SNS COLLEGE OF ENGINEERING

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19OE120 AUTOMOTIVE ELECTRONICS

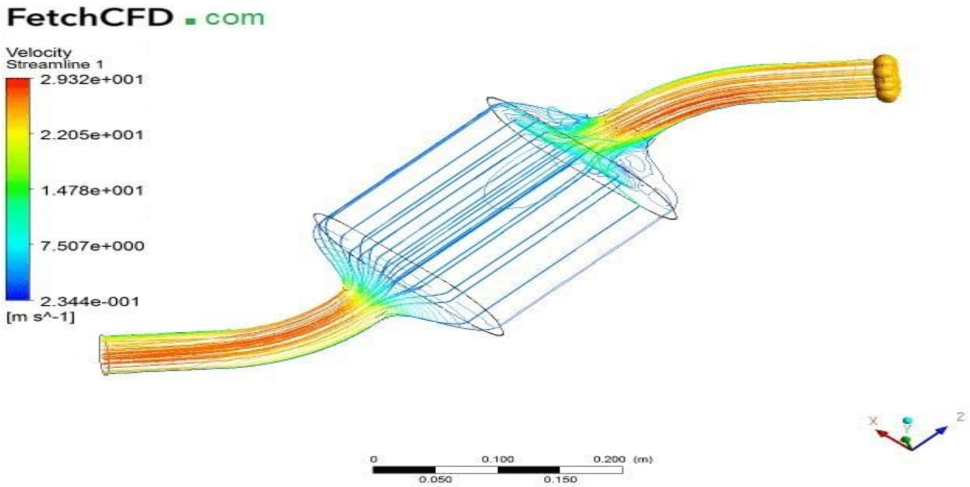
I YEAR /I SEMESTER MECHATRONICS ENGINEERING

Unit 1 – Introduction to ECU

Exhaust Catalytic converter

Exhaust Catalytic converter

- A **catalytic converter** is an exhaust emission control device that converts toxic gases and pollutants in exhaust gas from an internal combustion engine into less-toxic pollutants by catalyzing a redox reaction.
- Catalytic converters are usually used with internal combustion engines fueled by gasoline or diesel, including lean-burn engines, and sometimes on kerosene heaters and stoves.



- Although catalytic converters are most commonly applied to exhaust systems in automobiles, they are also used on electrical generators, forklifts, mining equipment, trucks, buses, locomotives, motorcycles, and on ships.
- They are even used on some wood stoves to control emissions
- This is usually in response to government regulation, either through environmental regulation or through health and safety regulations.
- Catalytic converters require a temperature of 400 °C (752 °F) to operate effectively. Therefore, they are placed as close to the engine as possible, or one or more smaller catalytic converters (known as "pre-cats") are placed immediately after the exhaust manifold.

Types

- **Two-way** Catalytic converter
- **Three-way** Catalytic converter

Two-way Catalytic converter

- A 2-way (or "oxidation", sometimes called an "oxi-cat") catalytic converter has two simultaneous tasks:

1. Oxidation of carbon monoxide to carbon dioxide: $2\ CO + O_2 \rightarrow 2\ CO_2$
2. Oxidation of hydrocarbons (unburnt and partially burned fuel) to carbon dioxide and water: $C_xH_{2x+2} + [(3x+1)/2]\ O_2 \rightarrow x\ CO_2 + (x+1)\ H_2O$ (a combustion reaction)

- This type of catalytic converter is widely used on diesel engines to reduce hydrocarbon and carbon monoxide emissions. They were also used on gasoline engines in American- and Canadian-market automobiles until 1981. Because of their inability to control oxides of nitrogen, they were superseded by three-way converters.

Three-way Catalytic converter

- Three-way catalytic converters have the additional advantage of controlling the emission of nitric oxide (NO) and nitrogen dioxide (NO_2) (both together abbreviated with NO_x and not to be confused with nitrous oxide (N_2O)). NO_x species are precursors to acid rain and smog.[19]
- Since 1981, "three-way" (oxidation-reduction) catalytic converters have been used in vehicle emission control systems in the United States and Canada; many other countries have also adopted stringent vehicle emission regulations that in effect require three-way converters on gasoline-powered vehicles.
- The reduction and oxidation catalysts are typically contained in a common housing; however, in some instances, they may be housed separately.

- three-way catalytic converter has three simultaneous tasks
- *Reduction of nitrogen oxides to nitrogen (N_2)*
- C+2NO2→CO2+2NO
- CO+NO→CO2+12N2
- 2CO+NO2→2CO2+12N2
- H2+NO→H2O+12N2
- *Oxidation of carbon, hydrocarbons, and carbon monoxide to carbon dioxide*
- C+O2→CO2
- CO+12O2→CO2
- $aC_x H_y$ + bO2-→c CO2+d H2O a,b,c,d,x,y€ z

- These three reactions occur most efficiently when the catalytic converter receives exhaust from an engine running slightly above the stoichiometric point. For gasoline combustion, this ratio is between 14.6 and 14.8 parts air to one part fuel, by weight.
- The ratio for Autogas (or liquefied petroleum gas LPG), natural gas, and ethanol fuels can vary significantly for each, notably so with oxygenated or alcohol based fuels, with e85 requiring approximately 34% more fuel, requiring modified fuel system tuning and components when using those fuels.
- In general, engines fitted with 3-way catalytic converters are equipped with a computerized closed-loop feedback fuel injection system using one or more oxygen sensors,though early in the deployment of three-way converters, carburetors equipped with feedback mixture control were used.

- Closed-loop engine control systems are used for effective operation of three-way catalytic converters because of this continuous rich-lean balance required for effective NO_x reduction and HC+CO oxidation.
- The control system allows the catalyst to release oxygen during slightly rich operating conditions, which oxidizes CO and HC under conditions that also favor the reduction of NOx.
- Before the stored oxygen is depleted, the control system shifts the air–fuel ratio to become slightly lean, improving HC and CO oxidation while storing additional oxygen in the catalyst material, at a small penalty in NO_x reduction efficiency.
- Then the air–fuel mixture is brought back to slightly rich, at a small penalty in CO and HC oxidation efficiency, and the cycle repeats. Efficiency is improved when this oscillation around the stoichiometric point is small and carefully controlled