Mineral wool sawdust additive effect on oil-well mortar and stone properties

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Abstract. The properties of mineral wool sawdust, formed during sawing of heat-insulating slabs at two enterprises, and its influence on the physical and mechanical properties of an oil-well mortar and cement stone are determined. Mineral wool sawdust has a low bulk density, fiber diameter 10-12 microns, fiber length is from 5 to 12 mm. It is shown that the introduction of mineral wool sawdust in the amount of up to 1.5 % of the cement mass slightly reduces the spreading and density, increases the water separation of the grouting mortar, increases the bending and compressive strength of the cement stone up to 28 and 41 %, respectively. It is recommended to use the mineral fertilizer sawdust of 'TIZOL' JSC in the amount of 1-1.5% as a reinforcing additive in the composition of oil-well cement.

1. Introduction

One of the effective ways to increase the bending and tensile strength of building concretes and mortars is the disperse reinforcement of the cement matrix with polypropylene, glass, basalt and metal fibers [1-6]. The use of dispersed reinforcement allows producing structures of complex configuration, increases the plasticity of the concrete mixture, reduces the formation of shrinkage cracks, increases frost resistance and reduces the mass of concrete structures [7-11].

Dispersal reinforcement is also an effective way to increase the bending and tensile strength of oil-well stone preventing the formation of cracks in it. Glass fiber and basalt fiber, as well as 6 and 7 asbestos fibers [12-14], were used as a fiber in oil-well cement. However, other fibrous materials can also be used as a reinforcing component, for example, sawdust having a fibrous structure and formed when cutting a mineral wool into heat-insulating products. Currently, mineral wool sawdust (MWS) is not disposed of and exported to the dump and it pollutes the surrounding environment. It is established that basalt fiber is the most effective modifying reinforcing additive for plugging materials. It has sufficient tensile strength, high elasticity modulus, slight elongation at break and high chemical resistance and adhesion to the cement matrix [15-17].

2. Raw materials and methodology

In the work, the possibility of using MWS as a reinforcing additive in the composition of oil-well cement is considered. The properties of the MWS formed at the enterprises for the heat-insulating slab production ('TIZOL' JSC and 'Uralasbest' JSC, Sverdlovsk region) were investigated. To prepare the mortar, oil-well Portland cement with mineral additives was used for low and normal temperatures

such as PCT II-50 satisfying the requirements of Russian Standard 1591-96 [18]. MWS was added in an amount of 0.5 to 2.0 % of the cement mass during the preparation of the cement slurry. The obtained results were compared with the properties of an oil-well mortar and cement stone with the addition of polypropylene fiber introduced in an amount of 0.25 % of the cement mass in accordance with Standard 32085-2013 [19]. The properties of an oil-well mortar were determined in accordance with Standard 26798.1-96 [20].

3. Results and discussion

It has been established that the MWS of 'TIZOL' JSC has larger agglomerates of fibers (figure 1), a smaller bulk density and a longer fiber length compared to the MWS of 'Uralasbest' JSC (table 1).

Figure 1. Appearance of mineral wool sawdust.

Table 1. Properties of mineral wool sawdust from the production of heat-insulating slabs.

Enterprise	Bulk density (kg/m^3)	Structure	Color	Fiber length (mm)	Fiber diameter (μm)
'TIZOL' JSC	74	Loose, the fibers are intertwined	Light yellow	7.1-12.2	10-12
'Uralasbest' JSC	90	Dense, the fibers are strongly intertwined	Dark yellow	4.9-11.1	10-12

The cement slurry must be homogeneous, do not exfoliate and have a spreadability of at least 200 mm. It has been established that the introduction of MWS in an amount of 0.5 % slightly increases the spreading of the cement mortar that decreases to 208-209 mm with an increase in the content of the additive to 1.5 %. Unlike MWS, the addition of polypropylene fiber in the amount of 0.25 % reduces the spreadability of the mortar to 194 mm, which does not meet the requirements of Standard 1581-96 (figure 2). It has also been found that increasing the reinforcing additive in an amount of up to 1.5 % reduces the density of the cement slurry, polypropylene fiber introduction reducing especially significant (figure 3).

The water separation of the cement slurry practically is not affected by the MWS addition (figure 4). At the same time, the use of polypropylene fiber leads to an increase in this indicator by almost 2 times that will negatively affect the operating properties of the oil-well stone in the future.

For oil-well stone, the most important characteristic is the bending strength that should be more than 2.7 MPa after 2 days of hardening. It is established that the increasing of the MWS amount of 'Uralasbest' JSC in the cement slurry composition up to 1.5 %, in contrast to the additive of the MWS of 'TIZOL' JSC enhances the bending strength of oil-well stone from 4.2 to 5.7 MPa and compressive strength - from 12.7 to 18.0 MPa (figure 5, 6). The introduction of a larger MWS amount (more than 1.5 %) reduces the strength of the oil-well stone, especially significantly with the MWS addition of 'TIZOL' JSC.

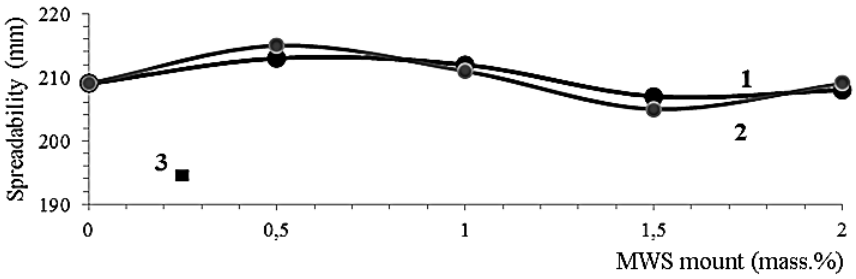

Figure 2. Influence of the MWS amount on the spreadability of the oil-well mortar: 1 – 'Uralasbest' JSC; 2 – 'TIZOL' JSC; 3 – polypropylene fiber.

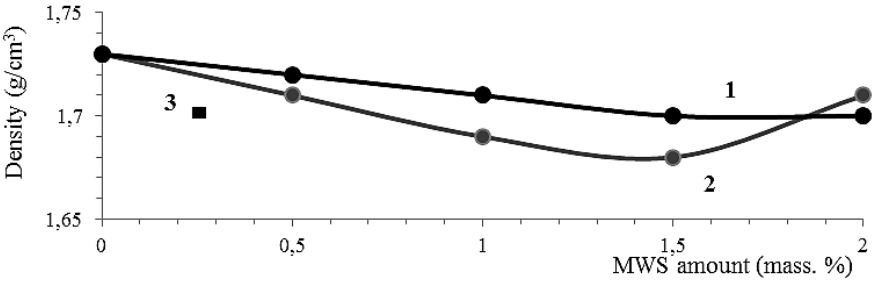

Figure 3. Influence of the MWS amount on the density of the oil-well mortar: 1 – MWS of 'Uralasbest' JSC; 2 – MWS of 'TIZOL' JSC; 3 – polypropylene fiber.

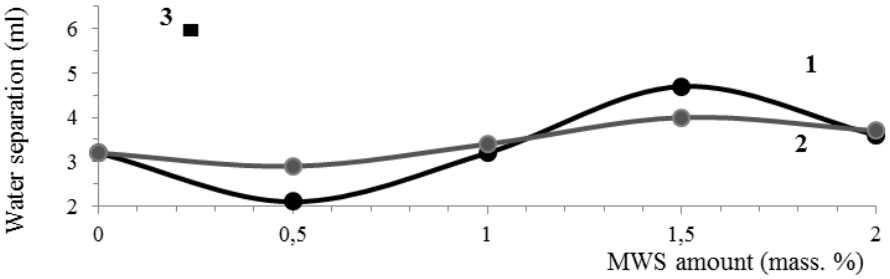

Figure 4. The influence of the MWS amount on the water separation of the oil-well mortar: 1 – MWS of 'Uralasbest' JSC; 2 – MWS of 'TIZOL' JSC; 3 – polypropylene fiber.

4. Conclusion

Mineral wool sawdust formed when sawing thermal insulation boards has a bulk density of 74-90 kg/m^3, fiber diameter of 10-12 microns, fiber length is from 5 to 12 mm. The introduction of mineral wool sawdust in an amount of up to 1.5 % of the weight of cement slightly reduces the spreadability and density, increases the water separation of the slurry, increases the strength of bending and compressing the cement stone up to 28 and 41 %, respectively, compared with no-additive cement. As a reinforcement additive in the composition of oil-well cement it is recommended to use mineral wool sawdust of the enterprise of 'Uralasbest' JSC in the amount of 1-1.5 %.

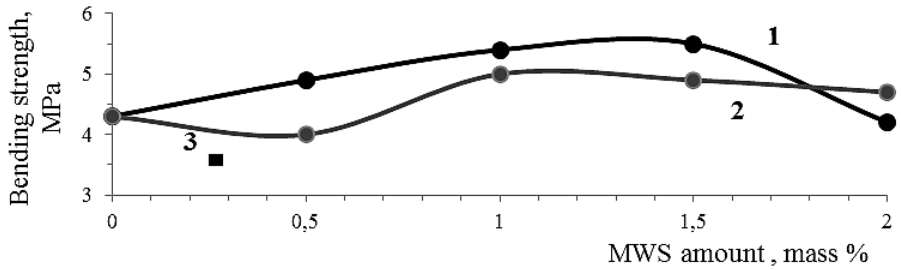

Figure 5. The influence of the MWS amount on the bending strength of cement stone: 1 – MWS of 'Uralasbest' JSC; 2 – MWS of 'TIZOL' JSC; 3 – polypropylene fiber.

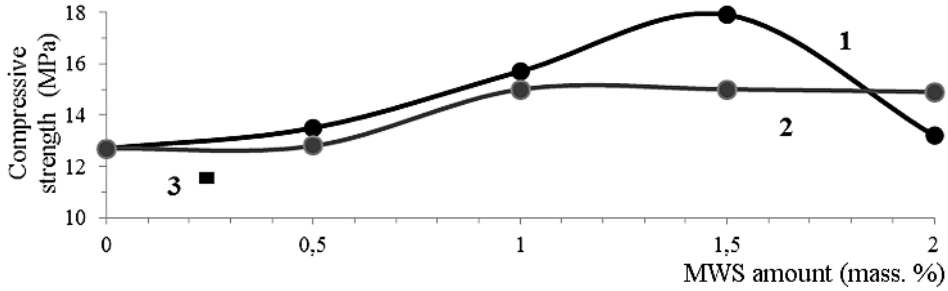

Figure 6. The influence of the MWS amount on the compressive strength of cement stone: 1 – MWS of JSC 'Uralasbest'; 2 – MWS of JSC 'TIZOL'; 3 – polypropylene fiber.

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