INCREASING DURABILITY OF SIDETRACK CEMENT STONE

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Sidetrack drilling from main well boreholes is among the most promising methods of well reconstruction. This method allows drilling in the oil-saturated deposits. It is becoming increasingly important as a method of enhanced oil recovery with different state-of-the-art navigation equipment, reliable hard-wearing rock-breaking tools, drilling technologies and accessories [5, 6].

However, satisfactory quality of sidetrack construction has not been provided, as such technology is not being developed properly. Sidetrack small diameters account for a thin cement sheath in the bore-hole annulus of sidetrack, which reduces the cement sheath integrity and durability; so there is a danger of cement stone contact lack between casing and wellbore walls, the effect appears especially while extending and reducing zenith intervals, and the cement stone can be destructed by casing perforation [2].

The majority of earlier drilled wells (about 85 %) were constructed with a 5 3/4'' casing string in Perm krai. A similar situation is in other oil regions of Russia. The 4 7/8'' bit is used for drilling sidetracks from the 5 3/4'' first well casing, and 4'' – for sidetracks. Thus, there is a 7/8'' gap for cement slurry. The required quality cannot be achieved by traditional casing technologies in these conditions [8].

That is why, it is vital to improve sidetrack drilling technology, in particular, to improve cement stone strength characteristics.

Adding ultrafine mineral additives to cement slurry is the most promising method to improve cement stone strength characteristics that meets the requirements and technologies of well cementing. The floured mineral additives can actively applied in the structural processes and fill the space between the cement grains, thereby sealing the structure.

Some laboratory tests have been conducted with the following mineral additives: silica flour (SF 0.05), diabase flour, metakaolin (MetaCem 85C), microsilica suspension (MS-85), and fine silica powder (FCS) [3].

The tests were conducted with oil-well portland cement 1-G which has high sulfate resistance (SCP Limited liability company). Water-cement ratio of cement-slurry composition was 0.49 and the composition included hydroxyethylcellulose (0.2% of cement weight), silicone defoamant (0.03% of cement weight). The mineral additives were added into the cement at about 1, 1.5, 2, 3, 5, 7, and 10 % of its weight. The cement stone strength tests were conducted on 20×20×80 mm prism samples which had been subjected to 75 and 158 °F in a bath of fresh water, after 24, 48 and 72 hours. The cement stone strength was determined by the best three average test results from the four (Table 1).

Table 1

Changes in cement stone strength relative to the base structure at the optimum mineral supplement concentration

The supplement	Temperature, °F	The supplement ratio, %	Strength increase, %
Silica flour	75	1	8.2
	158	2	23.7
Diabase flour	75	1.5	-0.6
	158	1	10.9
Metakaolin	75	7	21.4
	158	10	22.6
Microsilica suspension-85	75	10	10.1
	158	3	9.1
Fine silica powder	75	5	39.1
	158	10	50.4

The mineral additives' effect on the cement stone strength characteristics was determined according to the laboratory work results. The cement stone with 5 % fine silica powder has the best strength characteristics for low temperatures (75 °F). Moreover, the cement stone with 10 % fine silica powder has the best strength characteristics for moderate temperatures (158 °F). This mineral additive participates in structural processes and forms the fine texture which improves cement stone strength characteristics significantly.

It is assumed that to achieve maximum cement stone strength, additives with different grain composition should be present in cement slurry. Therefore, further research was carried out with the best result additive combinations. To maximize cement stone strength the research was conducted with mineral additive combinations which have a ratio of 20/80: metakaolin/fine silica powder, silica flour/metakaolin, microsilica suspension-85/ silica flour. The ratio was set up by modeling.

As a basic formula the same cement-slurry composition was used for the research. Combinations of the mineral additives were added into the cement at about 3, 5, 7, and 10 % of its weight.

According to the experiment results an optimum concentration of mineral additive combinations of metakaolin in cement slurry was determined. It was revealed that: 10% metakaolin/fine silica powder had increased cement stone strength by 28% in low temperatures (75 °F) and by 9,1% in moderate temperatures (158 °F) (table 2). The increase of the slurry yield was determined by small particle size and increased activity of fine silica powder in moderate temperatures. However, fine silica powder increased cement stone strength more effectively than the listed above additive combination.

Therefore, its use for increasing cement stone strength is unreasonable.

An optimum concentration of silica flour/metakaolin in cement slurry is 10% for 75 °F and 158 °F. Strength increasing was 24% for 75 °F and 19% for 158 °F (Table 2). The additive combination increases strength not as good as separate mineral supplements in moderate temperatures, but in low temperature this combination had proved its effectiveness.

The laboratory tests showed that the highest cement stone strength increasing was achieved with the 5% microsilica suspension-85/silica flour. The increasing was 15% in low temperatures (75 °F) and 12% in moderate temperatures (Table 2). In low temperatures this combination made cement stone stronger than separate microsilica suspension-85 and silica flour. However, in moderate temperatures the silica flour increases strength of cement stone more effectively, since it becomes active at temperatures above 140 °F.

Table 2

Changes in cement stone strength relative to the base structure at the optimum concentration of mineral supplement combinations

Temperature, °F	3%	5%	7%	10%
Metakaolin/Fine silica powder				
75	11.8	19.3	20.8	28
158	0.3	7.8	8.5	9.1
Silica flour/Metakaolin				
75	-9.2	7.5	12	24
158	2.5	11	17	19
Microsilica suspension-85/Silica flour				
75	13	15	2.8	9.6
158	6.8	12	2.9	11.3

According to the results of the laboratory experiments effective influence of mineral additives combinations on cement stone strength was proved towards a base cement-slurry composition and cement-slurry with separate mineral additives. For this reason next research will be carried out for modeling other combinations of the mineral additives with different graduation.

During the development of oil fields it is necessary to apply special cement slurries that provide integrity of the cement stone in long-term influence of corrosive formation waters for reliable and durable production well construction [4, 9]. Cement stone's resistance to corrosion can be improved by adding the ultrafine additives into the slurry [1, 3, 7, 10]. Thus, addition of the studded additives into the cement slurry can significantly increase the resistance to corrosion of the stone.

To sum up, suggested technical and technological solutions will provide durable wells' cement stone, increase interrepair time and enhance oil production.

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