SULFATE-REDUCING BACTERIA BIOFILM GROWTH INHIBITION IN INJECT SEA WATER BY GREEN" ZNO-INTERLINKED CHITOSAN NANOPARTICLES

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Abstract - Biofilm formation is a major problem in many industrial processes including oil and gas industry. Among the anaerobic microorganisms, sulfate-reducing bacteria (SRB) are one of the most important groups commonly associated with microbial corrosion. Biocides and corrosion inhibitors are generally used to disinfect the water and to inhibit biofilm growth. However, conventional biocides are not efficient and environment friendly. In this first systematic study, we synthesized a "green" and highly stable biocide formulations composed of ZnO interlinked chitosan nanoparticles (CZNCs) and applied it to inhibit the growth of SRB culture enriched from real oil field sludge. CZNCs showed great stability in highly saline inject seawater and significant inhibitory effects to sulfate reduction and organics oxidation. The inhibition of SRB activity was concentration-dependent and more than 73% and 43% inhibition of sulfate reduction and organics oxidation, respectively, was observed at 250 µg/mL CZNCs at 10% initial ZnO loading. Much higher LDH release of 113.48% coupled with SEM analysis suggested cell membrane disruption. Moreover, extracellular polymeric substances (EPS) from SRB biofilm showed a decrease in concentrations of carbohydrates, proteins, humic substances, and lipids in the presence of CZNCs. CZNCs did not show any significant specific acute toxicity or teratogenic phenotype at any of the concentrations tested. On the basis of obtained results we present CZNCs as a "green" biocide which is expected to be beneficial for industry against biofouling and reducing the risks of piping corrosion, reservoir souring, and improve surface facilities lifetime, with minimal impact on the environment and marine life.

Keywords - Biocide; Chitosan; ZnO; SRB; Biofilm Inhibition; Acute Toxicity, Zebrafish