Three - Way- Catalyst- Monolith Converters (Pt- Loaded) for Gasoline Engine: Experimental Study and Modeling

Intisar Hussain Aljumiliy[1], Farah Talib Al-Sudani[2] , Zaidoon Muhsen[3]
University of Technology, Chemical Engineering Department,Baghdad,Iraq.
1 Email: intisar59@yahoo.com, 2 Email: falsudany@yahoo.com , 3 Email: dr_zaidoon@yahoo.com

ABSTRACT

In this study the experimental and theoretical investigation have been carried out to study the performance of Commercial ceramic monolith catalyst with Pt loading of 0.5, 1 , and 1.5 wt% on the oxidation and reduction of exhaust gas (NO, CO, and HC) emitted from gasoline generator. The results showed that the increase in metal content leads to the decreasing of performance of the commercial ceramic monolith catalyst. Also the Pt loading over commercial ceramic monolith catalyst improves the CO oxidation rather than HC oxidation and NO reduction. One-dimensional heterogeneous (reactor and pellet) and axial dispersion model of non-isothermal operation was applied to describe a single channel of the monolith. This model takes into account both intra and surface concentration and temperature gradients within channel. Concentration profile along the reactor and into intra-catalyst dimension for the reactants and products were estimated.

INTRODUCTION

The reduction of CO,NO and hydrocarbon emissions from automotive exhaust gases has been extensively studied in the past two decades (Granger et.al ,2002).The catalytic monolith reactor has been widely used as a pollution abatement device for reducing the emission of CO,NO and hydrocarbon, because of its structural integrity and unique advantages such as high heat and mass transfer rates per unit pressure drop, high specific interfacial area, and ease of scale-up compared to packed-bed or ceramic foam reactors. It consists of a matrix of a large number of parallel channels of about 1mm hydraulic diameter. The catalysts deposited in the form of a wash coat (of typical average thickness of (10 - 250 mm) on the inner walls of the channel. As the reacting fluid flows along the channel, the reactants diffuse transverse to the flow direction from the bulk gas phase in to the washcoat where they diffuse and react on the active catalyst sites(wang et al,2011). The oxidation of CO and hydrocarbons and reduction of NOx takes place simutaneslly in the complex pours structure of catalytic washcoat layer which are formed by $\gamma - Al_2O_3$ support (alumina) with dispersed crystallites of nobile metals (typically Pt) as catalytic sites (Koci et. al,2004). The selective reduction of nitrogen oxide by various hydrocarbons was investigated with alumina and silica supported Pt catalyst by Burch et al,1997. They found the tendency to produce N2O in substantial quantities (typically up to 65% of the NO is converted in to N2O). Fabiano et al 2007, found that the methane conversion and CO selectivity increased with used of higher Pt content . Wang et al 2011 added the Pt to beta zeolite–Al_2O_3/cordierite, the Pt/beta zeolite–Al2O3/cordierite monolith exhibited good performance for the catalytic purification of automobile exhaust from real lean-burn engine. The main pollutants NOx, HC and CO can be simultaneously purified at 300–400 °C .In the present work , the performance of Pt/Al_2O_3 with Pt loading of 0.5 , 1, and 1.5 wt% on the treatment of exhaust gas emission from gasoline generator has been investigated experimentally and theoretically .

EXPERIMENTAL Work

CHARACTERISTIC OF THE SUPORT

Monolithic catalyst was made of ceramic honeycomb substrate The chemical composition was $\gamma - Al_2O_3$ 69.76%, SiO_2 11.3% , $Fe_2O_3$9.4 %, CeO_2 6.75% ,BaO2.6% ,TiO_2 0.01% , CuO 0.02% ,Rh 0.16% . The main physical parameters of honeycomb support are presented in Table 1 .

Table 1. physical properties of commercial monolith catalyst.

Physicals Properties	
Channel Structure	Circle
Number of channels, channel / cm^2	64
Channel spacing, mm	1.4
Wall thickness, mm	0.3
Wall porosity %	60
Bulk density, g / cm^3	1.4
Pore volume, cm^3 / gm	0.93
Surface area, m^2 / g	97