Knowledge-Based Design and Innovative Applications of "Green Chemistry" Products from Humic Materials

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Facing the growing needs in world consumption of mineral oil along with deterioration of its reserves, particular importance gains development of new principles and technologies of fuel and chemical production based on a use of alternative and renewable resources (*1*). Alternative biogenic resources are presented by fossil and technogenic materials. The former consist of oxygenated organic rocks such as young coal (leonardite), peat, sapropel, etc., while the latter include industrial and agricultural organic wastes (spent pulp liquors, activated sludge, composts, etc.). Main component of these resources are humic and humic-like compounds, whose inherent properties are: non-toxicity, biocompatibility, resistance to biodegradation. Despite immense reserves of inexpensive humic materials and unique biological properties; they do not find a broad practical application. This is connected to large polydispersity and structural heterogeneity of humic substances, which translates into properties that are difficult to control. To overcome this problem, chemical modification and surface chemistry are proposed as promising tools for acquiring humic materials with properties tailored to the needs of specific application.

The goals of this study were threefold: first, humic materials were modified to enhance function or property inherent within natural humics (e.g., complexation ability, redox activity); second, humic materials were modified to acquire a novel, tailored property not inherent within natural humics (adhesive ability to mineral phase); and, finally, humic derivatives were immobilized onto mineral support to change their disperse phase.

Polycondensation approach was used to enhance redox and complexing properties of humics. This approach allows for incorporation of the desired phenolic- or quinonic fragment with the known redox properties into the humic backbone. The obtained humic derivatives possess much higher reducing capacity which enables, for examples, reduction of Np(V) to Np(IV). To obtain humic materials with capacity to adhere to mineral phases, alkoxy-silylation was used. Incorporation of alkoxysilyl-groups yielded humic derivatives capable of covalent binding with hydroxyl-carrying surfaces (e.g. silica gel) (*2*). The obtained derivatives are water soluble and immobilize onto mineral supports under mild ambient conditions in aqueous solutions. The tests for sequestration of radionuclides and bacterial endotoxin (lipopolysacharide) showed high affinity of the produced coatings both for Pu(V) and bacterial endotoxin. Of importance is that all humic derivatives synthesized did not acquire toxicity as a result of modification that allows for considering them and derived materials as "green" chemicals and biomaterials.

be lost to the hydrocarbon phase. KHI can significantly delay the hydrate nucleation and growth with little amount, but the major limitation of KHI lies in that it ceases to function when the subcooling is over about 20 °F. AA allows gas hydrates to form but keep the hydrate crystals small and dispersed in the hydrocarbon phase.

The hydrate-based technique for separating and concentration is based on the difference of hydrate formation conditions or capability of various gas or liquid species. The proposed separating technique is attractive for separating gas mixtures of H_2+CH_4, H_2+CO_2, CH_4+H_2S, and CH_4+CO_2; and the concentration focus on desalination of sea water, concentration of juice and Chinese medicine.

The storage and transportation of gas (natural gas, hydrogen) in hydrate form is one of the hot fields in hydrate-based new technology development. The main problems in these technologies are how to shorten the induction time of hydrate and increase the formation rate and gas storage capacity. Besides gas storage, storage of thermal energy through hydrate formation or dissociation is a promising technique for balancing the on-peak and off-peak electric-load. These technologies have closely connected with biomass energy and energy-saving.

In South China University of Technology, we are carrying on researches about the inhibition and accelerate of hydrate formation, separation of mixture gas by hydrate, hydrogen/methane/propane storage in hydrate, and obtain some achievements.