

Research on and Application to BH-HTC High Density Cementing Slurry System on Tarim Region

Song Yuanhong, Gao Fei, He Jianyong, Yang Qixiang, Yang Jiang, Liu Xia

No.1 Cementing Company, BHDC. Renqiu

Guje_syh076@cnpc.com.cn, gaofei08@cnpc.com.cn, hejianyong@cnpc.com.cn,
719737885@qq.com, mingjunangel@163.com, 43362648@qq.com.

Abstract. A large section of salt bed is contented in Tarim region Piedmont which constructs complex geological conditions. For high-pressure gas well cementing difficulties from the region, high density cement slurry system has been researched through reasonable level of particle size distribution and second weighting up. The results of laboratory tests and field applications show that the high density cementing slurry system is available to Tarim region cementing because this system has a well performance in slurry stability, gas breakthrough control, fluidity, water loss, and strength.

1. Introduction

These guidelines, written in the style of a submission to *J. Phys.: Conf. Ser.*, show the best layout for your paper using Microsoft Word. If you don't wish to use the Word template provided, please use the following page setup measurements. In the Tarim area, the geologic conditions of the piedmont tectonic well are complicated, and the drilling depth of the well is generally above 4000m. There are large-scale salt paste layers in the underground area. The formation pressure is large and the long naked eye section forms multiple sets of pressure system. The fluid activity is easy channeling^[1,2]. Therefore, the cement slurry system not only requires high density, but also requires anti-high temperature and good anti-gas channeling ability^[3,4]. The author has improved the bulk density of cement by reasonable combination of cement particle size, and combined with the secondary attaching technology of slurry, it has developed a kind of high density cement slurry which can be applied to deep well cementing, low water consumption, small free water, easy to adjust the time of thickening, and has a high early strength, to meet the Tarim area high pressure oil well cementing the basic requirements.

2. The grain grading with the secondary slurry secondary technology

2.1. Design of particle gradation

In recent years, with the development of high-performance concrete technology, people have come to realize that the fine particle size of fine particulate minerals in cement dry ash is rationally designed to effectively fill the micro-pores inside the gel when cement hydration, Stone strength and durability. Andreasen^[5] is the advocate of the classical theory of continuous stacking of particles, and his proposed Andreasen equation uses the distribution modulus to maximize the density of the powder. In this paper, the relationship between the particle size and the porosity of the particles at different levels is deduced theoretically, and the particle size, porosity and accumulation degree of the three grains with different particle size are calculated.



Table 1. Particle size, porosity, and accumulation degree of compacted sphere

Basic Particles	Calculation formula	Theoretical calculation		Accumulation rate (%)
		Balls relative numbers	Porosity (%)	
	R	1	25.94	74.06
Particles	Level One	$r_1=0.414R$	1	20.7
	Level Two	$r_2=0.225R$	2	19
	Level Three	$r_3=0.177R$	8	15.8

2.2. Secondary aggravated for Base pulp

Secondary aggravating technology refers to the use of industrial re-salt first to increase the base fluid, so that with the slurry to achieve a higher density, and then with the pulp, and the use of heavier two ways to increase. In general, Na^+ , Cl^- , NO_3^- plasma in industrial salt will have some influence on the performance of cement slurry, mainly for the production of cement slurry dispersion, coagulation, retardation and other different effects, making the cement slurry loss is difficult Control, thickening time is not easy to adjust, etc. , so the deployment process in the deployment of the need for good use of salt-resistant cement admixture, and through a large number of indoor testing for deployment.

3. Design and preparation of cement slurry

3.1. The choice of weighting agent

Theoretical calculation of particle size and measured main filler material particle size can be seen in Table 2.

Table 2. Main filler material theoretical calculation of particle size and measured particle size

Basic Particles		Theoretical calculation		name	Actual detection	
		Calculation formula	Theoretical average (μm)		D ₅₀ (μm)	density (g/cm^3)
		R	58.74	Iron ore powder	58.74	6.5
Particles	Level One	$r_1=0.414R$	24.32	H grade cement	18.17	3.15
	Level Two	$r_2=0.225R$	13.21	CEA-1	14.82	2.2-2.4
	Level Three	$r_3=0.177R$	10.20	UFM	8.557	4.80

Where CEA-1 is micro-silicon, UFM is an ultra-fine manganese. It can be seen from Table 2 that the particle size of the primary and secondary fillers is smaller than the theoretical calculation of the particle size. Because the particle size is not uniform, the D₅₀ is only the mean of the measurement and can not represent the true particle size distribution. According to the tight accumulation theory, less than the calculated value is more conducive to particle accumulation.

3.2. Preparation of the slurry

When the slurry is formulated, the industrial double salt is first added to the water, and the liquid density is increased to $1.25 \text{ g}/\text{cm}^3$ or more. Then, UFM and other adjuvants are added to the heavy liquid to a higher level after mixing with dry ash into high-density cement slurry. The basic formula of cement slurry is: H grade cement, silica powder, CEA-1 (micro silicon), UFM, industrial double salt, ilmenite powder, high temperature loss reducing agent (HX-11L), high temperature retarder HX-36L, high-efficiency drag reducing agent (HX-21L), defoamer (DF-A), stabilizer (O-SP).

H-grade cement, ilmenite powder, CEA-1 and UFM are based on particle grading theory to select the optimal stacking rate. In order to realize the close accumulation of the components in the cement slurry, it is necessary to add the high efficiency drag reducing agent effectively to play the synergistic

effect. The low molecular weight polymer and organic matter in the descaling agent and retarder also have this function, which can adsorb the hydration film on the surface of the fine particles and produce electrostatic repulsion, thereby reducing the friction, so that the cement slurry fluidity Increase.

After a large number of tests, a comprehensive performance of high-density cement slurry has been eventually designed. It has a small water-cement ratio, good and stable fluid slurry, dense and high strength.

4. Performance evaluation and result analysis

A high density anti - gas channeling slurry with a density of $2.20 \sim 2.60 \text{ g / cm}^3$ was designed and its comprehensive performance was evaluated.

4.1. Rheological properties of different density cement

Six - speed rotational viscometer readings of the high-density cement slurry are showed in table 3.

Table 3. Different density of cement slurry before and after curing rheology

Density g/cm^3	Temperature $^{\circ}\text{C}$	Rheological parameter reading					
		$\Phi 600$	$\Phi 300$	$\Phi 200$	$\Phi 100$	$\Phi 6$	$\Phi 3$
2.20	25	--	265	210	150	13	8
	90	278	160	115	65	9	6
2.40	25	--	270	230	149	14	7
	90	--	210	154	89	11	7
2.60	25	--	281	233	159	16	11
	90	--	214	174	97	11	8

-- indicates overrange.

As can be seen from Table 3, high density rheology is good. $\Phi 600$ and $\Phi 300$ readings show that the consistency of cement slurry within the scope of the project needs, after aging, mud slurry thinning, rheological performance is more excellent, showing a good slurry of good temperature resistance. At the same time $\Phi 6$ and $\Phi 3$ values show good stability before and after aging of the cement slurry.

4.2. Basic properties of high density

Table 4. 2.60 g / cm^3 high-density cement slurry basic performance

Cycle temperature °C	Density g/cm ³	FL API mL	Free liquid %	Thickening time Min	Compressive strength (BHCT)		settling density difference g/cm ³	n	K Pa.s ⁿ
					MPa				
					24h	48h			
110	2.60	35	0.40	316	18.5	21.4	0.030	0.65	0.84
120	2.60	41	0.38	324	19.2	22.0	0.028	0.67	0.78
130	2.60	46	0.21	341	18.9	21.5	0.026	0.66	0.80
140	2.60	49	0.06	352	18.3	21.2	0.027	0.64	0.82
145	2.60	42	0.33	328	18.8	22.0	0.022	0.63	0.85
150	2.60	39	0.17	331	19.3	21.8	0.025	0.62	0.88
155	2.60	45	0.33	346	19.5	22.6	0.02	0.67	0.77
160	2.60	49	0.40	362	19.0	22.4	0.03	0.66	0.79

Table 4 is the basic performance of 2.60 g / cm^3 high density cement slurry. It can be seen that the density of 2.60 g / cm^3 high-density cement slurry is good (basically greater than 21 cm), the slurry is stable (the upper and lower density difference is less than 0.05 g / cm^3), the water loss is small (less than 50 mL) Control thickening time effect is good, high compressive strength, has a good overall performance, to meet the requirements of high pressure well cementing construction.

5. Application of high density cement slurry

The cement slurry system has been in the Tarim area since 2011, 30 wells, cementing quality of all qualified, part of the well cementing excellent quality. The cementing condition is described in detail in the case of tail pipe cementing at $\Phi 201.7\text{mm}$.

In the Tarim Oilfield, the Tertiary salt layer is generally developed, and the deep well is located in the Karasu structural belt of the Kuqa Depression in the Tarim Oilfield. The drilling depth is 6547m. Mainly sealed has been drilled at the bottom of the Kumgelite salt layer and above the open hole (main seal salt layer). Under the $\Phi 201.7\text{mm} \times \text{TP155V} \times 15.12\text{mm} \times \text{TP-FJ}$ unconventional casing, the design of the casing under the deep 6546.8m, seat hanging point 4215m, bell mouth 4210m. Tail pipe cementing used high density salt-resistant cement slurry cementing. The performance of the cement slurry is shown in Table 5.

Table 5. Grams of deep 203 well cement basic performance

Density g/cm^3	Water-cement ratio	Bottomhole cycle temperature $^{\circ}\text{C}$	FL API mL	Thickening time min	Transition time min	SP N	72h strength Mpa
2.38	0.261	135	42	390	5	1.3 7	17.8

Optimized OMEX-HX high temperature resistant salt water slurry system, H grade + GM iron ore powder + silica powder + filler CEA-1 + anti-flooding agent FLOK-2. To ensure that 2.38 g/cm^3 cement slurry mixing evenly, with the slurry solution after the addition of cement slurry configuration of the liquid-like way of mixing.

Construction process is normal, wells well after the drilling plug of 48 hours, the quality of the lower quality of the upper qualified.

6. Conclusion and suggestion

In view of the difficulty of cementing in high-pressure stratum in Tarim area, the accumulation density of cement is improved by optimizing the high-density external admixture and high-temperature anti-air deflator, and the particle size of cement particle is reasonable, and combined with secondary whitening technology, Designed a high-density anti-gas channeling mud.

The results of indoor experiment and field application show that the design of high density cement slurry has good performance, which can meet the requirements of high pressure gas well cementing construction in northeastern Sichuan region, and has good application prospect.

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