CHAPTER 1

INTRODUCTION

Because of the widely uses of heavy metals and inorganic compounds in many countries, those hazardous wastes being released into the environments have resulted and caused health problems. In Thailand, the evidences of heavy metal (e. g., chromium, Cr*) and hazardous waste (e. g., phenol, Ph) contaminations in the environment have been found frequently. Those pollutants are removed from industrial wastewater by physico-chemical methods, i. e., evaporation, ion exchange, precipitation and reverse osmosis, or by biological treatments, i.e., aerobic and anaerobic technologies or by the combination of both methods.

Biological methods have been successfully employed to remove the pollutants in treatment systems because they are probably more effective and less costly than the physico-chemical treatments. A variety of previous works have revealed the biological detoxification of chromium through microbial reduction of Cr(VI) to Cr(III) by various bacteria, i. e., ***Pseudomonas aeruginosa*** (Summers and Jacoby, 1978 and Cervantes et.al., 1990), ***P. fluorescens*** (Bopp et.al., 1983 and Ohtake et.al., 1987), ***P. ambigua*** (Horitsu et.al., 1987 and Suzuki et.al., 1992), ***P. putida*** (Ishibashi et.al., 1990) and ***Escherchia coli*** (Shen and Wang, 1992 and 1993). Phenol degradation is also occurred in certain bacteria, i. e., ***P. putida*** (Feist and Hegeman, 1969 and Bayly and Wigmore, 1973) and ***P. acidovoran*** (Schmidt and Alexander, 1985).

---

* The abbreviations of terms used in the text were shown in **ABBREVIATIONS AND SYMBOLS** on page xxi.

Biodegradation, owing to its potential cost effectiveness, efficiency and less impact on natural environments, was a primary technology for removing contaminants from polluted sites and water streams. Bioremediation technology has focused on removing both organic compounds, e. g., aromatic compounds and inorganic compounds, e. g., heavy metals. Frequently, some organics, such as, phenols were detected along with inorganics, such as, heavy metals (Shen et.al., 1996). Chromium and phenol were detected in the environments and toxic to terrestrial and aquatic lifes including human, and thus were listed as priority pollutants (Keith and Telliard, 1979). Generally, they were cocontaminants (Shen et.al., 1996) and found to be discharged together in the same industrial processes, i. e., wood preserving, metal finishing, petroleum refining, leather tanning and finishing, paint and ink formation and manufacturing of automobile parts (Shen and Wang, 1995a). Thus, microbial or bacterial reduction of Cr(VI) with simultaneous degradation of aromatic pollutants may represent a beneficially biological process (Shen and Wang, 1995a). It is known that microorganism could not destroy metals, but they may alter the oxidation state and reduce the toxicity of the metals. Biological transformation for detoxification and removal of metals may be found in many aspects, including microbial reduction of chromate, from hexavalent form to less toxic and less soluble form or trivalent form (Lovley, 1993). The approach may be to combine the bioremediation of organic and inorganic contaminants, which could benefit the biooxidation of organic by minimizing the toxic effects of metals (Shen et.al., 1996). Possibly, simultaneous reduction of chromium and degradation of phenol were studied in a coculture of ***E. coli*** **ATCC 33456** and ***P. putida*** **DMP-1** (Elovitz and Fish, 1994; Shen and Wang, 1995b). A kinetic model was proposed to describe simultaneous Cr(VI) reduction and phenol degradation in the coculture (Shen and Wang,

1995a). In fact, it was shown that certain strain of *P. putida* can transform both chromium (Ishibashi et.al., 1990) and phenol (Bayly and Wigmore, 1973).

In Thailand, researches in this area were chromium recovery from tanning industrial wastewater (Pransawad T. and Chavalparit A., 1994), the uses of anion-exchange method in chromium removal from chrome plating effluent (Kitchainukool K. and Nakkeaw P., 1994) and the uses of aquatic plant in constructed wetlands for chromium treatment from electroplating industrial wastewater (Kananidhinan L., 1996).

To define further the efficiency of chromium and phenol transformations by bacterial strains, isolated in Thailand, i. e., one strain was capable of transforming both chromium and phenol or coculture of chromium-transforming bacterial strain and phenol-transforming one, the isolation, screening and selection of those bacterial isolates were performed. The studies were conducted in laboratory scale. Three of 150 strains in pure culture of chromium-resistant bacteria, 3 of 225 strains of phenol-resistant bacteria and 3 of 120 strains of chromium/phenol-resistant bacteria were selected and chosen for coculturing and single culture in chromium/phenol transformation.

1.1 OBJECTIVES

i) To perform the isolation, screening and selection of chromium detoxifying and/or phenol-degrading bacterial strains in pure cultures;

ii) to examine the effects of pH and temperature on growth of the selected bacterial strains;

iii) to investigate the efficiency of simultaneous chromium detoxification and phenol degradation by the selected bacterial strains; and

iv) to study some mechanisms related to simultaneous chromium detoxification and phenol degradation by the selected bacterial strains.

1.2 SCOPES OF STUDY

In this thesis, bacterial isolates, i. e., chromium-resistant, phenol-resistant and chromium/phenol-resistant, were isolated from, at least, fifty samples of soils, sludges and waters were collected from contaminated areas or natural sources. Those selected strains were further tested, i. e., chromium detoxification and/or phenol transformation and degradation, effect of pH and temperature on growth and some mechanisms related to simultaneous chromium detoxification and phenol degradation.

1.3 PLACES

Laboratories, especially, Rm. 305 and 306, the Department of General Science, the Faculty of Science, Chulalongkorn University.

Scientific and Technological Research Equipment Centre, Chulalongkorn University, for electron microscopy and high performance liquid chromatography.

1.4 ANTICIPATED BENEFITS

The studies may provide available results for some applications as following :

i) The uses of single and coculture of the selected bacterial strains in simultaneous chromium detoxification and phenol degradation could be an alternative and beneficial way for treatment of chromium and/or phenol contamination;

ii) The selected bacterial strains, i. e., chromium- and/or phenol-resistant could be used and applied to other systems of organic and inorganic contamination efficiency; and

iii) Advanced researches should be promoted financially and academically, i. e., genetic manipulation and factors, for development of appropriate technology used in industrial scale in Thailand.

1.5 COMPONENT OF THE THESIS

This thesis comprises five chapters including this introduction. Chapter 2 gives literature survey concerning chromium, phenol, methods for removal, mechanisms used by microorganisms for chromium-resistance, phenol-resistance and chromium/phenol-resistance and application of microorganisms for bioremediation. In Chapter 3, materials and methods are discussed. The results could be found in Chapter 4 and the Chapter 5 are discussion, conclusion and some useful suggestions.