INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Bioengineered systems for the biodegradation and toxicity removal of endocrine disrupting phthalates (EDPs).**

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SHORT ABSTRACT

The world's water resources are increasingly threatened by climate change and various organic and inorganic pollutants. Phthalic acid esters (PAEs) are one such pollutant and have emerged as an environmental threat to aquatic ecosystems. PAEs are synthetic chemicals that mimic activity of natural hormones and disrupt the endocrine system of organisms, including humans, leading to harmful effects. Due to their endocrine-disrupting nature, PAEs are also known as endocrine disrupting phthalates (EDPs). Hence, this thesis work focused to establish the efficient and low-cost treatment strategy for biodegradation and toxicity removal of EDPs. In order to find out the best treatment system, the biodegradation of different EDPs at various concentration combinations were evaluated using different bioengineered systems, viz. continuous stirred tank bioreactor (CSTB), two-phase partitioning bioreactor (TPPB) and membrane-integrated bioreactor system, under aerobic condition. The toxicity removal efficiency of different systems was evaluated by the toxicity assessment of the treated water using brine shrimp mortality and seed germination bioassays.

In preliminary experiments using three bacteria (Rhodococcus opacus, Cellulosimicrobium funkei and Ochrobactrum sp.), C. funkei was identified to be the best for the biodegradation of dimethyl phthalate (DMP) and diethyl phthalate (DEP). In addition to C. funkei, another novel bacterium, Gordonia sp., showed complete degradation of a mixture of six priority phthalates including DMP, DEP, dibutyl phthalate (DBP), benzyl-butyl phthalate (BBP), di-2-ehtyl hexyl phthalate (DEHP) and di-n-octyl phthalate (DnOP). However, using batch shake flask, low degradation efficiency was obtained at 1250 mg/L initial concentration of the EDPs. Hence, a CSTB was examined under batch, fed batch and continuous operation mode and complete degradation was achieved at 1250 mg/L initial mixture concentration under fed-batch mode. In order to achieve high degradation rate under continuous operation mode at low hydraulic retention time (HRT), the biomass from the effluent was microfiltered using an indigenous low-cost tubular ceramic membrane and recycled into the bioreactor. This biomass recycling strategy was overcoming the biomass wash-out limitation of the continuous operation without biomass recycle and enhance the biomass concentration in the bioreactor which leads complete degradation of EDPs, even at 24 h HRT. A novel TPPB system showed complete degradation of DMP and DEP by C. funkei at 3500 mg/L initial concentration of their mixture within 30 h under fed-batch mode.

The results obtained in this study suggest that membrane-integrated bioreactor was best for efficient and continuous treatment of EDPs containing wastewater. In addition, toxicity analysis of the degraded phthalates revealed very high GI and low mortality of brine shrimps, further confirming the potential of membrane-integrated bioreactor system for treating such wastewater. The significance of this study lies in its potential to provide an effective and efficient solution to treat wastewater containing such emerging pollutant. The use of bioengineered system for biodegradation can provide a cost-effective and environmentally friendly alternative to conventional treatment methods. The outcomes of this study will contribute to the development of innovative and eco-friendly approaches for treating wastewater and mitigating the impact of EDPs on the human, animal and aquatic environment.