New role of microbes in the construction industry

Such well-established areas of Biotechnology as Medical, Agricultural, and Environmental Biotechnology have thousands of valuable applications but Construction Biotechnology, which is science and engineering of using of microorganisms in construction industry, is just arising. Before that, microbes in construction industry were associated only with biodestruction, biocorrosion and biodeterioration of materials and constructions. Now, microbes are used in Construction Biotechnology by two ways: production of construction materials and performance of construction processes on site.

Fig. 1. Different types of biocemented structures in sand: calcite crust of sand surface, a layer and a block of biocemented sand.

The examples of construction materials are different microbial admixtures to cement, which are used for better setting, plasticity, and lower shrinkage of cement pastes. The microbially produced biodegradable bioplastics and the bioplastic foams from biotechnologically produced polyhydroxyalkanoates (PHAs) or polylactic acids (PLA) can be used as construction materials for the temporarily constructions, which are composted after use or just left in soil for their biodegradation.

The bioagents can be used in construction biotechnologies as a pure or enrichment culture of bacteria cultivated in special reactor, and then mixed in liquid or dry state with the chemical reagents so making biocement to strengthen soil or biogrout to reduce hydraulic conductivity of soil. This material is dissolved in water on the construction site and then the solution with very low viscosity can be injected into or sprayed over the porous soil or the fractured rocks. These

biocements or biogrouts can be used for bioaggregation of soil in dust and soil erosion control, for biocementation of soil to make soft soil stronger (Fig.1), and for bioclogging of soil to diminish groundwater flow into the construction site or to stop the seepage from the pond, channel, or landfill constructed in permeable soil.

Valuable applications of construction biotechnology can be biocoating of surfaces of concrete and brick constructions (Fig.2) for decoration or protection of construction surfaces from carbonate corrosion and water permeability. Natural formation of coral reef required a hundred years but it is possible to construct the calcium carbonate coated artificial coral reef with the shape of natural corals just for few days (Fig.2). This calcium carbonate coating will facilitate colonization of artificial reef with the coral larvae and quick formation of the natural-like corals.

Fig. 2. The calcite-coated brick (“marble brick”) and the artificial coral, which was biocoated to facilitate formation of natural-like artificial coral reef.

There are possible different types of biocement and biogrout, which are based on urea hydrolysis, calcium bicarbonate decay, ferric hydroxide gel formation, and precipitation of calcium or magnesium phosphates. Inorganic raw materials for biocementation and bioclogging can be calcium chloride or magnesium sulfate brines and the waste powder of limestone, dolomite, or iron ore. An organic component for the construction bioprocesses can be cellulose or starch of agricultural, food-processing, or municipal wastes. The best way for commercial production of the biocements, biogrouts, and other biotechnological construction materials is to use the facilities and by-products of the biorefinery that is producing biofuel. In this case, the production of biocement or biogrout will improve economics of the biorefinery.

The biotechnologically produced construction materials and the microbially-mediated construction technologies have a lot of advantages in comparison with the conventional construction materials

and processes in terms of cost of reagents, equipment, carbon footprint and environmental safety. Proper practical implementations of the construction biotechnologies could give significant economic and environmental benefits.

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