DESIGNAND ANALYSIS OF CATALYTIC CONVERTER MODEL WITH SHAPE CHANGE FOR OVERALL IMPROVEMENT IN FLUID FLOW

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ABSTRACT

The main objective is to improve the fluid flow through the catalytic converter there by increasing the overall efficiency of its working. Based on this concept we intend to propose a new shape for the monolith present commonly used in the catalytic converter.

The catalyst converter acting as substrate. The automotive catalytic converter, usually the core is a ceramic monolith that has the honeycomb structure. The Metallic foil monoliths finished by Kanthal (FeCrAl) ware used in various applications particularly wherever high heat resistance is needed. The substrate was structured to produce a big surface area. The most catalytic converters are used in cordierite ceramic substrate.

In a catalytic converter as there are no moving parts, its working and operating efficiencies are solely dependent on the fluid flow inside its chambers which is the exhaust gases from the engine room. The absorption rate is proportionally high when the flow is laminar. However, due to the inner workings of the combustion chambers, it is not the case in general.

The main purpose is intend to regulate the flow with shape change of the monolith thereby expecting improved fluid flow with less turbulence and high dissipation rate through the substrate.

Abbreviations

CFD	Computational Fluid Dynamics
CC	Catalytic Converter
IC	Internal Combustion

1. INTRODUCTION

The catalytic converter is a device which acts as exhaust emission control that the converts toxic such as pollutants and gases in the exhaust gas from the IC engine into less-toxic pollutants through the catalyzing a redox reaction. The catalytic converters were frequently used in IC engine fuelled by gasoline or diesel as fuel. The first catalytic converter was in United States et. al. Arulprakasajothi (2015).. The two-way converter combines oxygen along with unburned hydrocarbons (HC), carbon monoxide (CO) and produce water

(H_2O) and carbon dioxide (CO2). However still the two-way converters are used to lean-burn engine etc. Because three-way-converter needs either stoichiometric or rich combustion for successfully minimize the NOx Vinod et. al. (2011).

The catalytic converters structured to produce a large surface area by substrate. The substrate is mostly used in the catalytic converter. The catalytic materials are titanium dioxide, Aluminium oxide, silicon dioxide can be used et. al. Mahalingam (2017). This in used maximizes the catalytically active surface which are available to react with the engine exhaust gases. The catalytic metal particles are withstand at high temperature of 1000 °C.

The platinum is mostly used as active catalyst, but is not suitable for such cases due to other reactions and cost.

2. METHODOLOGY

Catalytic Converter Model Creation in NXCAD

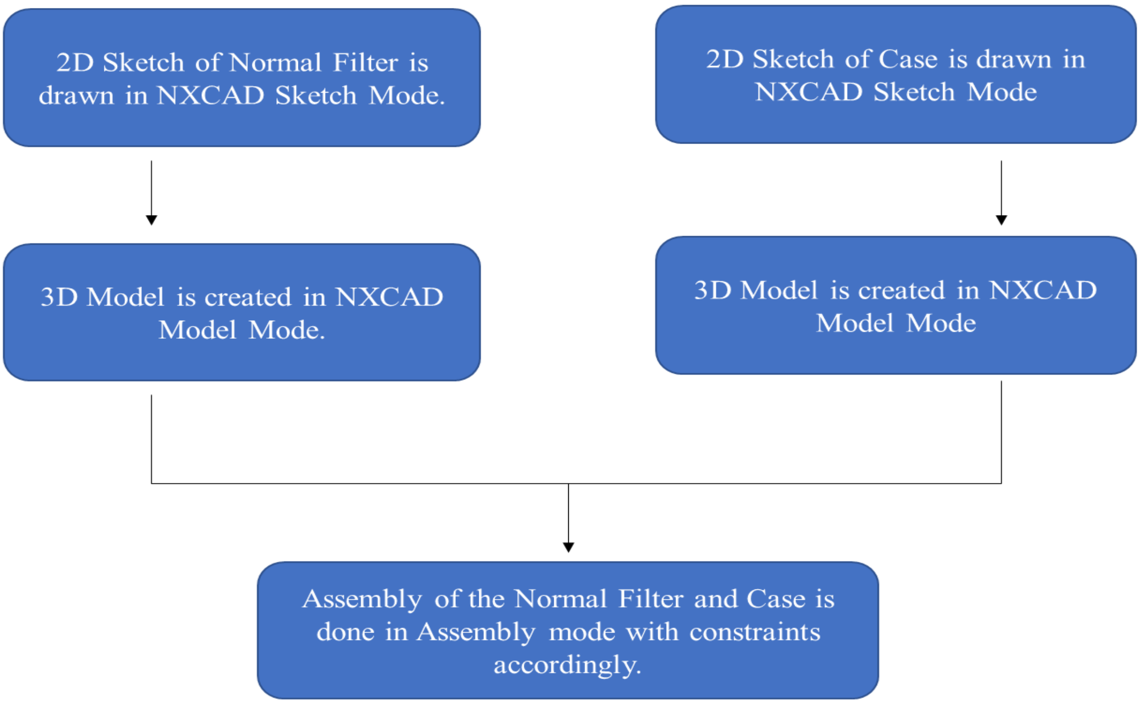

Fig.2.1 Catalytic Converter model

The genaral catalytic converter model creation is shown in above figure 2.1. The model was developed by using NXCAD. The 2D sketch is prepared by using NXCAD and convert into 3D model by same software. The assembly work is carried out by using normal filter followed bu various constraints.

3. DESIGN OF CATALYTIC CONVERTER

3.1 Reference Model

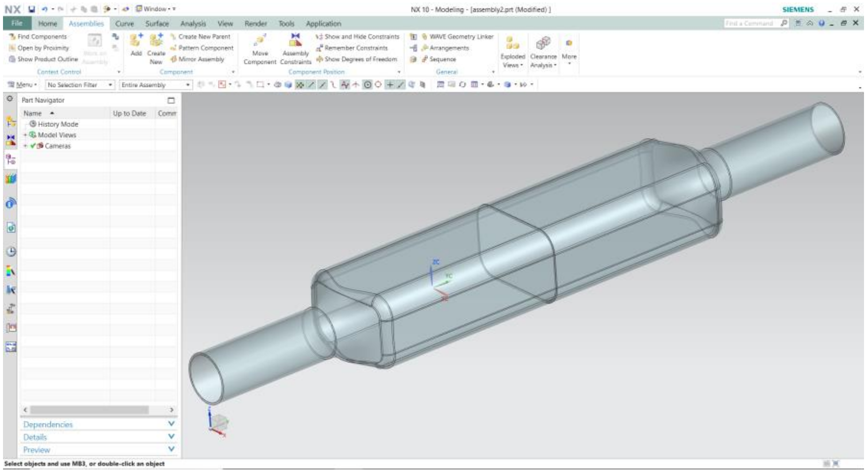

Fig. 3.1 Reference Model

The reference model which is shown in figure 3.1 and aero model is shown in figure 3.2. The both model plotted by using NXCAD.

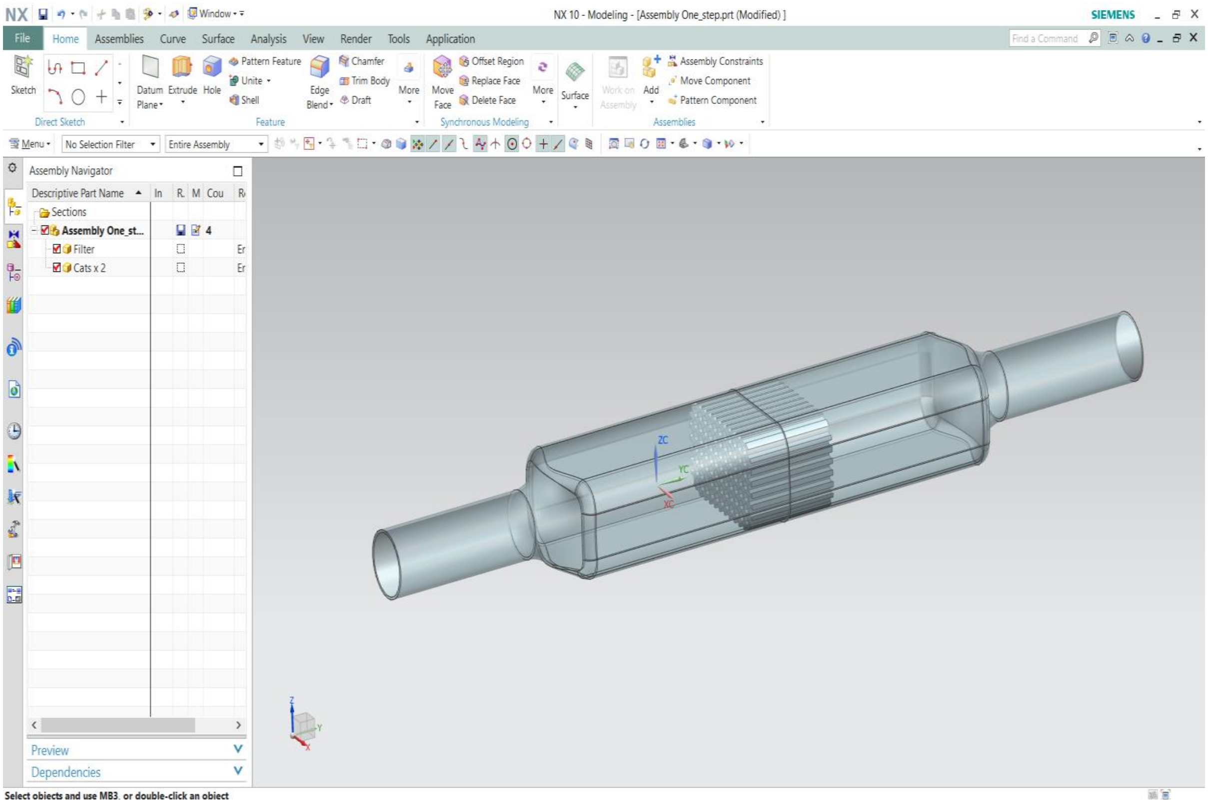

Fig. 3.1 Aero Model

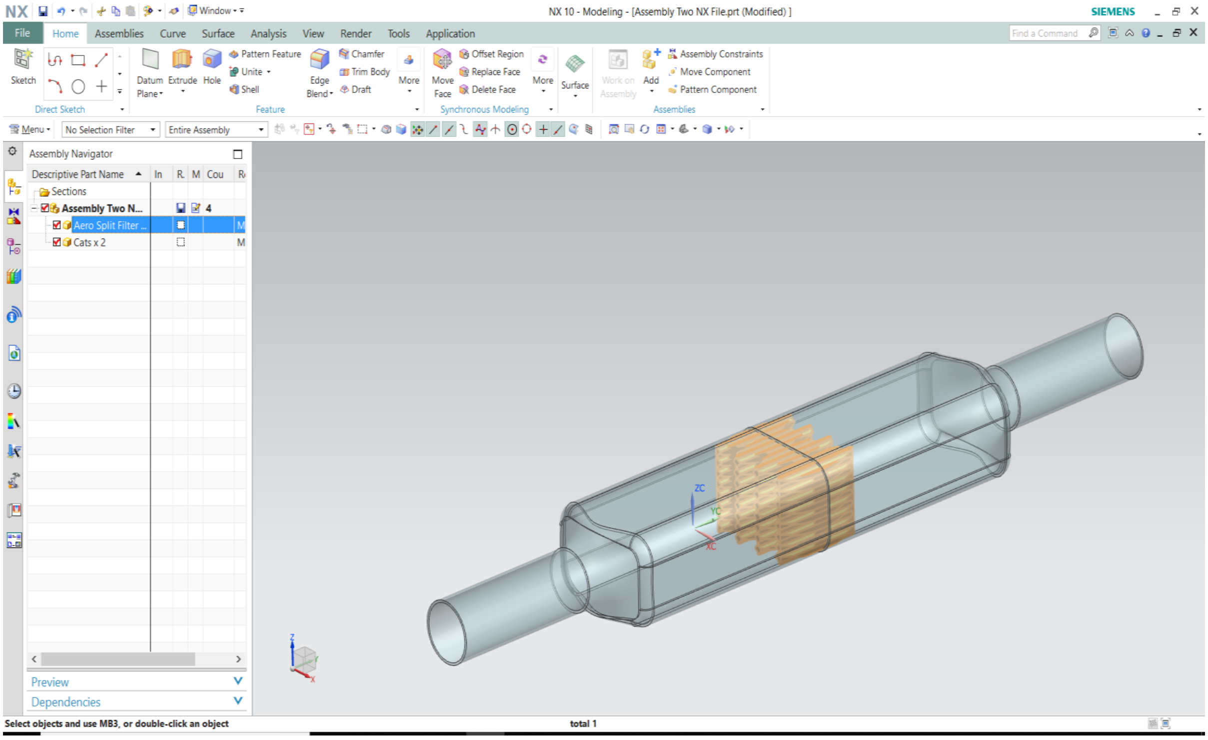

Fig. 3.3 Updated Reference Model

The updated reference model which is shown in figure 3.3 and updated aero model is shown in figure 3.3. The both model plotted by using NXCAD.

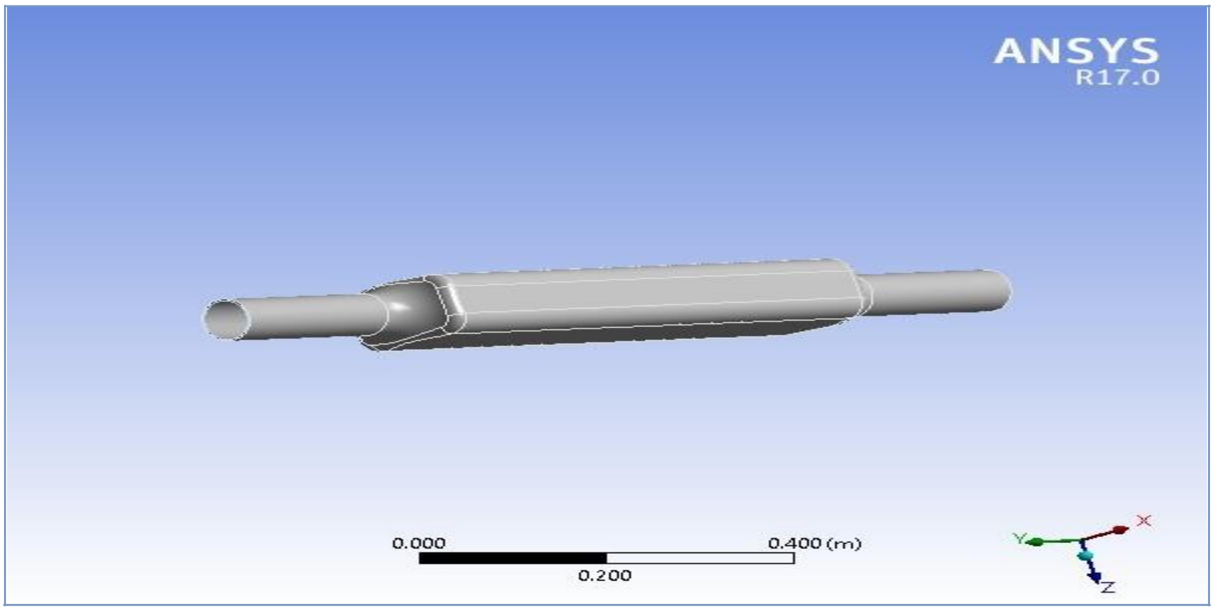

Fig. 3.4 Updated Aero Model

4. REFERENCE MODEL CFD RESULTS

Case material consideration: Aluminium 6061.

Inlet Condition: Velocity – 50 m/s | Outlet Condition: No back pressure.

Operating outside temperature: 300K | Working Fluid: Carbon di-oxide (CO_2).

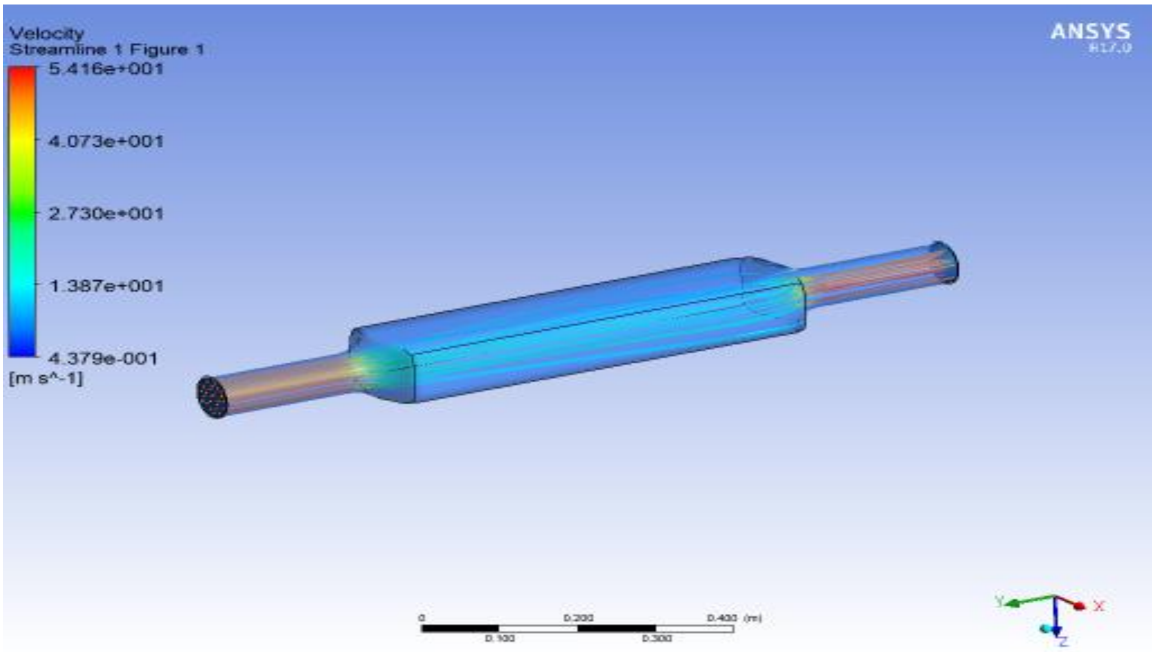

Fig.4.1 Velocity Streamline

The velocity streamline analysis is shown in figure 4.1 and velocity distribution contour in flow direction is shown in figure 4.2.

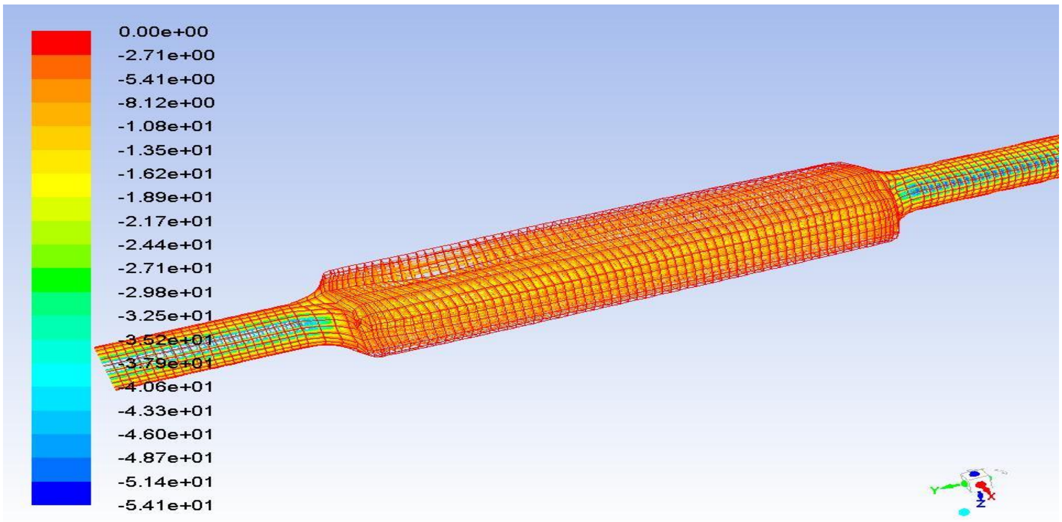

Fig. 4.2 Velocity Distribution Contour in Flow Direction

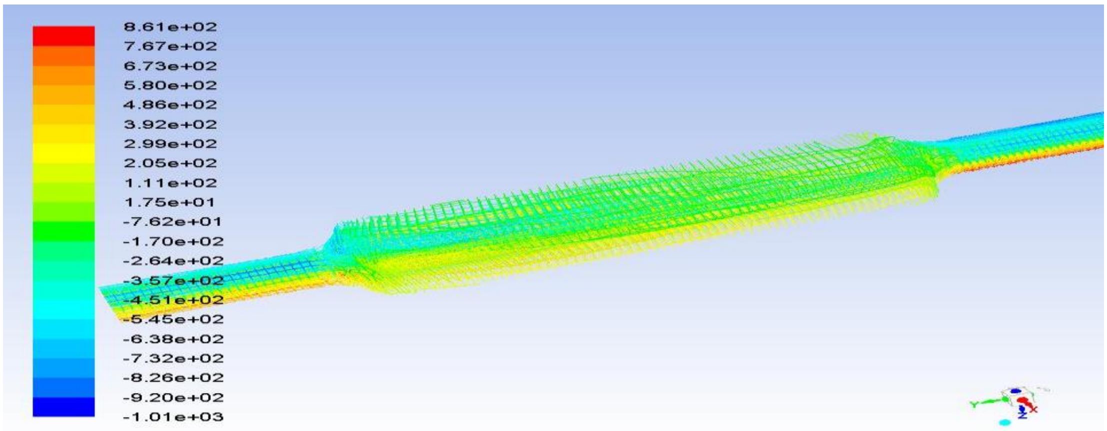

Fig.4.3 Change in Velocity (dY) Vs Position

The change in velocity vs Position is shown in figure 4.3. Here change in velocity taken in X axis and Position taken in Y axis.

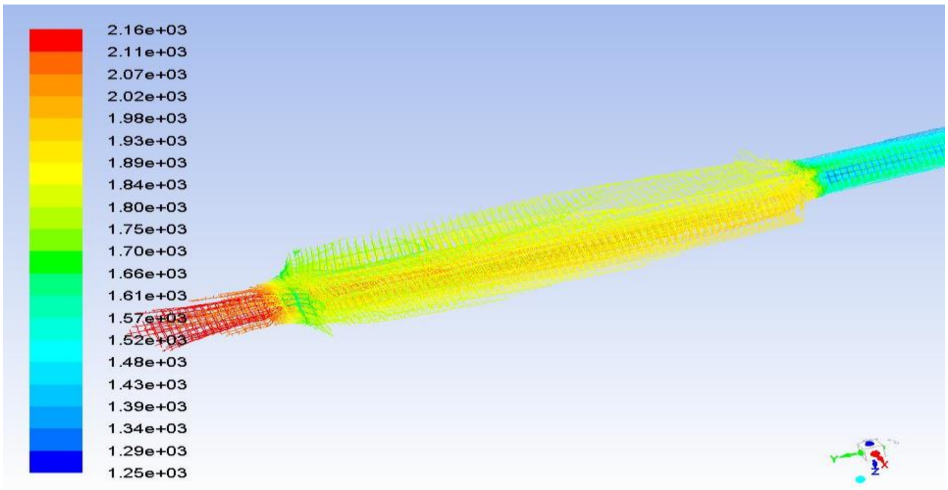

Fig.4.4 Total Pressure Distribution Vs Position

The total pressure distribution vs position is shown in figure 4.4. Here total pressure distribution taken in X axis and Position taken in Y axis.

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5. CONCLUSION

The proposal of new design for catalytic converter filter is created in PLM software NXCAD. The new aero model created would be analysed with CFD tests using analysis software ANSYS FLUENT. In the current model of Catalytic Converter (CC) the Filter used is a conventional one with honeycomb design for the fluid dissipation. The honey comb structure is selected for its structural stiffness as the working environment is fluctuating in high temperature differences. In conventional model the absorption is done logically by fluid flow obstruction. This results in turbulences and backpressure of the exhaust gases. The new shape facilitates an aero foil profile which will reduce the turbulence and caters to less obstruction in fluid flow. This improvement is expected based on the new shape in comparison with the conventional filter which has more obstructive shape for absorption. Moreover, the less material for surface absorption than conventional design is achieved by adding more aero foil split units in the updated Aero Filter Model and Analysed. On conclusion of complete project, we expect improved velocity distribution and pressure distribution with the new design model than the conventional model which is used in current models. This facilitates uniform reaction states and also high dissipation rate with less back pressure for the exhaust systems.

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