator, retarder, fluid loss	0.55	1.77	start – 139 final - 153	12.4	48

Rheological properties of these cement mixtures, Table 9 does not allow the achievement of a turbulent regime of displacement (displacement capacity greater than 1800 l / min) [8], but the displacement of slurry occurs in a highly laminar regime - Re = 2000.

Table 9 Fluid reology

	Density kg/l	PV mPas	GT Pa	Gel Pa
Mud	1.13	16	7	4/12
lead cement	1.59	23	4	4/13
tail cement	1.77	33	12	5/12

CONCLUSION

Regulation time densification cement mixtures with local cement is possible for most of the primary and secondary operations for temperatures up to 120 ° C. Partially increased demand loss control additive for filtration compared to API cements may cause loss of cement slurries in the filtrate is satisfactory framework for the type of case. Delayed development of compressive strength of cement paste, ie. WOC longer than the API cements increases drilling unproductive plants, and therefore costs. Density cement slurries to 1849 kg/m3 meet most requirements. The problem is the density 1849 kg/m3 above the high w / c ratio and the increased concentration of retarder and dispersant that could endanger the stability of the system.

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