Biodegradation Of Irradiated Toxic Aromatic Compounds

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1.Summary

There is minimal information on the bioremediation of the radioactive waste let alone biodegradation of irradiated organic compounds. The irradiated organic pollutants, even if not severely radioactive, are mostly toxic and hard to degrade (recalcitrant) in nature. Irradiated organics and radioactive actinides occur as mixed wastes which poise disposal challenges since different regulatory requirements apply for the disposal of radioactive wastes and hazardous conventional wastes (Roberts, 1998). The problem is further compounded, if there is a mixture of organic compounds in the radioactive waste. Other compounds in the mixture may inhibit the degradation of one component and different conditions may be required to treat different compounds in the mixture. Hence there is a need to consider these pollutants when deciding a suitable disposal option for radioactive waste. In this study, the biodegradation pathways of organic compounds discharged together with radioactive waste are investigated. Preliminary studies conducted to treat the irradiated organic compounds in simulated waste streams have shown significant impacts of both the presence of nuclides and irradiated carbon species on the organic pollutant removal kinetics.

Keywords: biodegradation, radioactive waste, radionuclides, irradiated organic compounds, phenol

2. Extended Abstract

Radioactive wastes are mostly generated from applications of nuclear technology in energy, medicine, agriculture and industrial applications and from activities of ores and production and processing of oil and gas. Uncontrolled release of radioactive wastes from medical and industrial application, from nuclear reprocessing plants and from production of nuclear weapons still pose many problems to human life and the natural environment due to its toxicity and the long half-lives of the radioisotopes. There has been an increased interest in the use of microorganisms for the treatment of contaminated sediments and waters impacted by nuclear waste due to the perceived cost-effectiveness and efficiency of biological systems over the currently used chemical-based methods (Gadd, 1996; Sar *et al.* 2004; Lloyd and Renshaw, 2005).

In this study, the biodegradation pathways of organic compounds discharged together with radioactive waste are investigated. Phenol and strontium a major radionuclide found in radioactive waste water was used to stimulate the organic radioactive waste. Phenol was used in the study as a model aromatic compound due to simplicity of its the structure and due to the fact that its biodegradation pathway generally known. In the initial phase biodegradation studies are carried out using pure cultures of

Pseudomonas aeruginosa and *Pseudomonas putida* obtained from the Department of Microbiology and Plant Pathology, at the University of Pretoria.

Methods

Phenol concentrations were determined sphectrophotometrrically according to the Folin-Ciocalteu method (Box, 1983).

Results and Discussion

The results obtained show that the rate of phenol degradation was similar for both *P putida* and *P. aeruginosa* and (Figure 1a and 1b). All tests were carried out in triplicate. The rate of phenol degradation was higher in the test without strontium, a major component of radioactive wastewaters. This suggests some degree of inhibition in the degradation of phenol by strontium. There was no phenol degradation in the sterile controls. This also suggests the feasibility of biodegradation of organic pollutants by *P putida* and *P. aeruginosa*.

In addition, during the biodegradation of phenol there was a development of brown colour in the test with phenol only and phenol with strontium. However the brown colour was darker in the test with only phenol. The brown colour was not due to phenol photoxidation since uninnoculated phenol medium (control) did not produce the brown colour. This observation was similar to that described in other reports in which it was attributed to the oxidation of phenol or one of its degradation pathway intermediates (Gibson *et al.* 1968b; Reardon *et al.* 2000).

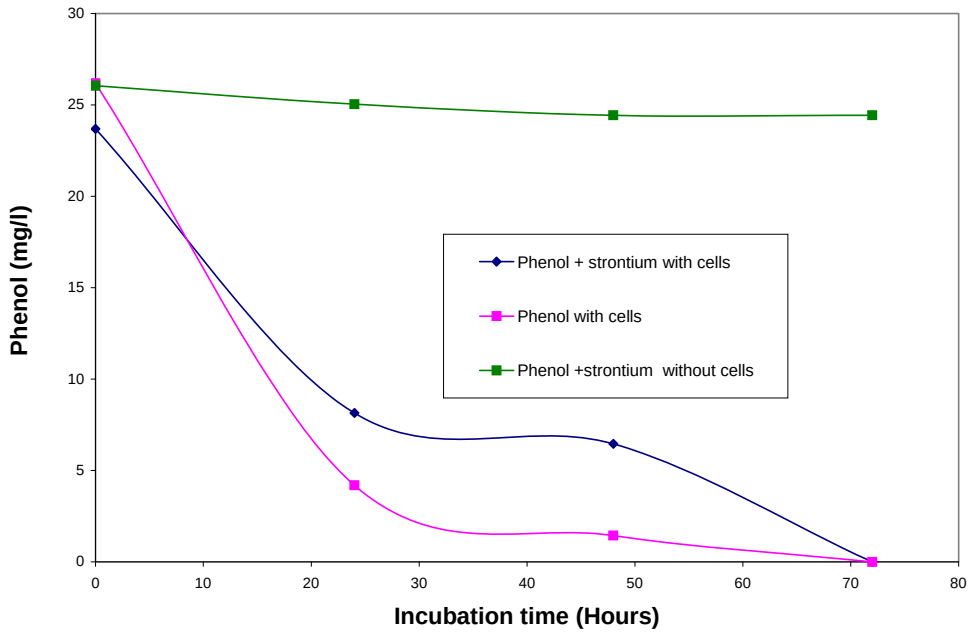

Figure 1a: Phenol degradation by *Pseudomonas putida*

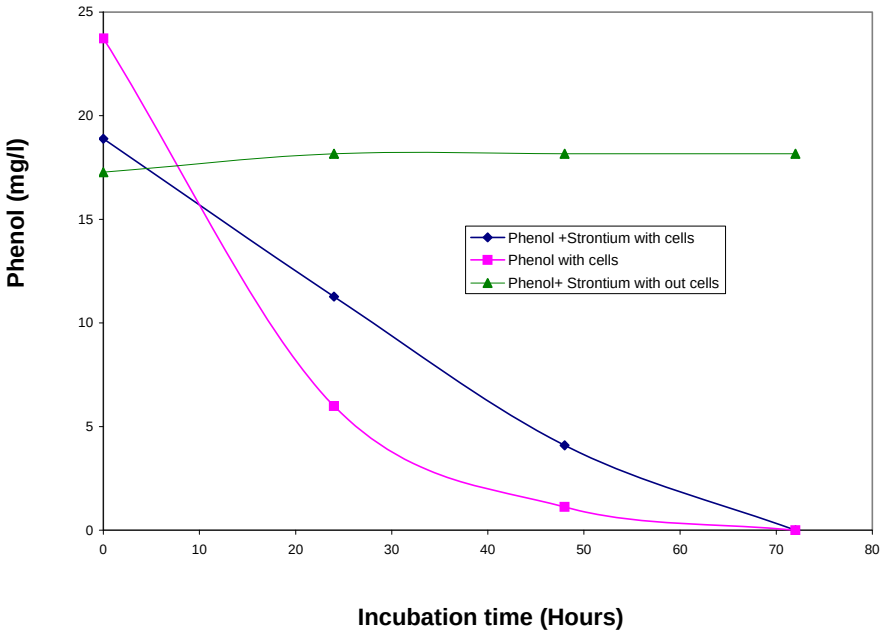

Figure 1b: Phenol degradation by *Pseudomonas aeruginosa*

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