EFFECT OF TEMPERATURE AND CARBON ON PHENOL DEGRADATION BY PSEUDOMONAS AERUGINOSA (NCIM 2074)

M.V.V. CHANDANA LAKSHMI* AND V. SRI DEVI *

Department of Chemical Engineering (Biotechnology), College of Engineering, Andhra University, Visakhapatnam 530 003, Andhra Pradesh, India

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ABSTRACT

Phenolic compounds are hazardous pollutants that are toxic relatively at low concentrations. Accumulation of phenol creates toxicity both for flora and fauna. Because of its toxicity, there is a need to decontaminate the phenol-laden soils. Hence, bioremediation is a very useful alternative to conventional clean-up methods. The aim of this work was to study the effect of two variables – temperature (30°C, 32°C, 33°C, 34°C) and carbon (0.5, 1, 2, 3, 4 gm/L) to identify the significant effects and interactions in the batch studies. It was found that the degrading potential of Pseudomonas aeruginosa (NCIM 2074) was strongly affected by the variations in carbon and temperature. Optimum conditions of the variables for the growth of P. aeruginosa (NCIM 2074) and for maximum biodegradation of phenol are temperature (32°C) and carbon (0.5gm/L). These results are useful to understand the physiological and biochemical properties of P. aeruginosa (NCIM 2074) before its optimum use in environmental application and these data will assist in choosing the right phenol degrader for a changeable environment.

INTRODUCTION

The massive increase in the synthesis of organic chemicals by man has led to the production of wide variety of compounds, some of which are xenobiotic. Their xenobiotic character means that their structures are not easily recognized by existing degradative enzymes and as a result they accumulate in the environment (Singleton, 1994). As they persist in the environment, they are capable of long-range transportation, bioaccumulation in human and animal tissue and biomagnifications in food chain. Phenol and its higher homology are aromatic molecules containing hydroxyl group attached to the benzene ring structure. The origin of phenol in the environment is both natural and industrial. Natural sources of phenol include forest fire, natural run off from urban area where asphalt is used as the binding material and natural decay of lignocellulosic material. Industrial sources such as oil refineries, chemical, petrochemical, pharmaceutical, metallurgical, pesticide products, paint and varnish industries, textile and also in the polymer industries like phenolic resins, bisphenol A, alkylphenols, caprolactums and adipic acid (Paula et al. 1998). The presence of phenol in water imparts carbolic odor to receiving water bodies and can cause toxic effects on aquatic flora and fauna (Ghadhi and Sangodkar, 1995). It is lethal to fish even at relatively low concentrations of 5-25 mg/L (Nuhoglu and Yakin, 2005). Phenols are toxic to human beings and effects several biochemical functions (Saha et al. 1999). The concentration of phenols in waste waters varies from 10 to 300 mg/L. Phenol is also a priority pollutant and is included...
in the list of EPA (1979) (Indu Nair et al. 2008). As a result, phenol - containing effluents have to be properly treated prior to discharge (Keith, 1976; Junglaus et al. 1976; Parkhurst et al. 1979; Pfeffer, 1979; Delfino and Dube, 1976). Efficient treatment methods are necessary to reduce phenol concentra-
tion in waste water to acceptable level, which is 5 
ppm (USEPA).

Conventional methods of treatment for pheno-
lac wastes have been largely chemical or physical methods like chlorination, advanced oxidation process (Santiago Esplugas et al. 2002), adsorption, solvent extraction, coagulation, flocculation, reverse osmosis, ozonation, photo catalysis, and electro-
lytic oxidation (Arutчhelnova et al. 2006), but these processes have led to secondary effluent problems. Biological treatment for the bulk removal of these pollutants is therefore generally preferred. Biological degradation of phenol has been extensively studied using pure and mixed cultures (Kang and Park, 1997; Huggens and Cooper, 1996; Wang et al. 1996; Ha et al. 2000; Chirwa and Wang, 2002). Several studies have been carried out with the bacterium P. aeruginosa in pure cultures (Agary et al. 2008) in which phenol is degraded via the meta-pathway (Sala-Trepat et al. 1996). The success of bioremediation may depend on the availability of microbial strains that can min-
eralize high levels of phenol and withstand adverse conditions to compete under in situ conditions. An effective bacterial inoculum should be able to toler-
ate high levels of phenol while maintaining a high level of activity to provide efficient mineralization (Shaw et al. 1997). Understanding the physiological and biochemical properties of phenol degrading bacteria is required before optimum use of bacteria in environmental applications.

The biodegradation of phenol by P. aeruginosa (NCIM 2074), a potential biodegrader of phenol has been investigated for its degrading potential under different operating conditions. Chandana and Srídevi (2006) identified the optimum conditions on phenol degradation by P. aeruginosa (NCIM 2074); pH 7, inoculum size 6% v/v. This is a continuation of previous studies. Two variables of temperature, glucose (as carbon source) were used to identify the significant effects and interactions in the batch studied.

**MATERIALS AND METHODS**

**Chemicals**

Phenol (99% pure, chemical grade) 4-amino an-
tipyrine and all other chemicals used were from Merck.

**Source of organism**

The microorganism P. aeruginosa (NCIM 2074) was obtained from culture collection (NCL) Pune, India. The microorganism was maintained on a medium containing Beef extract: 1.0 gm/L; Yeast extract: 2.0 gm/L; Peptone: 5.0 gm/L; NaCl: 5.0 gm/L and Agar: 20 gm/L. The pH of the medium was adjusted to 7.0 by adding 1N NaOH. It was stored at 32°C for further use.

**Effect of temperature and carbon source**

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phenol degradation. In addition, the rate of phenol degradation was tested.

REFERENCES


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