CHAPTER I

INTRODUCTION

Like many countries, Thailand has been facing many environmental problems caused by growth of human activities. The heavy concentration of vehicles in most big cities seriously causes a large amount of toxic and obnoxious automobile emissions. In addition, city air may have an unacceptable level of various gaseous pollutants as well as particulate matter because of a sizable number of industrial plants. It has been reported that these gaseous pollutants significantly contribute to global impacts such as the greenhouse effect, acid rain, urban smog, and depletion of ozone layer in the upper stratosphere. It is also known that even though the concentration levels of the gases (toxic gases, malodorous gases, ozone-depleting gases, etc.) released are very low in the ppm or ppb orders, they not only lead to environmental deterioration but also cause public nuisances and may be detrimental to public health. Because of greater public awareness of the danger associated with polluted air, several attempts at environmental treatments have increasingly been made.

Recently, the following types of gas purification are of interest to the public as well as the industry, 1) removal of indoor air pollutants; 2) complete removal of dioxin from incineration plants; 3) complete removal of radioactive iodine compounds; 4) simultaneous removal of NO_x and SO_x in exhaust gases from cogeneration plants; 5) removal and decomposition of halocarbons; 6) ultrahigh purification of gas used for semiconductor industries (Tamon et al.,1995). These gases contain electronegative impurities such as sulfur

compounds and halogen compounds. Hence, development of efficient methods for ultrahigh purification is necessitated. In order to fulfill such requirement, Tamon et al. (1989) proposed a novel approach of gas purification based on the concept of electron attachment that has not yet been applied in the research field of gas separation.

The new method of electron attachment mechanism has an entirely different working principle from those of the widely-used conventional gas separation methods, such as 1) gas absorption, 2) adsorption, 3) membrane separation, 4) distillation, 5) cryogenic separation. In comparison to the conventional methods, the new method possesses the distinction that it has been shown capable of removing a variety of gaseous pollutants and harmful gases, including toxic gases, particularly at extremely low concentration levels (ppm or ppb orders). Whereas the conventional methods either have relatively low efficiency or are energy intensive at such low levels.

The present work aims at the research and development of a gaseous pollutant remover using electron attachment reaction. As found in prior works, the electron attachment method has already shown great potential for commercial application in gas purification. The important question is how to scale up the device. As a first step the effect of the reactor structure on removal efficiency must be understood. This is because a structural change is expected to affect simultaneously several important factors such as discharge current, electron energy or residence time in the reactor. Therefore, the main objective of the present work is to investigate the effects of the reactor structure (the cathode diameter, the anode shape, and the number of cathodes) on the resulting removal efficiency.

In fact, research and development activities on this new technology of removing gaseous pollutants were first initiated in Thailand by Wiwut Tanthapanichakoon et al. with close collaboration from M. Okazaki and H. Tamon. So far, no on-site test in an industrial plant has been carried out. Though the present work will not involve the on-site application, it is believed that the gaseous pollutant remover to be constructed, using the concept of electron attachment mechanism, will play an important role in environmental protection as well as protection of the health of people living in the affected communities.

With further development to enhance the effectiveness of this method, it is reasonable to expect the simultaneous removal of both gaseous pollutants and submicron aerosol particles since the basic principle of corona discharge and subsequent deposition on the anode is similar to that of an electrostatic precipitator. On the other hand, the pertinent phenomena here can be complicated by the decomposition of gaseous molecules. This is however beyond the scope of this work.

1.1 Objectives of present study

1.1.1 Development and construction of a gaseous pollutant remover using electron attachment reaction in the Department of Chemical Engineering, Chulalongkorn University

1.1.2 Carrying out a fundamental study on the gaseous pollutant remover in lab-scale experimental setup with emphasis on the effect of the reactor structure

1.2 Scope of this Study

1.2.1 Literature review

1.2.2 Design and construction of a lab-scale gaseous pollutant remover to be used in the laboratory

1.2.3 Setting up the experimental equipment including preparation of analytical instrument and a high-voltage DC generator

1.2.4 Studying the influence of the structure of a corona-discharge reactor on the removal efficiency by changing the following

- the cathode diameter
- the anode shape
- the number of cathodes inside the reactor

1.2.5 Proposing guideline for use in the scale-up of the reactor