CHAPTER I

INTRODUCTION

1.1 Statement of problem

Over the past fifteen years, Thailand has an increase of petroleum industries and gas stations. This is especially from 1994 to 2007 when the numbers of gas stations increased from 9,000 to 18,534 stations and also produced a large volume of wastewater containing various pollutants (Panpanit *et al.*, 2001; Department of Energy Business, 2008). These gas stations generate an average of 20 m^3 per day of wastewater (Panpanit *et al.*, 2001). US-EPA has raise awareness of the following parameters from vehicle and equipment wash waters: TSS, pH, salts, particulate matter, oil, grease, organics, COD, chlorinated solvents, detergents, lubricants, additives, heavy metals, antifreeze, and acid/alkaline wastes (Environmental Protection Agency [EPA], 1999). Thus, this enormous volume of wastewater and its harmful properties have become an environmental concern in Thailand. Generally, wastewater from gas station is generated from various activities such as car washing, floor cleaning, toilet and cafeteria usage, lubricant changing, etc. Wastewater from car washing operations contains suspended solid, emulsifier, and oily wastewater. Mixed lubricant oil and emulsifier are always found in car wash wastewater (Panpanit *et al.*, 2001). The lubricating oils from the refinery processes of crude oil are very complex and contained mixtures of hydrocarbons including linear and branched paraffins; and cyclic alkanes and aromatic hydrocarbons ($> C_{15}$ with boiling points between 300 and 600 °C). However, lubricating oils obtained from the residual fractions have some compounds with boiling points of up to 815 °C (Vazquez-Duhalt, 1989). A major problem of lubricating oils is that they can contain as much as 4 to 8% polyaromatic hydrocarbon before use (Wright *et al.*, 1993). Thus, car wash wastewater is considered as hazardous industrial wastewater.

Oily wastewater is not only present in free oil form, but also in oil-in-water emulsion formed by admixture of automotive oil such as lubricant oil with emulsifier and wash water (Delchad, 1992). The conventional treatment method such as the American Petroleum Institute (API) gravitational oil separator and Corrugated Plate Interceptor (CPI) can remove only free oil and settled solid. These techniques can not satisfactorily handle the oil-in-water emulsion (Panpanit *et al.*, 2001). Therefore, the oily wastewater from car wash process in gas stations has become a crucial problem to the public sewer system.

Emulsified oil can be removed by several methods such as heating, configuration, biological treatment, filtration, adsorption, and chemical treatment (Delchad, 1992; Panpanit *et al.*, 2001). In recent year, biodegradation has been a focus of interest for the treatment of petroleum contaminated area. However, in the natural environment microbial degradation is slow essentially because of the lack of hydrocarbon-degrading microorganisms, the toxicity of some components, such as aromatic compounds, the limited oil-water interface, the insufficiency of dissolved oxygen, the non-optimal temperature, and the lack of nutrients (Atlas *et al.,* 1972). The use of oil sorbent materials, for example chitin, chitosan, bentonite, and activated carbon, can enhance oil contaminated water biodegradation (Ahmad *et al.*, 2005).

Chitosan is a natural sorbent, which have been used in many applications, ranging from food and separation technology to wastewater treatment (Ahmad *et al.*, 2005). Many reports demonstrate that chitosan has excellent properties, such as biodegradability, biocompatibility, adsorption property, and flocculating ability, consequently it can be applied to various processes such as sorption, coagulation, and biodegradation (Majeti, 2000). This research used chitosan instead of conventional sorbents or coagulants to treat oily wastewater containing lubricating oil and an emulsifier. The application of chitosan for oil removal was previously studied but only with palm oil mill effluent and crude oil contaminated sea water (Majeti, 2000; Ahmad *et al.*, 2006). To improve the oil removal efficiency, chitosan was later used as matrix for bacterial immobilization. Immobilized cells can degrade toxic chemicals faster than conventional wastewater treatment systems since high densities of specialized microorganisms are used (Jianlong *et al.,* 1998). The use of bacterial immobilized chitosan to clean-up oil-in-water emulsion has never been done. Therefore, this research immobilized oil-degrading bacteria on chitosan and then investigated the potential and effectiveness of the immobilized bacteria on oily wastewater treatment.

1.2 Objectives

The main objective of this study was to treat the oil-in-water emulsion, the major problematic component of oily wastewater from gas station, by bacteria immobilized on chitosan. The specific objectives were:

1.2.1 To determine the optimal oil sorption condition of chitosan in terms of chitosan dose and mixing time.

1.2.2 To evaluate the efficiency of oil-degrading bacteria isolated from soils for degrading lubricating oil and oil-in-water emulsion.

1.2.3 To develop bacterial inoculum for clean-up oil-in-water emulsion by immobilizing oil-degrading bacteria on chitosan.

1.2.4 To evaluate the efficiency of bacteria immobilized on chitosan for the treatment of oily wastewater.

1.3 Hypothesis

Chitosan-immobilized bacteria could be applied for clean-up the oily wastewater from gas station since the emulsified oil was sorped on chitosan and simultaneously degraded by the immobilized bacteria.

1.4 Scopes of the study

The research was divided into three phases as follows:

1.4.1 The optimal oil treatment condition of chitosan

The amount of chitosan was varied to find the lowest amount of chitosan that provide maximum oil removal efficiency. Mixing time was varied to find the appropriate time for oil sorption. Synthetic oil-in-water emulsion, which represents an actual car wash wastewater, was used in this study. It was prepared by mixing lubricating oil (PTT V-120) with distilled water and an emulsifier. Tween80, a nonionic emulsifier representing the major components in commercial car wash detergent (Alters, 1998), was used.

1.4.2 The effectiveness of oil biodegradation by bacteria isolated from soils

Lubricating oil-degrading bacteria were isolated from five soil samples. Then, the biodegradability of all isolates was determined to select the strains of bacteria that provided the highest oil biodegradation. The selected strains were applied to degrade oil-in-water emulsion.

1.4.3 Oil-in-water emulsion treatment by chitosan-immobilized bacteria

A bacterial strain that provide the highest oil-in-water emulsion degradability from previous study was selected and immobilized on chitosan. The study compared three forms of chitosan, including powder chitosan, flake shrimp shell chitosan, and flake squid pen chitosan for bacterial immobilization. Then, three types of treatment were examined: (I) sorption by chitosan, (II) degradation by the isolated bacteria, and (III) sorption and degradation by chitosan-immobilized cells. Finally, oil removal efficiency of each treatment was determined.