CHAPTER I

INTRODUCTION

Hazardous inorganic contamination due to fluoride can seriously endanger the aquatic environment (Ndiaye *et al.*, 2005). The ingestion of excess fluoride by humans can cause fluorosis, which affects the teeth and bones. Drinking water is typically the most significant source of fluoride (Peter Sehn, 2007). The World Health Organization (WHO) recommends 1.5 mg/L as the maximum acceptable concentration of fluoride (WHO, 2004).

Lamphun province, located in Northern Thailand, is currently one of the areas where groundwater contains high amounts of fluoride--as high as 16 mg/L (Wongrueng, 2006). Thus, dental fluorosis has been extensively found in school children, and now some of the elderly are suffering from skeletal fluorosis.

Membrane filtration by reverse osmosis (RO) membrane was applied to remove fluoride from groundwater in Lamphun province. The ultra low pressure reverse osmosis (ULPRO) membrane is a new type of membrane that requires low operating pressures of 0.1-0.5 MPa, as compared to a typical RO membrane, which needs high operating pressures of 1.5-15 MPa.

Membrane fouling is a major problem in the membrane filtration process. It is referred to as a flux decline of a membrane filter caused by the accumulation of certain constituents in the feed water on the surface of the membrane or in the membrane matrix (Liu, C. *et al.*, 1998).

Silica fouling has been a major unresolved problem in RO processes. Deleterious effects include reductions in process equipment efficiency due to high-pressure drops, damage to membranes, unsteady-state operations as well as increases in energy losses and the overall cost (Sahachaiyunta, P. *et al.*, 2002). Thus, the effects of polymerized and colloidal silica fouling on fluoride removal by an ultra low pressure reverse osmosis (ULPRO) membrane were investigated.

1.1 Objectives of the study

The main objective of this research was to study the effects of silica fouling, both polymerized silica fouling and colloidal fouling, on fluoride removal by an ultra low pressure reverse osmosis membrane. The sub-objective was to investigate the concentration polarization phenomenon's effects on fluoride removal by the ULPRO membrane.

1.2 Hypotheses

1. The ULPRO membrane, a new advancement in membrane technology, can be utilized under low pressure conditions (0.1-0.5 MPa).

2. Silica fouling does not only cause a decline in the permeate flux, but also a reduction of the fluoride rejection rate.

3. The concentration polarization phenomenon may affect fluoride removal by the ULPRO membrane.

1.3 Scope of study

This study was conducted in a cross-flow filtration unit using UTC-70, which is an ultra low pressure reverse membrane. A membrane area of 60.0×10^{-4} m^2 was used under three transmembrane pressures (i.e., 0.1, 0.3, and 0.5 MPa). Concentration polarization was investigated to determine the mass transfer coefficient. Water, containing a fluoride concentration of 15 mg/L, was combined with silica concentrations of 0, 100, and 300 mg/L to prepare the feed solutions used to study the effects of silica fouling on fluoride removal by the ULPRO membrane.