INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Phenol degradation by free and immobilized bacterial consortia isolated from crude oil contaminated sites of Assam, India**

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SHORT ABSTRACT

Rapid industrialization and development of nations around the world have increased the demand for exploring energy resources. Majority of the world's energy demand still heavily rely on fossil fuels, primarily petroleum and petroleum products. Phenolic compounds are amongst the most noxious derivatives of crude oil and their removal from wastewaters is imperative before releasing into the environment. The thesis focuses on isolation of bacterial cultures which are capable of tolerating and degrading high concentration of phenol in wastewaters. An efficient phenol degrading mixed bacterial culture was isolated from sludge sample collected from one of the petroleum refinery located in Assam, India. On further investigation, it was found that the mixed bacterial consortia consisted mainly of three culturable bacterial strains. These were identified as *Stenotrophomonas acidaminiphila* strain DBK (GenBank Accession no. KC992293), *Brevibacterium sp*. strain DBK1 (GenBank Accession no. KP231222) and *Brucella sp*. strain DBK2 (GenBank Accession no. KP231223). Further, batch biodegradation experiments were conducted for a wide range of initial phenol concentrations at optimized pH and temperature conditions. It was found that the mixed culture was able to degrade a maximum phenol concentration of up to 1000 mg L^{-1} within 96 h while the maximum specific growth rate (μ_{max}) was observed at 100 mg L^{-1}. The pH and temperature required for optimal phenol degradation was 6.5 and 37 ^{o}C respectively. The mixed culture degrades phenol via the *ortho*-cleavage pathway by formation of an intermediate (*cis, cis*-muconate) which was detected spectrophotometrically at 260 nm. The experimental data were validated by fitting the growth and substrate utilization curves with their corresponding simulated dynamic profiles obtained by solving Haldane's equation via MATLAB.

In the next part of the study, an attempt was made to immobilize the mixed culture on two unreported (for phenol biodegradation) lignocellulosic matrices. The matrices used in the study were dried areca nut husks and dried mature luffa sponge fibres. These matrices are available in most Asian countries very abundantly. The phenol-acclimatized mixed bacterial consortia was immobilized on the matrices via

natural adsorption. Phenol degradation studies were performed in batches to optimize the physicochemical parameters. Optimum pH and temperature for phenol degradation was found to be 8.0 and 37 ^{o}C. At an optimum pH and temperature, the areca nut husk and luffa sponge systems immobilized with the mixed culture could degrade 1000 mg L^{-1} phenol in 28 h and 30 h respectively. The highest experimental degradation rates in areca nut husk and luffa sponge systems were 0.37 h^{-1} and 0.21 h^{-1} respectively at 200 mg L^{-1} phenol. Degradation kinetic studies were carried out using several inhibition models. Further studies revealed that both matrices with immobilized microbes could be reused for several successive batch degradation experiments and stored at 4 ^{o}C for several weeks without any noticeable loss in degradation efficiency. Further, lab-scale packed bed reactors were fabricated and degradation studies were carried out with synthetic phenol feed at varying feed flow rates.