Application of silsesquioxane-humic complexes as dust suppressants

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The particulate matter (PM) contained in the dust, when weathered, pose a serious danger to the health of citizens and the ecology. Modification of humic substances with silanol derivatives leads to the possibility of their immobilization on various mineral particles, which can be used to bind dust and prevent wind erosion. Due to their lack of toxicity and resistance to biodegradation, they can be safely used on city streets using sprinklers. Previously, our laboratory developed methods and approaches for the synthesis of highly adhesive derivatives of humic substances - silsesquioxane-humic complexes (SSHC). The resulting complexes in the aqueous medium gradually condense with the formation of more curly and crosslinked structures. Spraying these complexes can lead to the binding of particulate matter especially coarse particles ($\leq 10 \mu\text{m}$ – PM10) and fine particles ($\leq 2.5 \mu\text{m}$ – PM2.5).

To synthesis SSHC 20 ml of a 10 g/l solution of humic substances (CHP-K, Powhumus potassium humate) were prepared. Then the aliquot of APTES (3-aminopropyltriethoxysilane) was added (50, 100, 200 mg for CHP-APTES-25, -50, -100, respectively). To prepare dust models the dried soil was sieved with 100 μm mesh. For the experiment, 10 grams of model dust was placed in Petri dishes, after which 5 ml of derivatives or distilled water as control were added to dust and dried in the electric oven at 50 °C. To study of binding particulate matter by SSHC lab-scale air-blowing tests were used. In this test after treatment of model dust with SSHC and water as control, the samples were placed in a plastic container equipped with a compressed air source and a particle matter sensor. The determined concentration of particulate matter after exposure of compressed air on the samples is shown bellow

Figure 1. Determined concentration of particulate matter after exposure of compressed air to dust samples.

As can be seen from the above results, treatment with SSHC leads to a decrease the content of particulate matter in the air. Treated samples are more resistant to wind erosion. It can also be seen that this effect increases with an increase of organosilane content in the complex. This can be explained by the binding of small particles in the dust by silanol groups in the complexes. Thus, the complexes can be considered as promising dust suppressants.

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