Chemical Engineering Journal 200–202 (2012) 459–470

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

Treatment of aqueous effluents containing non-aqueous phase liquids in rotating biological contactor with algal bacterial biofilm

Suparna Mukherji *, Anal Chavan

Centre for Environmental Science and Engineering (CESE), Indian Institute of Technology (Bombay), Powai, Mumbai 400076, India

HIGHLIGHTS

- A biofilm of oil degrading bacteria and sessile algae was developed in a RBC.
- Greater than 99% TPH removal could be achieved at HRT greater than 18 h.
- Algae facilitated operation at relatively high organic loading rate.
- In-situ generation of alkalinity prevented pH drop during oil biodegradation.
- Oil was sorbed on the biofilm and bulk of the aliphatic fraction was biodegraded.

ARTICLE INFO

Article history:
Received 3 January 2012
Received in revised form 8 June 2012
Accepted 11 June 2012
Available online 30 June 2012

Keywords:
Algal–bacterial system
Biofilm reactor
Oily wastewater treatment
Petroleum hydrocarbon degradation

ABSTRACT

Rotating biological contactors (RBCs) have been widely used for treatment of effluents containing soluble organic compounds. This study reports treatment of aqueous effluent containing diesel oil (0.6%) as a model non-aqueous phase liquid (NAPL) in a RBC. The NAPL serves as the sole substrate for the bacterial culture, *Burkholderia cepacia* that is inoculated along with a sessile algal culture for biofilm formation. After biofilm formation in batch mode, the 3-stage reactor was operated in a flow through mode. Data was collected over the unsteady state and also for steady state operation over hydraulic retention time (HRT) range 12–24 h and total petroleum hydrocarbon (TPH) loading range 23.9–47.8 g TPH/m^2 d. Greater than 99% removal could be achieved for TPH loading up to 31.8 g TPH/m^2 d. The models available for predicting removal efficiency of soluble substrate at various HRT values could not be applied for this system. While the assumption of uniform distribution in each stage of the RBC is valid for soluble substrate, it is invalid for NAPLs as illustrated by the unsteady state profile. The stage-wise effluent TPH profiles obtained during unsteady-state operation was indicative of a plug flow reactor with dispersion (PFDR) with sorption and biodegradation occurring simultaneously. The diesel oil in the aqueous phase sorbed on the algal–bacterial biomass and bulk of the aliphatic fraction was biodegraded. The aromatic fraction of diesel accumulated on the biofilm. This system is very complex and new models need to be formulated for understanding and elucidating treatment of NAPL containing aqueous effluents in RBCs.

1. Introduction

A rotating biological contactor (RBC) is an attached growth bioreactor consisting of a series of discs covered with active microbial film that are partially submerged in the wastewater. Rotation alternately exposes the biofilm on the discs to air and wastewater for efficient oxygenation. Due to its various advantages, the RBC reactor has been widely used for the treatment of effluents containing soluble organic compounds. The advantages include: high treatment efficiency, low energy requirement, low manpower requirement and resistance towards shock loadings. Successful application of RBC has been reported for domestic sewage treatment and for treatment of wastewater containing soluble organics, such as, phenols [1] and complex wastewater containing phenolics, heterocyclics and polynuclear aromatic hydrocarbons (PAHs) in dissolved form [2].

In addition to the utilization of RBC for the treatment of soluble substrate, a few studies have proposed the use of RBC for treatment of effluents containing oil and other non-aqueous phase liquids (NAPLs). Tyagi et al. [3] reported the treatment of petroleum refinery wastewater containing low concentration of oil (27–125 mg/L) using a RBC equipped with discs lined with polyurethane foam (RBC–PUF) and inoculated with seed culture obtained from an activated sludge unit treating the same wastewater. In petroleum refineries and petrochemical complexes biological treatment is typically attempted after recovery of oil in oil–water separators

* Corresponding author. Tel.: +91 022 25767854; fax: +91 022 25764650.
E-mail address: mitras@iitb.ac.in (S. Mukherji).

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http://dx.doi.org/10.1016/j.cej.2012.06.076