The use of gel made of silanol derivates of humic substances for long time storage of alive microorganisms

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Liquid biopreparations for bioremediation are convenient and economically attractive, but microbial survival under standard environmental conditions is poor. A novel way to increase survival of various hydrocarbon oxidizing microorganisms (HOM) during long-term storage was developed and tested. A new type of biocompatible gel based on humates modified with organosilanes has been recently developed (Volikov et al. 2016 a, b). Gel was prepared with the use of humate of Na and K "Powhumus" (Humintech, Germany) and the 3-aminopropyltriethoxysilane (APTES) (AGM-9, Penta 91, Russia) according to the previously modified procedure. This gel was used for immobilization of HOM cells of different types: bacteria *Rhodococcus qingshengii*, *Acinetobacter seifertii*, *Pseudomonas aeruginosa*, *P. extremaustralis* and yeast *Yarrowia lipolytica*. Microbial cultures of stationary phases were mixed (1:3 of total volume) with gel and left at room temperature for few months. After storage for up to 12 months, titers of alive cells (colony forming units, CFU) of HOM in the gel were ten to one hundred times higher than in the control (as shown in fig. 1 for *A. seifertii* and *P. aeruginosa*). Hydrocarbon degradation by the stabilized cultures began earlier and was faster and more complete than in the control after few month storage.

Figure 1. Effect of immobilization of *A. seifertii* (a) and *P. aeruginosa* (b) into the silanol-humic gel on their survival during storage.

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