# Biodegradation of cyanide and evaluation of kinetic models by immobilized cells of Serratia marcescens strain AQ07

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ORIGINAL PAPER

# Biodegradation of cyanide and evaluation of kinetic models by immobilized cells of *Serratia marcescens* strain AQ07

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**Abstract** Immobilized form of *Serratia marcescens* strain AQ07 was experimented for cyanide biodegradation. Cyanide degradation (200 ppm) was achieved after 24-h incubation. Three parameters were optimized which included gellan gum concentration, beads size, and number of beads. In accordance with one-factor-at-a-time method, cyanide removal was optimum at 0.6% w/v gellan gum gel, 0.3-cm-diameter beads, and 50 beads number. It was able to withstand cyanide toxicity of 800 ppm, which makes it very suitable candidate in cyanide remediation. Beads reusability indicates one-cycle ability. The first cycle removed 96.3%, while the second removed 78.5%. Effects of heavy metals at 1.0 ppm demonstrated that mercury has a considerable effect on bacteria, inhibiting degradation to 61.6%, while other heavy metals have less effect, removing 97–98%. Maximum specific degradation rate of 0.9997 $h^{-1}$ was observed at 200 ppm cyanide concentration. Gellan gum was used as the encapsulation matrix. ɤ-picoline-barbituric acid spectrophotometric analytical method was used to optimize the condition in buffer medium integrated with potassium cyanide via one-factor-at-a-time and response surface method. The range of cyanide concentrations used in this research, specific biodegradation rate was obtained to model the substrate inhibition kinetics. This rate fits to the kinetic models of Teisser, Aiba and Yano, which are utilized to elucidate substrate inhibition on degradation. One-factor-at-a-time approach parameters were adopted because it removes more cyanide compared to response surface methodology modules. The predicted biokinetic constant from this model suggests suitability of the bacteria for use in cyanide treatment of industrial waste effluents.

**Keywords** Gellan gum · Immobilized · Kinetic models · Substrate inhibition

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## Introduction

Huge quantities of cyanide are used in industrial activities all over the world. This includes electroplating, gold mining, metal plating, coal gasification, pharmaceuticals, ore leaching, plastics, aluminum electrolysis, and synthetic fiber (Kjeldsen 1999; Yanase et al. 2000). Cyanide is considered as one of the most toxic chemicals in the world. In living organisms, it deactivates respiratory function of a living cell by firmly binding to the terminal oxidase (Chena and Liu 1999; Yanase et al. 2000). In order to protect the environment, all cyanide-polluted waters need to be treated before being discharged to the environment (Chen et al. 2008). Several conventional treatment methods that are utilized in

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