Geophysical Research Abstracts
Vol. 13, EGU2011-9361, 2011
EGU General Assembly 2011
© Author(s) 2011

Design of surface-active humic substances capable for stabilization of soil aggregates

Irina Perminova (1), Alexander Volikov (1), Sergey Ponomarenko (2), Vladimir Kholodov (3), Elena Lasareva (1), and Kirk Hatfield (4)

(1) Lomonosov Moscow State University, Moscow, Russian Federation (iperm@org.chem.msu.ru), (2) Enikolopov Institute of Synthetic Polymeric Materials of RAS, Moscow, Russian Federation (ponomarenko@ispm.ru), (3) Dokuchaev Soil Science Institute of RAAS, Moscow, Russian Federation (vkholod@mail.ru) , (4) University of Florida, Gainesville, USA (khh@ce.ufl.edu)

Humic substances play important role in soil fertility by forming stable organomineral aggregates (soil crumbs) which retain water and structure soil: Depletion of soil with humic matter is believed to be a primary factor that causes destruction of aggregates and brings about soil degradation. Despite this general knowledge, there is no consensus either on structure of soil aggregates or on mechanism of their formation. This precludes directed design of soil conditioners which could effectively restore or reassemble soil aggregates. In this study, we hypothesized that soil aggregates can be considered as a special type of inverse phase Pickering emulsion of water in air stabilized by solid organoclay complexes. This comparison looks rather feasible given the role of soil aggregates as water containers. The proposed model allows for knowledge-based search of optimum stabilizers for soil aggregates from the principles of emulsion stability. In case of water-in-air emulsion, the stabilizer should be hydrophobic due to hydrophobicity of the disperse medium - air. Hence, immobilization of hydrophobic coating on the surface of highly hydrophilic clay particles should bring about an increase in aggregate stability. To prove this hypothesis, we have designed surface-active humic substances carrying silanol groups. Those humic surfactants were expected to adhere to mineral surfaces bringing about their hydrophobization. Native humic materials from coal and peat were used as source humic matter. The commercially available 3-aminopropyl triethoxysilan was used as a silanizing agent. The silanol humic derivatives were synthesized using different reagent ratio to assure different performance of the surfactants. The adhesion capability of the synthesized derivatives was tested using sorption isotherms approach. It was shown that sorption capacity of the derivatives with respect to bentonite reached 150 mg/g of clay which equals about 7% organic carbon in the resulting clay-mineral substrates. The given results showed high adhesion ability of the derivatives on clay. The performance of the derivatives with respect to hydrophobicity change was tested using contact angle measurement of water droplet resting on glass modified with the derivatives under study. The maximum increase from 40 to 57 degrees was observed for humic substances from lignite with 100% modification degree. This confirmed the ability of the silanol derivatives to increase hydrophobicity of mineral surfaces. To prove performance of the derivatives as soil stabilizers they were used in water resistance test (so called Andriyanov test). For this purpose, soil aggregates with sizes from 3 to 5 mm were isolated by dry sieving from the degraded mollisol. The aggregates were placed onto filter paper soaked with water, non-modified potassium humate and silanol derivatives. The aggregates were let to soak with the corresponding liquid and dry. After that, they were contacted with water and water resistance coefficient as well a kinetics of aggregate disruption was measured. It was shown that water resistance coefficient for aggregates treated with humic surfactants has doubled as compared to those treated with water and potassium humate. The obtained results show good promise for new humic surfactants to be used as soil conditioners for restoring degraded soils. In turn, Pickering emulsion model can be used for directed design of efficient soil aggregates stabilizers.
Acknowledgements. This work was supported by the grants of NATO CLG 983197, RFBR 10-03-00803, and GK 16.740.11.0183 of Russian Ministry for Education and Science.