CHAPTER I

INTRODUCTION

Nowadays air pollution in Thailand has become one of the most serious environmental problems. There are many sources of air pollutants such as heavy concentration of vehicles that release a large amount of toxic and obnoxious emissions. One of the air pollution problems in Thailand is emission gas from the crematoria during cremation rites. There are nearly 30,000 temples nationwide, including approximately 300 temples with crematory furnaces in Bangkok Metropolitan Area alone. Various malodorous gases and particulate are emitted during cremation, causing frequent complaints from vicinal communities. Typically ceremony gases are emitted from a stack to the atmosphere without adequate treatment. Only a few temples have installed furnaces with after-burning systems but an overwhelming majority of Bangkok temples have inadequate systems for treating the exhausted gas. For this reason it is worthwhile to develop an alternative gas treatment method that has high efficiency and low energy consumption to tackle this problem. In this research, the application of electron-attachment reactors in series to the removal of dilute gaseous pollutants will be investigated. Electron-attachment is a reaction involving low energy electrons and an extremely high selectivity for electronegative gases. Therefore, it has prospect potential to eliminate such malodorous gases which is emitted from the crematoria with a relatively low concentration.

Table 1.1 Types and concentrations of gaseous emission from a crematorium after 100-fold dilution (Nishida K. 1981, 1988).

	Components	**Concentration**
Air	N_2	78 %
	O_2	20~21 %
Low – concentration components	CO_2	0.01~0.02 %
	H_2O	0.022 %
	NO_x	80 ppm (max)
	SO_x	5.8 ppm (max)
	Acetic acid (CH_3COOH)	24 ppm
	Hydrocarbons	230 ppm (as propane)
Ultra-low-concentration malodorous components	Acetaldehyde (CH_3CHO)	0.04 ppm
	Styrene ($C_6H_5CH{=}CH_2$)	0.01 ppm
	Hydrogen sulfide (H_2S)	0.01 ppm
	Methyl mercaptan (CH_3SH)	0.001 ppm
	Dimethyl sulfide ($(CH_3)_2S$)	0.0005 ppm
	Ammonia (NH_3)	0.37 ppm
	Trimethyl amine ($(CH_3)_3N$)	0.023 ppm

Table 1.1 shows an example of the types and concentrations of gases emitted from the stack of a crematory furnace after the exhaust gas has been diluted 100-fold with ambient air. According to the treatment mentioned, their original concentrations of the malodorous gases are nearly 100 times higher before the dilution.

Table 1.2 VOC and odor control methods.

Method	Suitable condition / requirement	Advantage	Disadvantage
After-burning (thermal combustion)	Uniform furnace temperature (800-900 °C). Residence time about 0.5~2 sec. High gas concentrations. Steady state operation.	Simple and widely available.	Unsuitable for unsteady state operation. Large furnace required.
Catalytic reaction (catalytic combustion)	Known unchanged gas species. High gas concentrations are preferable. Adequate residence time. Steady state operation.	Can be operated at relatively lower temperatures compared to thermal combustion. High selectivity of targeted gas species.	One catalyst type not effective simultaneously for several gas species. Combustion requires moderate to high temperatures Disposal of spent catalysts or regeneration.
Adsorption	Relatively low temperature and low space velocity. Low gas concentrations.	Steady and unsteady operations.	Regeneration is often necessary to reduce costs. Relatively high pressure drop

	Usually unsteady operation. Known types of gas species.		Continuous operation requires multiple units Disposal of solid adsorbents. Complicated operation.
Gas absorption	Low to very high temperature. Usually steady operation. Low to relatively high gas concentrations. Known types of gas species.	Can simultaneously remove particulate and gas species.	Difficult to find the appropriate liquid absorbent Regeneration is often necessary to reduce costs. Complicated operation. Disposal of liquid absorbent.
Corona discharge, electron attachment	Low space velocity. Dilute to low gas concentrations. Electronegative gas species and/or oxidizable species by ozone. Steady and unsteady operation.	Rapidly reach the steady state. Multiple removal mechanisms.	Relatively big reactor. High investment. High voltage entails risks, including explosion when the combustible gas concentration is high. Automatic cleaning of the anodic surface is difficult. Undesirable by-product gas may be produced.

1.1 Objective of research work:

Investigate the effect of high temperature, coexisting gases and operating conditions on the removal efficiency of dilute malodorous gases mixed in nitrogen using single or double electron-attachment reactors in series.

1.2 Scope of research work:

1.2.1 The target systems in this research are either binary or tertiary combinations of:

- Acetaldehyde
- Ammonia
- Trimethyl amine

The emphasis will be on tertiary systems

1.2.2 The coexisting gas is one of the following:

- Oxygen (0-20%)
- Water vapor (0-10,000 ppm)
- Carbon dioxide (0-20%)

1.2.3 The range of experimental conditions investigated is as follows :

- Discharge current range 0 -3.0 mA
- The reaction temperature range from room temperature to 300 °C
- Concentrations of target gases are limited to the range of 100-2,000 ppm
- Operating conditions of 2 reactors in series will be varied to enhance the overall and individual removal efficiency while minimizing generation of byproducts