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A Review on Working and Design of Convertor for Exhaust Gas Convertion

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Abstract

Air pollution produced from vehicles sources such as automobiles contributes major air pollution issues in rural as well as metro cities and industrialized hubs in both big and small population countries. Around 50 million cars are produced per year and over 700 million vehicles will be running worldwide.Vehicle population issue is estimated to grow close to 1300 million by the year 2035. In recent years, the demand for new and high performance of product is on the rise. Design changes in the product is subjected to efficient design. Apart from developing high performing products, different design approach is needed. Also it is essential to eliminate the over design which is finally not helpful to achieve the required results. Considering the catalytic convertor design research.

Keywords: *Air pollution, Exhaust gas converter, Monolith*

1.0 Introduction

Air pollution produced from vehicles sources such as automobiles contributes major air pollution issues in rural as well as metro cities and industrialized hubs in both big and small population countries [1]. Around 50 million cars are produced per year and over 700 million vehicles will be running worldwide. Vehicle population issue is estimated to grow close to 1300 million by the year 2035 [2].

Catalytic converter is the device that converts toxic and pollutants gas particles from engine exhaust into less toxic [3]. To address the current environmental issue, it is not only essential to use the current existing technology in all the vehicle as the convertor technology is well established with different types of convertors from many years, it is also important to use the convertor efficiently by ensuring suitable design which will help to convert all the gases coming from the engine.

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2.0 Convertor Parts

Metal cover: It is the metal cover to hold the monolith. Monolith Monolithic: are extruded structures that are the core of many catalytic converters, most diesel particulate filters, and some catalytic reactors. Most catalytic converters are used for vehicle emissions control.

Fiber mat: The ceramic fiber support mat can provide mechanical support, sealing, protection, thermal and sound insulation or other functions for the catalytic converter.

3.0 Observations and Findings

Fiber mat design will have the two sides as smooth and rough side. Smooth side should be on the body tube side to avoid the friction while stuffing the substrate and mat inside the canning and mat rough side should be towards substrate to have sufficient friction force to hold the substrate inside the canning thought the vehicle running.

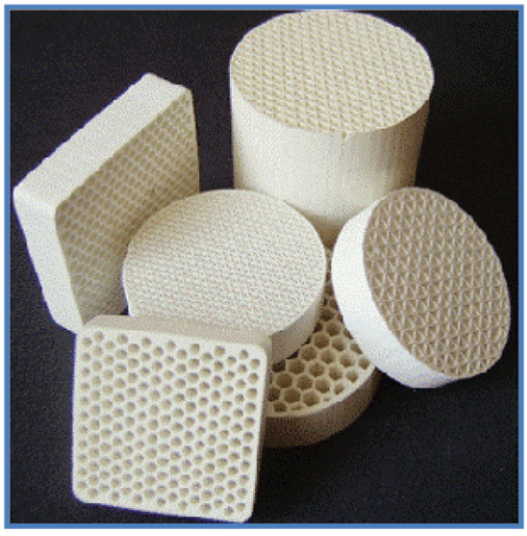

Figure 1: Monolith

As assembling the mat is very important in the canning, we have to use the concept of Poke-yoke to avoid the reserve of mat. Poke-yoke is the mechanism to avoid the error by automatic detecting mechanism or by the physical process tool or the design which will block to happen the error in the production of the product. As in the industry nowadays it is not allowed to have human assurance in the production, it is must to have the 100% detection of the error happening in the production and blocking the further production of the parts. In some production process whenever error will be detected there will be red light highlight which will alert the industrial production leader to stop the production. We can see that in the end of the mat we have tongue and groove shape which is placed in the tool having same tough groove

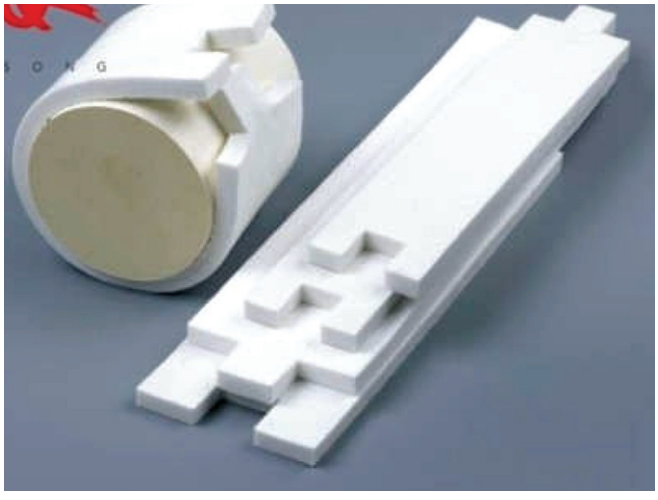

Figure 2: Fiber mat

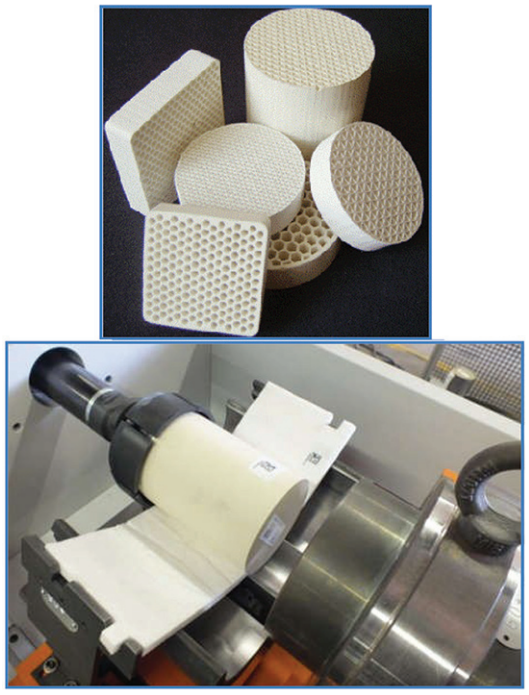

Figure 3: Monolith and Wrapping process

to fix the mat. When we put the mat in reverse way tool will not allow mat place and in some case sensor will not detect the tongue of the mat and it will alert and stop the production.

4.0 Working Method

After closely observing all the types of manufacturing process and design of convertor, we can say that shrinking and stuffing are both cost effective design as we will not have welding process included. This is the design widely available in the recent exhaust systems of car. But with this type of design its challenging to meet the product functional requirement as the shape of design should be circular. If it is the clamshell design then it is easy to achieve the required shape as we will be forming the sheet metal sheets. In the stuffing and shirking process its difficult achieve the required shape and hence required CFD flow. By understanding the design, product function and the manufacturing process. it is understood that we need to make a design which is able to hold the convertor in the place in the vehicle condition and also inlet of the convertor to be designed such a way that the flow of exhaust gas coming from the engine should be controlled to be guided in the proper way to flow the gas inside all the cells of the substrate.

Below is the design of the convertor showing the catalyst is placed with the holding force from the mat and the inlet conical shape to guide the flow.

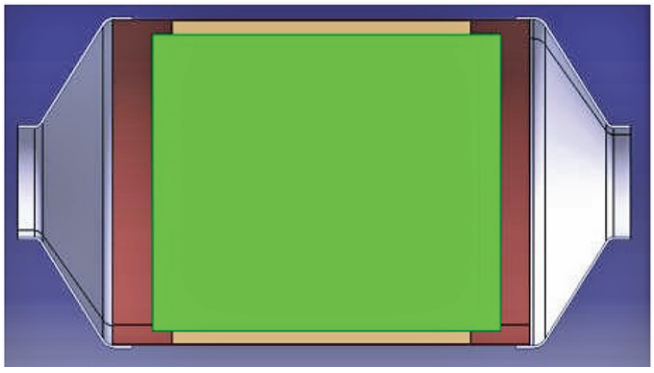

Figure 4: CAD Model

The above 3D design to be validated for the flow simulation to understand that the flow is distributed along all the substrate channels with equal velocity so that the complete exhaust gas will convert and all the precious metals in the catalytic convertor is efficiently used. The precious metals in the convertor are platinum, rhodium, palladium.

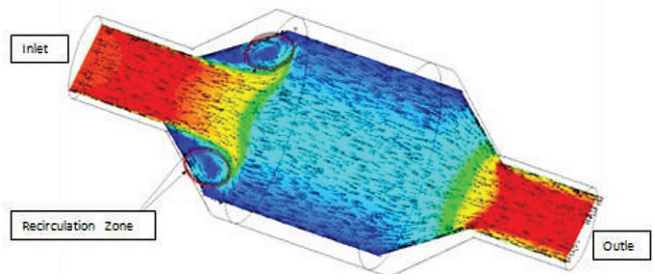

Figure 5: Air flow through container

From the above most of the existing design of convert CFD flow we can clearly see that there will be more recirculation zone and this will not allow to flow the exhaust gas uniformly through the catalytic convertor with same velocity. So here all the precious metal in the convertor will be efficiently used. By above results we can understand that inlet design should be such a way that flow should be distributed along the face of the substrate so that the flow will go in all the cells of the convertor and precious metal will be efficiently used. Solution can be a defector design in the front side of the convertor which will help to distribute the flow along all the cells of convertor.

5.0 Results and Discussions

This paper presents explanation of the different components of the exhaust system convertor, its function, characteristic and type of the manufacturing process. It is clearly discussed the design and manufacturing constraints of the convertor like clam shell can be manufactured with different required shapes but circular canning cover will have constraints to manufacture the required shape.

Considering all the design constraints and the manufacturing constraints innovating the new design to increase the efficiency was only by observing the CFD flow and having deflector design in the front side of the convertor will help to the precious metal like platinum, rhodium, palladium efficiently in the convertor. This design will have decrease the high temperature zones on the substrate by this way lifetime of the substrate can be increased.

Deflector material should be able to withstand high temperature gas coming from the inlet and also should be able to withstand high thermal fatigue.

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