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Catalytic Converter in Automobile Exhaust Emission

Anupam Mukherjee
Student
Department of Chemical Engineering
Haldia Institute of Technology, West-Bengal, India

Kunal Roy
Student
Department of Chemical Engineering
Haldia Institute of Technology, West-Bengal, India

Jayabrata Bagchi
Student
Department of Chemistry
Sripat Singh College, West-Bengal, India

Konika Mondal
Student
Department of Mathematics
Krishnath College, West-Bengal, India

Abstract

A major part of the air pollution caused is due to the vehicular emission which is increasing at an alarming rate. The different types of vehicles like car, bus, truck etc. contribute a way as well as play a dominant duty in increasing air pollution. These vehicles find its running source mainly form the extracts of fossil fuels like petrol, diesel. The fuels undergo combustion to generate energy so as to support the vehicle for duty. The incomplete combustion of the fuels in the engine paves a way for production of products like the carbon monoxide, hydrocarbons and particulate matters. A high emission level is therefore a proved result. For the purpose of forcing the fuel to have efficient combustion and for reduction of the emission levels for reducing air pollution a wide range of processes are applicable. These include improvising engine design, fuel pre-treatment etc. Among these wide ranges of options available catalytic converter is found to be a better way for establishing an efficient combustion in the controller engine of the vehicle. Usage of noble group metal is an effective way for effective combustion like the platinum group metal serves way good for reducing the exhausts. With the help of secondary measures efficiency of the engine is improved as well. The techniques are still under development as because there are some limitations of the catalytic converters which are needed to be dealt with but the application of this technique has better achievement points as well.

Keywords: Automobile Exhaust System, Catalytic Converter in Exhaust System, Necessity of Catalytic Converter

I. INTRODUCTION

Always been disputed among the ecologists over the centuries and recent years is pollution of air. As the technology carry on sprouting and extending, it brings along many unwanted hazardous effects on topof its wide ranging applications. The vehicle exhaust limit takes a main production part for the emission of polluted gases. As we know that a number of vehicles voyages thousands of miles per year for the purpose of carrying various needs and demands. Subsequently, an increase in the number of vehicles led to the increase of pollutants in air [1].

Various combustion products and by-products are formed due to the partial combustion in the engine. The products formed from incomplete combustion of engine are hydrocarbons (HC), CO (carbon mono-oxide), NO_x (oxides of nitrogen) and the by-product formed from it is ground-level ozone due to reaction with hydrocarbons in the presence ofnitrogen oxides and sunlight, which is responsible mainly for smog. Also ozone is hazardous for our respiratory system. Nitrogen oxides and hydrocarbons have also contribution for the formation of ozone and acid rain. Carbonmonoxide creates obstruction for the flow of oxygen in the blood stream and it isvery much dangerous heart patient. Carbon dioxide does not affect human health directly,it goes about as a "Green-house gas" that traps the world's warmth vitality and produces global warming as industrialization and urbanization has assumed an immense part in making work for ordinary individuals[16].An exhaust system is the most important part of automobile as it takes a vital role in environment. Roughly 1/3 of the contamination the air is from the automobile fleet. So it is of considerable hugeness to control car contamination to accomplish the objective of cleaner air, which ought to help for lessening of green-house gasses. [2,3].

A. Exhaust System in Automobiles

The major persistence of the exhaust system is to eject burned gases or exhaust to the tail of the vehicle and to inhibit the sound of engine ignition. Exhaust system in automobiles take a very significant role to abate the environmental contamination.

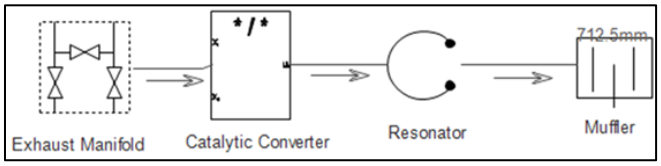

Fig. 1: Exhaust System in Automobile System.

B. Major Components of Exhaust System

- Exhaust manifold.
- Catalytic converter.
- Resonator.
- Muffler.
- Exhaust tail.

C. Working Process of Exhaust System

Exhaust gasses are gathered from the barrel head in the motor by an exhaust manifold. The exhaust manifold goes about as a channel, redirecting fumes gasses from all barrels of the motor then discharges them through a solitary opening, frequently alluded to as the front pipe. This exhaust gasses then go through a catalytic converter which expels hurtful components including carbon monoxide and hydrogen monoxide which are changed over into dormant gasses. The gasses then go through a silencer or muffler. It's exclusive when you hear an auto with a harmed silencer that you understand what a colossal contrast it makes to diminishing clamor levels. The silencer on your fumes contains a misleadingly basic arrangement of tubes that are finely tuned to mirror the sound waves created by the motor with the goal that they counteract each other. The silencer will consume after some time and when it in the end builds up a gap, regardless of how little, the sound waves are no longer constrained through the tubes and escape outside – making a ton of commotion simultaneously. At last the fumes exhaust exit by means of the tail pipe at the back which diverts gasses from the vehicle and the travelers inside.

II. CATALYTIC CONVERTER

As indicated by the meaning of chemistry, a catalyst is a substance that causes or quickens a compound response without itself being influenced. Catalysts take an interest in the responses, however are neither reactants nor results of the response they catalyze. An exhaust system is a vehicle discharges control gadget which changes over lethal by-results of burning in the fumes of an interior ignition motor to less poisonous substances by method for catalyzed compound responses [3]. It lessens temperature at which CO and HC change over into CO_2 and H_2O. Big and large exhaust systems utilize platinum gathering ofrespectable metals [4].

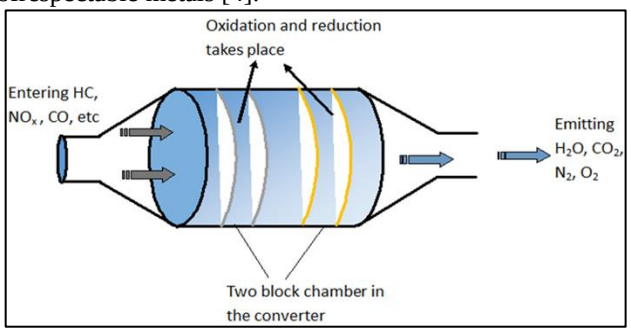

Fig. 2: Converting system in catalytic converter.

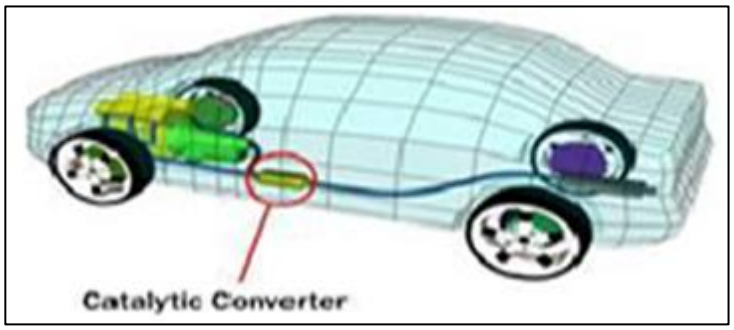

Fig. 3: Position of catalytic converter in automobile [15].

The contaminations have negative effect on air quality, environment and human wellbeing that leads in stringent standards of poison outflow. Quantities of option innovations like change in motor plan, fuel pretreatment, utilization of option energizes, fuel added substances, fumes treatment or better tuning of the ignition procedure and so forth, are being considered to lower the release levels of the engine. Out of various progressions available for auto vapor radiation control a fumes framework is found to best choice to control CO, HC and NO_x discharges from petrol driven vehicles while diesel particulate channel and oxidation forces converter or diesel oxidation impulse have so far been the most potential other option to control particulates outpourings from diesel driven vehicle [5]. An exhaust system (CC) is put inside the tailpipe through which destructive fumes gasses containing unburnt fuel, CO, NO_x are transmitted [6].

III. BACKGROUND OF CATALYTIC CONVERTER

The exhaust system was developed by Eugene Houdry, a French mechanical specialist who lived in the United States [6,7]. In 1950, when the consequences of early investigations of brown haze in Los Angeles were distributed, Houdry got to be distinctly worried about the part of car fumes in air contamination and established a unique organization, Oxy-Catalyst, to create exhaust systems for fuel motors - a thought relatively revolutionary for which he achieved a patent (US2742437). In any case, until the to a great degree viable against thump specialist tetra-ethyl lead was dispensed with from most gas over natural concerns, it would "harm" the converter by shaping a covering on the impetus' surface, successfully crippling it. The fumes framework was later on further made by John J. Mooney and Carl D. Keith at the Engelhard Corporation making the essential creation debilitate framework in 1973. Starting in 1979, an ordered diminishment in NOx required the advancement and utilization of a three path impetus for CO, HC and NOx reduction [8-13].

IV. TYPES OF CATALYTIC CONVERTER[4]

Mainly it is classified into two types- 1) Two-way catalytic converter & 2) Three-way catalytic converter. In another way it can be classified into two types also- 3) Monolithic converter & 4) Dual Bed converter.

A. Two-Way Catalytic Converter

This type is also known as a two-way catalytic converter, because it can only operate with hydrocarbons (unburned fuel) and carbon monoxide (brought about by somewhat blazed fuel). Oxidation converter components are normally canvassed in platinum. In two-way catalytic converter mainly two tasks simultaneously occur [14]. One is oxidation of carbon mono oxide to carbon dioxide. Another one is oxidation of unburnt and partially burnt hydrocarbons to carbon dioxide and water. For these two types of oxidation reactions, it is also known as oxidation type catalytic converter.

1) *Conversion Reactions in Two Way Catalytic Converter*

$$C_xH_{4x} + 2xO_2 \rightarrow xCO_2 + 2xH_2O \text{ (conversion of hydrocarbons)}$$
$$2xCO + O_2 \rightarrow 2xCO_2 \text{ (conversion of carbon mono-oxides)}$$

B. Three-way Catalytic Converter

Similar to the oxidation converter, the reduction catalytic converter helps to eliminate hydrocarbons and carbon-monoxide emanations, in addition to oxides of nitrogen discharges, or NO_x. NO_x outflows are created in the motor burning chamber when it reaches extremely high temperatures more than 2,500 degrees Fahrenheit, approximately. In this type of converter, a reduction reaction also occurs in addition to two oxidation reactions same as two-way converter. The reduction reaction occurs during the conversion of oxides of nitrogen to nitrogen and oxygen. So this type of converter is also known as reduction type catalytic converter.

1) *Conversion Reactions in Three Way Catalytic Converter*

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$$2NO_x \rightarrow N_2 + xO_2\ [O_2 + 2H_2 \rightarrow 2H_2O] \text{ (Decomposition of oxides of nitrogen)}$$

C. Monolithic Converters

These types of converters consist of ceramic material finished in a honeycomb arrangement to regulate exhaust gases flowing through it. The catalytic elements mean catalysts are sealed off by stainless steel. When ceramic beads are used rather than honeycomb structure, the operating unit is known as pellet type converter.

D. Dual Bed Converter

This is possibly one of the most proficient converters. The dual-bed is nothing but the combination of two-and three-way catalytic converters accommodated in a single part. Both converters are coupled through a chamber where incoming emissions are mixed. An air-line plugs into the blending chamber to drive air into the chamber to respond with the joined emanations and diminish hydrocarbon and carbon-monoxide discharges.

V. CONSTRUCTION OF THE CATALYTIC CONVERTER

It consists of following several components-

A. Core or Substrate

The core is regularly an earthenware honeycomb in advanced catalytic converter, yet stainless steel thwart honeycombs are utilized, as well. The honeycomb surface expands the measure of surface region accessible to support the catalyst, and in this way is frequently called a "catalyst supporter" [3].

B. The Wash Coat

A washcoat is utilized to make converters more proficient, regularly as a blend of silica and alumina. The washcoat, when added to the center, frames a harsh, sporadic surface, which has a far more prominent surface zone than the level center surfaces do, which then gives the converter center a bigger surface territory, and in this way more places for dynamic valuable metal destinations. The impetus is added to the wash coat (in suspension) before being connected to the core [14].

Fig. 4: Ceramic core converter [3].

C. The Catalyst

The catalystitself is regularly a valuable metal. Platinum is the most dynamic catalyst and is broadly utilized. It is not reasonable for all applications, be that as it may, on account of undesirable extra responses as well as cost. Palladium and rhodium are two other valuable metals utilized. Platinum and rhodium are utilized as a decrease catalyst, while platinum and palladium are utilized as an oxidization catalyst [3].

VI. INFLUENCE ON ENVIRONMENT[3]

Catalytic converter has turned out to be solid and powerful in lessening harmful tailpipe discharges. However, they may have some unfavorable natural effects being used:

The obligation for a rich blaze motor to keep running at the stoichiometric point implies it utilizes more fuel than a "lean burn" engine running at a blend of 20:1 or less. This builds the measure of fossil fuel expended and the carbon dioxide outflows of the vehicle. In any case, NO_x control on incline smolder motors is hazardous and troublesome.

Catalytic converter generation requires palladium and additionally platinum; part of the world supply of these valuable metals is delivered close to the Russian city of Norilsk, where the business (among others) has created Norilsk of most contaminated spots.

VII. CONCLUSION

Natural, environmental and wellbeing concern result in progressively stringent outflows controls of poison outflows from vehicle motors. Among every one of the sorts of advancements grew in this way, utilization of exhaust systems is the most ideal approach to control auto fumes outflow. Three-way catalyst with stoichiometric motor control frameworks remain the condition of workmanship technique for all the while controlling hydrocarbon, CO and NOx¬ outflows from vehicle. The practical reasons, constrained assets of platinum gathering (honorable) metal and some working confinements of platinum assemble metal based exhaust systems have roused the examination of option impetus materials [5].

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