Kinetic modelling for removal of *m*-cresol from wastewater using mixed microbial culture in batch reactor

Sudipta Dey and Somnath Mukherjee

ABSTRACT

An indigenous mixed microbial culture isolated from an effluent treatment section of a coke oven plant has been studied for its *m*-cresol biodegradation capacity under aerobic batch reactor operation. The culture, after acclimatization could biodegrade up to 700 mg/L of *m*-cresol. The *m*-cresol concentration in the present study was at 50 mg/L and then ranged from 100 to 700 mg/L with step up concentration of 100 mg/L. Both biodegradation kinetics and microorganism growth kinetics were studied and kinetic parameters were estimated. The result showed that *m*-cresol was an inhibitory-type substrate and the inhibition effect became predominant after 200 mg/L of initial *m*-cresol. The specific growth rate of microorganisms increased up to 200 mg/L of *m*-cresol as sole carbon source, and then started decreasing. The kinetic data obtained in this study have been fitted to different substrate inhibition models (Haldane, Han-Levenspiel, Edward, Luong, Aiba, Teissier, Yano-Koga). Among all models, Han-Levenspiel and Luong were best fitted for this study (root mean square error = 0.001349). In addition, the variation of observed yield coefficient Yx/s with initial *m*-cresol concentration was investigated. The values of kinetic constants estimated by the models proved that the mixed culture used in the study had good potential for *m*-cresol degradation.

Key words | biodegradation, kinetic models, *m*-cresol, mixed culture, substrate inhibition kinetics

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ABBREVIATIONS

μ	specific growth rate (hr^{-1})
μ_{max}	maximum specific growth rate (hr^{-1})
S	substrate concentration (mg/L)
Ks	half saturation constant (mg/L)
Ki, Ksi	substrate inhibition constant (mg/L)
K_1, K_2, K	positive constant (mg/L)
S_m	critical substrate concentration (mg/L)
q	specific substrate degradation rate (hr^{-1})
q_{max}	maximum specific substrate degradation rate (hr^{-1})
So	initial substrate concentration (mg/L)
X	microorganism concentration (mg/L)
Xo	initial microorganism concentration (mg/L)
Yx/s	microbial growth yield (mg/mg)
T	time (hr)
n, m	empirical constants

INTRODUCTION

Phenolic compounds are common water pollutants from various industrial waste streams, such as polymeric resin producing companies, coal gasification plants, oil refining and coke oven industries, fibreglass units, pharmaceuticals, explosive manufacturers and varnish industries (Juang & Tsai 2006; Yan *et al.* 2006). They are also included in the list of priority organic pollutants of the US Environmental Protection Agency (Yan *et al.* 2006). Among all phenolic compounds, cresols are the major toxic organic pollutants that remain at the top of the list for the inherent difficulties they pose during their degradation. *m*-cresol is an isomeric phenol, with a methyl substituent at the meta position relative to hydroxyl group of phenol. In addition to being highly toxic and a potential carcinogen, cresol causes adverse effects on the central nervous system, lungs, kidneys and

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