CHAPTER I

INTRODUCTION

The significant cause of air pollution is exhaust gases from automobiles which seems to be more and more. The toxic pollutants from gasoline engines are combined with suspended particle matter, carbon monoxide (CO), oxides of nitrogen (NO_X) and unburnt hydrocarbons (HCs). These pollutants have serious harmful effects not only for human beings but also for all environments.

It is necessary to take these pollutants control into action. Many ways of control and treatment exhaust gases are being used as follows:

1. Improvement of internal combustion engine system
2. Development of new engine design
3. Comsumption of others suitable fuels
4. Installation of pollutant control equipment

Nowadays, automobiles always use treatment technology to control exhaust gases before being emitted to atmosphere. The treatment technology is a catalytic converter or three-way catalyst containing the noble metals platinum (Pt), palladium (Pd) or rhodium (Rh) as active component [1]. These metals are deposited on alumina modified by additives like ceria. Such catalyst consist of a ceramic or metallic monolith coated with a washcoat, in most cases of alumina, which provides a high surface area.

Organic solvent vapors, however, can be eliminated by catalytic combustion over catalysts which have many features in common with catalytic converters for cars [2]. These organic solvent molecules are often considerably larger than CO and NO_X , so that compared to catalytic converters for cars, catalytic oxidation may require washcoats having pore-size distributions shifts towards larger pores in order to reduce intra-particle diffusion resistance [3].

Vehicle exhaust gases are complex mixtures, the composition of which depend on engine operating conditions [4]. Catalytic converters are used to minimize pollutants in the gas stream, mainly by reducting nitrogen oxides to nitrogen and by oxidizing carbon monoxide, unburnt hydrocarbons and hydrogen.

Many hydrocarbon species are present in automotive exhaust gases and three-way Pt-Rh catalyst are commonly used for their elimination [5]. Aside from the nature of the hydrocarbon species, their oxidation is influenced by many other parameters such as:

- The partial pressure of oxygen, nitrogen oxide, water vapour and sulfur dioxide.
- The nature, concentration and dispersion of the noble metal used. (Pt, Pd or Rh)
- The nature of the noble metal carrier. (Al_2O_3, CeO_2, etc.)
- Catalyst contamination by poisons.

For three-way catalyst the oxygen partial pressure is rather low and can become substoichiometric if there are momentary excursions of the air/fuel ratio into the rich region.

The water gas shift reaction,

$$CO + H_2O \longrightarrow H_2 + CO_2 \quad (1.1)$$

and the steam reforming reaction,

$$HC + H_2O \longrightarrow CO + CO_2 + H_2 \quad (1.2)$$

can also play a role in carbon monoxide and hydrocarbon removal.

Due to its good activity of Pt/Al_2O_3 in the oxidation of carbon monoxide and hydrocarbons as well as for the reduction of NO. This study is interested in the catalytic performance for automotive emission control. Conventional Pt automotive exhaust catalyst have a propane light-off temperature of about 495 °C; the light-off temperature is the temperature at which a 50% conversion is reached with respect to the gas being converted [6]. It is desirable to achieve lower light-off temperature for hydrocarbon oxidation because hydrocarbon emissions during cold-start operation of an automobile can significantly affect the emission content that is released. For example, during the first 60 sec. of cold-start , 65-70% of hydrocarbon emitted remain unconverted.

The preferred method of making conventional platinum automotive exhaust catalysts comprise [6]: (i) impregnating with platinum on alumina washcoat or support comprised substantially of alumina. (ii) The platinum applied to the washcoat or support may be added in a diluted aqueous solution containing chloroplatinic acid. The solvents are evaporated by heating to a temperature of about 80-100 °C and then subsequently calcining at temperature in the range of 400-600 °C for 4 hr.

A particular equipment is necessary for calcination. Thus, one of the purposes of this study is to find the possible way to reduce this procedure of preparing platinum supported on alumina catalyst (Pt/Al_2O_3) by using thermal pretreatment in simulated exhaust gas instead. The catalysts prepared by this method were investigated for automotive exhaust gas emission control.

The aims of this study is to enhance the performance of alumina-supported platinum catalyst (Pt/Al_2O_3) by replacing calcination step with pretreatment catalyst in simulated exhaust gas technique. Besides, the research is aimed to study the catalytic activity in the oxidation of carbon monoxide and hydrocarbon including the reduction of NO. The last purpose is to investigate the catalytic activity of Pt supported on washcoat monolithic catalyst.

1.1 The Objectives of This Study

1.1.1 To enhance the performance of platinum supported on gamma-alumina catalyst for the elimination of carbon monoxide and hydrocarbon.

1.1.2 To characterize the prepared catalyst.

1.1.3 To study the effect of pretreatment conditions in making catalyst on the catalytic activity in the redox reaction.

1.2 The scope of this study

1.2.1 Enhancing the performance of prepared catalyst by study the effect of

- platinum precursor salts.
- the calcination time.
- calcination and pretreatment in a simulated exhaust gas on the prepared catalyst.

1.2.2 Studying the effect of the following parameters on the activity of prepared catalysts in the simulated exhaust gases pretreatment:

- the oxygen content in exhaust gas for pretreatment.
- the pretreatment temperature from 200 ^{o}C to 700 ^{o}C
- the pretreatment time between 2 to 10 hours.

1.2.3 Testing the activity of prepared Pt-based metal catalyst which can be divided into two sections as follows:

1.2.3.1 Testing in simulated exhaust gases which has CO and propane as major components:

- At excess oxygen condition

1.2.3.2 Testing in simulated exhaust gases which has CO, propane, and NO as major components:

- At stoichiometric condition. [Stoichiometric No.(S) = 1.0]