CHAPTER 1
INTRODUCTION

Air pollution was a major problem in our society, especially in the large cities. Air pollution is generated by six major types of sources:

1. Transportation;
2. Domestic heating;
3. Electric power plants;
4. Refuse burning;
5. Forest and agricultural fires;
6. Industrial fuel burning and process emissions (Sell, 1992).

The pollutants, in the air, include carbon monoxide (CO), oxides of nitrogen (NO_x), unburned hydrocarbon (HC), oxides of sulfurs, heavy metal, soots, polyaromatics, aldehydes, ketones, and nitro-olefins. The first four pollutants play important roles in an air pollution problem.

Oxides of nitrogen (NO_x) are hazardous substances causing the formation of smog and acid rain. The NO_x is formed by thermal fixation of nitrogen in the air at very high temperatures (> 1500 °C). The main source of NO_x is combustion. 43% of NO_x comes from automobile sources where NO_x levels are in the 100 to 3,000 vppm range (Heck and Farrauto, 1995). There are many factors that affect thermal NO_x formation such as oxygen availability, temperature, pressure, and residence time in combustion unit.

Oxides of nitrogen (NO_x) can be divided into six known gaseous compounds:

1. Nitric oxide (NO);
2. Nitrogen dioxide (NO_2);
3. Nitrous oxide (N_2O);
4. Nitrogen sesquioxide (N_2O_3);
5. Nitrogen tetroxide (N_2O_4);
6. Nitrogen pentoxide (N_2O_5).

Nitric oxide (NO) and nitrogen dioxide (NO_2) are the most hazardous gaseous among the oxides of nitrogen (NO_x), especially nitric oxide (NO). For these gases, the effect on humans is not well understood. However, they do act as irritants to breathing, and discomforting the eyes. NO_2 causes bronchitis, pneumonia, susceptibility to viral infection, and alterations to the immune system (Armor, 1993). NO is the key starting point for all of the other oxides of nitrogen. Moreover, NO is rapidly oxidized by ozone, OH, or H_2O radicals to form the higher oxides of nitrogen such as NO_2, HNO_2 and HO_2NO_2. Thus, if NO is prevented from entering the atmosphere, the problem of NO_x pollution can be eliminated.

Carbon monoxide which is a toxic, colorless, and odorless gas is produced by the incomplete combustion of carbon-based fuels. The concentration of CO in the atmosphere is dependent on time of day, location, weather and human activities. CO levels tend to be the highest in areas of heavy vehicular traffic (Hay, 1987).

The toxicity of CO is due to the interaction of CO with blood hemoglobin. When a mixture of air and CO is breathed, both are transferred through the lungs to the blood and adsorbed onto hemoglobin. Carbon

monoxide reacts with hemoglobin, 200 times more stronger than oxygen, to form carboxyhemoglobin (COHb) in the blood. Two percent of carboxyhemoglobin is enough to generate observable effects, and can be formed by an 8-hour exposure to only 10 ppm CO (Sell, 1992).

One of the most efficient technologies used to control nitric oxide emission is catalytic reduction using carbon monoxide, hydrogen, or hydrocarbon as a reducing agent. In this project, carbon monoxide was used as the reducing agent.

Following reactions that may occur in the study are:

$$2NO + 2CO \rightarrow 2CO_2 + N_2 \qquad (2.2.1)$$

$$2NO + CO \rightarrow CO_2 + N_2O \qquad (2.2.2)$$

$$2NO \rightarrow O_2 + N_2 \qquad (2.2.3)$$

In reaction (2.2.1), the rate of CO_2 formation is double the rate of N_2 formation. In contrast, if the nitrogen rate is greater than a half of CO_2 rate, it means that the catalyst should promote both NO-CO reaction (2.2.1) and NO decomposition (2.2.3). If the catalysts promote only reaction (2.2.2), N_2 rate will be less than a half of CO rate.