FLOATING AGGREGATES WITH IMMOBILIZED BACTERIA VS FLOATING OILS: SEARCH FOR APPROPRIATE CERAMICS

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The natural granular aggregates are used for removing floating crude oil from water surfaces via its transformation into immobile phase. The aim of this study was to produce the porous ceramic granules with bulk density below 1 g/cm3 with further their testing for floating ability in the presence of synthetic wastewaters, silicone oil and hydrocarbon-degrading bacteria consortium under laboratory conditions.

Materials and methods

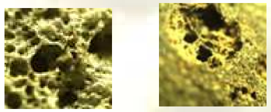
The granules of Quaternary clay with additive of 45 % of milled SiO_2 and 3% sawdust were investigated.

Size of pellet

Dry granules were put into kiln, heated up to 1200 °C and exposed during 10 min at this temperature. Bulk density of these pellets was 0.95 – 1.00 g/cm3.

Inside of granules

The part of the granules before sintering were coated with the SiO_2 powder to decrease the agglutination of granules in fabricating process.



Micrographs of granules pores

Composition of the synthetic wastewaters was as follows, g/ L: $CO(NH_2)_2$ – 0.06; $(NH_4)_2SO_4$ – 0.132; Na_2HPO_4 x $12H_2O$ – 0.716; $MgSO_4$ x $7H_2O$ – 0.123; CH_3COONa – 0.1; NaCl – 0.05; trace element solution – 10 mL (with the following composition, g L-1: $CoCl_2$. $6H_2O$ – 0.1; $ZnSO_4$ – 0.1; $CuCl_2$. $2H_2O$ – 0.01; H_3BO_3 – 0.01; Na_2MoO_4 – 0.01; $NiCl_2$. $6H_2O$ – 0.02). 500 mL synthetic wastewaters were amended by 1 mL silicone oil and 5 mL inoculum of bacterial consortium (1.0 x 10^9 CFU).

Fluorescent microscopy of bacteria cells

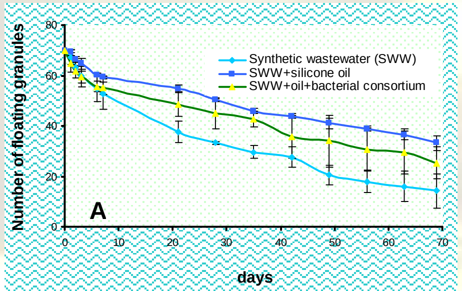
Cells were fixed with ethanol and stained with propidium iodide (PI) in a concentration of 20 µmol ml-1. Samples were analyzed with the confocal laser scanning microscope Leica DM RA-2 (Germany) equipped with a TCS-SL confocal scanning head. PI was excited with a 488-nm band and fluorescence was detected between 600 nm and 640 nm.

Porous ceramic granule

Commercial ceramsite

Porous granule with SiO2 coating

Results



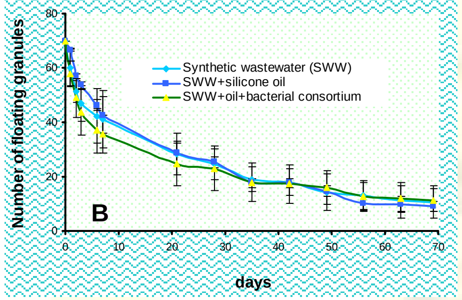


Fig.1. Floating ability of porous granules. A-porous ceramic, B- porous ceramic with SiO2 coating.

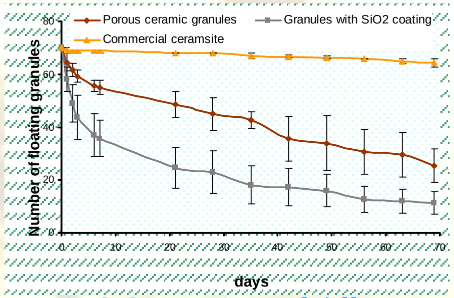


Fig.2.Comparison of different ceramic granules for their floating ability

I. Untreated granules

II. Granules coated with SiO2 powder

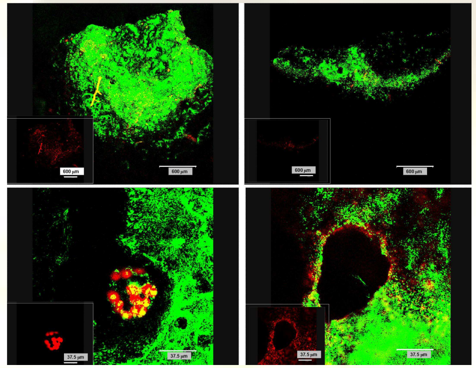


Fig.3.Fluorescent micrographs of bacteria cells on the surface of ceramic granules. Green colour corresponds to abiotic substances, red and yellow colour – bacterial cells, respectively.

Conclusions

During the 70 days experiment the floatage of the SiO2-treated granules gradually decreased up to 15 %, irrespectively of the presence of oil and bacteria. In turn, sedimentation of non-treated granules was retained in the presence of oil. Thus, after 70 days, the percentage of floating granules in the sets with synthetic wastewaters, synthetic wastewaters + silicone oil, synthetic wastewaters + silicone oil + bacterial consortium was found to be 20.5 ± 9.7 %; 47.6 ± 7.1 %; 36.2 ± 9.2 %, respectively.

References

Boglaienko D., Tansel B., 2015. Instantaneous stabilization of floating oils by surface application of natural granular materials (beach sand and limestone). *Marine Pollution Bulletin* 91, 107–112.

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