PHYSICAL AND CHEMICAL NANODESIGN OF POLYMER COMPISITES

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New unique materials for environmental protection were recently created in the Siberian Federal University using nanotechnology techniques. Polymer composite "Unipolymer" stands out among them because of its superior characteristics, which allow him to effectively recultivate agricultural soils [1]. This paper discusses physical and chemical characteristics of “Unipolymer” for the development of methods of polymer composites nanodesign with given parameters necessary for biological soil remediation after oil spills. We also discuss some of the possible applications of this material.

Polymer composite “Unipolymer” represents a macro porous material, obtained by polymerization of formaldehyde in the presence of carbonates with additional additives. The method of obtaining is close to production of polyurethane foams, but in addition we use special surfactants that allow us to control porous structure and properties of polymer composite [2, 3]. The synthesized composite turned out to be sufficiently versatile in terms of the wide range of applications. “Unipolymer” has a mesh structure. The average pore size is about 20-30 μm. The polymer composite is produced in the form of pellets, crumbs, powder, mats, booms, filters and other sort of products.

Our polymer composite has pronounced sorption properties. It is capable of absorbing all kinds of crude oil and petroleum products. It is a very lightweight composite and it does not sink even with the sorbed oil within it. The “Unipolymer” sorbent capacity reaches about 70 grams of oil per 1 g of sorbent. The composite is absolutely harmless to the environment, since it is fully decomposed over time (max. 3 months). Furthermore, once it has sorbed any oil, the oil can be squeezed out of the polymer composite. Oil quality is not changed, and the “Unipolymer” can be reused multiple times. And also our composite is weakly flammable. When heated the sorption capacity decreases, physical size reduces, durability increases. The ignition temperature of crude oil and petroleum products exceeds 290°C.

These unique characteristics, we suggest, are due to its mechanism of sorption, which can be represented as a wetting of oil by “Unipolymer”. When the oil is wetted, the capillary forces start to play an important role due to the unique structure. We call this effect low-dimensional capillary

condensation. Detailed study of this effect is the subject of our further research.

At the moment we have two types of polymer composite, called “Unipolymer-M” and “Unipolymer-Bio”. The last one is characterized by addition of bacteria strain that again emphasizes its environmental safety.

Now let us discuss different applications of the polymer composite. The “Unipolymer-M” is mostly used as oil sorbent, as it has good sorption characteristics, as shown earlier. The sorbate can be mechanically removed from the surface of water of soil. If left alone, polymer composite will eventually decompose, causing no harm to the environment.

Another important application of polymer composite is soil recultivation [1]. For example, intrusion of “Unipolymer” into the polluted with diesel fuel soil at a concentration of 10 g per kg allows barley to be grown on this soil again. The productivity of barley can reach up to 90% compared to pure soil.

In addition, depending on the composition of the polymer composite we can get excellent thermal insulation properties, which allow us to use it as insulation material for houses and also as covering material for soils. The last one is relevant for the northern areas where there is permafrost and the construction on the frozen ground is more expensive.

The last possible application is about utilizing polymer composite as a matrix for different bacteria including marine bacteria. Eventually bacteria will multiply and eat the composite. This property, in theory, can be used for creation of islands of life in different parts of the World ocean or across the coastline.

Thus, physical and chemical properties of polymer composite “Unipolymer” provide great opportunities for nanodesign in ecology and biology. The use of such new materials for environmental protection allows us to reduce the consequences of industrial oil spills to a minimum.

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