CHAPTER 1
INTRODUCTION

1.1 Introduction

A lack of proper sanitation system is a common problem in developing countries, especially those with rapid urbanization. Septic tanks are a typical wastewater treatment system largely found in the developing countries owing to their simplicity, ease of operation, low costs. However, it is found that the septic tank effluents often fail to meet the effluent standard and, when released to the environment, cause contamination problems with surface and underground water. Therefore, septic tank effluent post-treatment is highly recommended (Chang *et al.*, 2007). The septic tank effluent polishing can be conducted using membrane bioreactors (MBRs) which are reported to have small footprint and reactor requirements, high effluent quality, good disinfection capability, higher volumetric loading and less sludge production comparing to traditional processes (Judd, 2005).

However, membrane bioreactors have some problems, in particular membrane fouling and concentration polarization. Operational and maintenance costs of the membrane bioreactor are high, due to membrane fouling. Membrane fouling deteriorates the permeability of the membrane and consequently increases energy consumption in a membrane bioreactor (Song *et al.*, 2008). Microfiltration (MF) or Ultrafiltration (UF) has limited ability to remove small colloidal particles and dissolved pollutants from water. In drinking water production, the presence of natural organic matter (NOM) leads to disinfection by-product (DBP) formation, which is a public health concern. Similarly, the effective removal of organic matter is essential in high-grade wastewater reuse applications. Another shortcoming is membrane fouling, which is the transient or irreversible loss of membrane productivity in terms of transmembrane pressure (TMP) and permeability (Erdei *et al.*, 2008).

Fouling is a complex phenomenon with many influencing factors including the membrane pore plugging, chemical degradation and concentration increase of contaminants including the bacteria, organic and inorganic material near the membrane surface. The flux decline resulting from fouling depends on the physical and chemical parameters of the solution to be treated such as concentration, temperature, pH, ionic strength and specific interactions (hydrogen bonding, dipole-dipole interactions). It has been known that organic materials in water and wastewater are largely responsible for membrane fouling, which reduces the membrane performance and causes irrecoverable loss in permeate flux thereby resulting in more frequent replacement of the membrane (Lee *et al.*, 2005). Fouling may be abated by various techniques, such as feed pre- treatment, using additional force fields, system operation at low fluxes, manipulating the hydrodynamic conditions, backflushing the membrane with permeate and/or air, membrane relaxation (intermittent operation) and preventive chemical treatment (Hilal *et al.*, 2005).

Coagulation and flocculation have been long employed to reduce fouling and improve organic matter removal in cross-flow MF/UF systems (Mietton *et al.*, 1992). Coagulation and flocculation is a physico-chemical process which allows fine particles and colloids to agglomerate in order to form bigger elements, which are easier to separate in the liquid phase. The feed pre-treatment could be helpful in minimization of membrane fouling because the relative small particles, which are considered as a cause of membrane fouling, could become bigger particles having less fouling tendency due to the coagulant/flocculant (Song *et al.*, 2008).

The addition of coagulant/flocculant before UF or MF units without settling (in-line flocculation) is used to reduce fouling and improve permeate quality (Erdei *et al.*, 2008). Guigui *et al.* (2002) reported that good conventional coagulation conditions in terms of coagulant solution pH, coagulant type and dose should also provide good performance and treated water quality for in-line flocculation with UF. As a result, the in-line flocculation process will increase permeate quality and reduce membrane fouling.

The objective of this study is to evaluate the performance of in-line flocculation membrane bioreactor hybrid system by using polymeric flocculants, focusing on the characteristics of membrane fouling and organic matter removal efficiency.

1.2 Objectives of Study

1. To evaluate the performance of in-line flocculation membrane bioreactor hybrid system
2. To examine the effects of different flocculants on the membrane fouling and organic matter removal efficiency
3. To investigate the characteristics of membrane fouling

1.3 Scope of This Study

1. Wastewater used for this study was collected from septic tanks located at Chia Nan University of Pharmacy and Science, Taiwan.
2. The in-line flocculation membrane bioreactor hybrid system was operated at ambient temperature and conditions found in Taiwan.
3. The laboratory scale membrane module was made for membrane bioreactor system.
4. The jar tests of MBR mixing liquid and raw septic tank effluent were carried out by using PAM with different kind of charges.
5. The application of in-line flocculation hybrid system was investigated, in order to study the effects of PAM at various dosages on system performance.