Lecture 26

3rd Semester M Tech. Mechanical Systems Design

Mechanical Engineering Department

Subject: Advanced Engine Design

I/C Prof M Marouf Wani

Lecture 26 – Technology used for Emissions reduction from internal combustion engines.

Topic – Catalytic Convertors – 19-11-2020

Catalytic Convertors

The **catalytic Convertors used in spark-ignition engines** consist of an active catalytic material in a specially designed metal casing which **directs the exhaust gas flow through the catalyst bed**.

The active material employed **for CO and HC oxidation or NO reduction** (**normally noble metals**, though base metal oxides can be used) must be distributed over a **large surface area** so that the mass transfer characteristics between the gas phase and the active catalyst surface are sufficient to allow close to **100 percent conversion with high catalytic activity**.

The **two configurations commonly used:**

One system employs a **ceramic honeycomb structure** or **monolith** held in a metal can in the exhaust stream.

The active (**noble metal**) **catalyst material** is **impregnated** into a highly **porous alumina wash-coat** about **20 µm thick** that is **applied to** the **passageway walls.**

The typical **monolith** has **square-cross-section passageways** with inside **dimensions of ~1 mm** separated by thin (**0.15 to 0.3 mm) porous walls.**

The number of **passageways per square centimeter** varies between **about 30 and 60**.
The **wash-coat**, 5 to 15 percent of the weight of the monolith, has a **surface area of 100 to 200 m^2/g.**

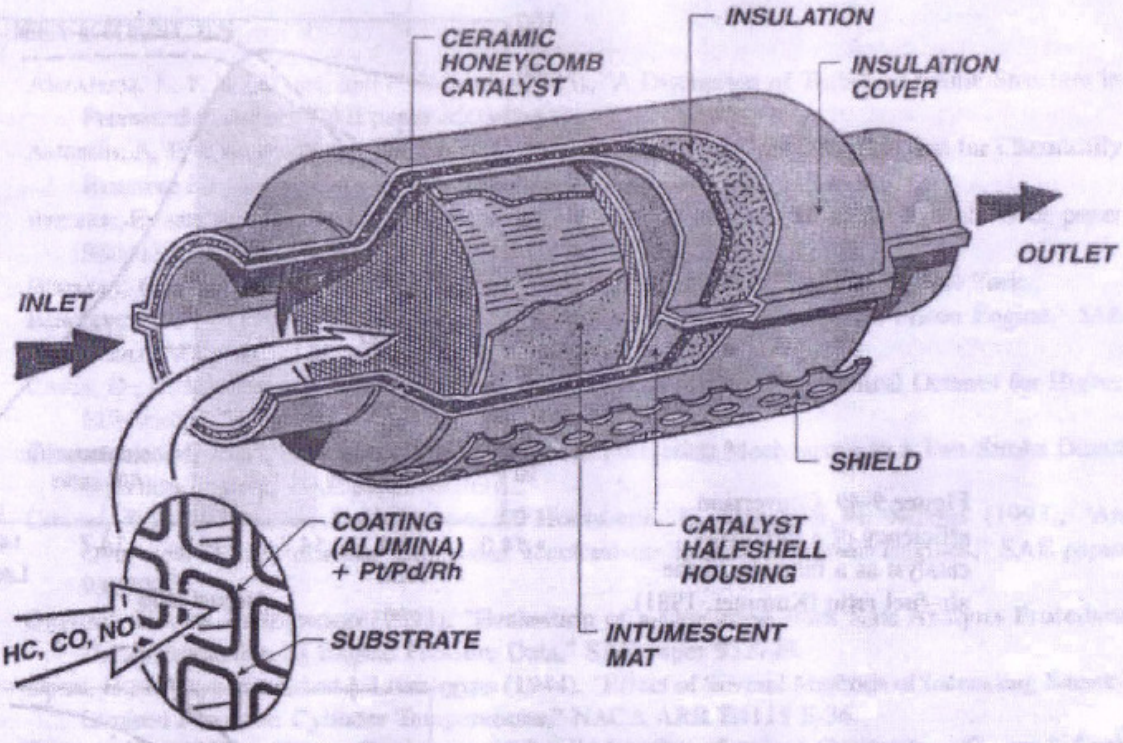
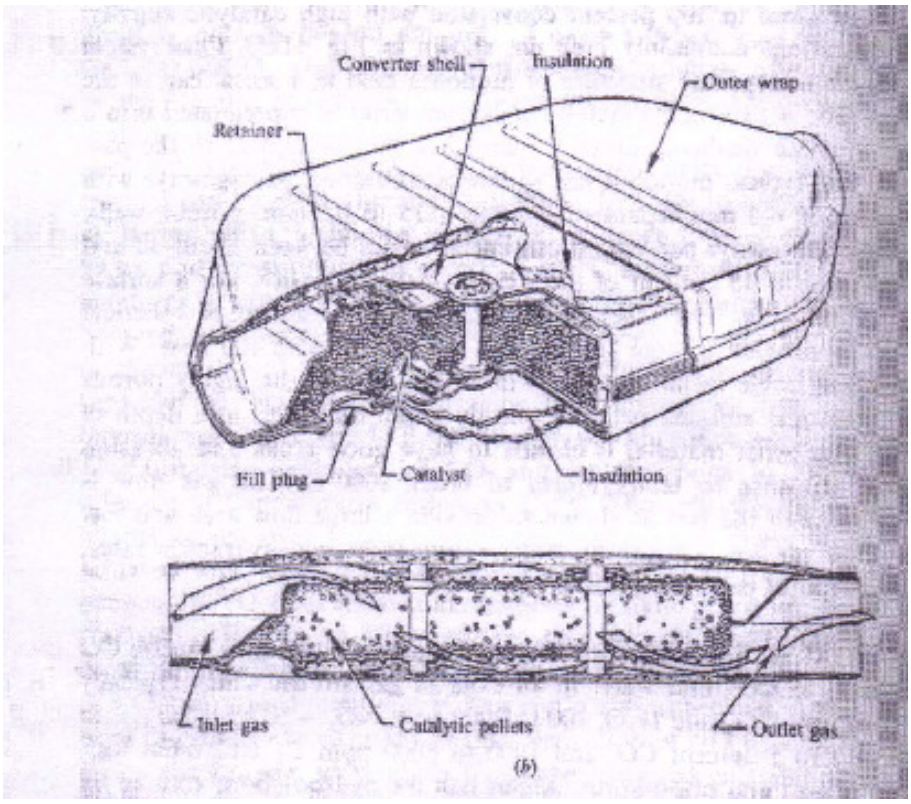


Figure 9-48 Catalytic converter components. (Courtesy Englehard Corporation.)

The **other convertor design** uses a **bed of spherical ceramic pellet catalysts**,
The **noble metal catalyst** is **impregnated** into the **highly porous surface** of the **spherical alumina pellets** (typically **3 mm diameter**) to a **depth of about 250 µm**.
The **pellet material** is chosen to have **good crush and abrasion resistance** after **exposure to** temperatures of order **1000 C**.
The gas flow is directed down through the bed as shown to **provide a large flow area and low pressure drop**.
The **gas flow is turbulent** which results in **high mass-transfer rates**; in the monolith catalyst passageways, it is laminar.



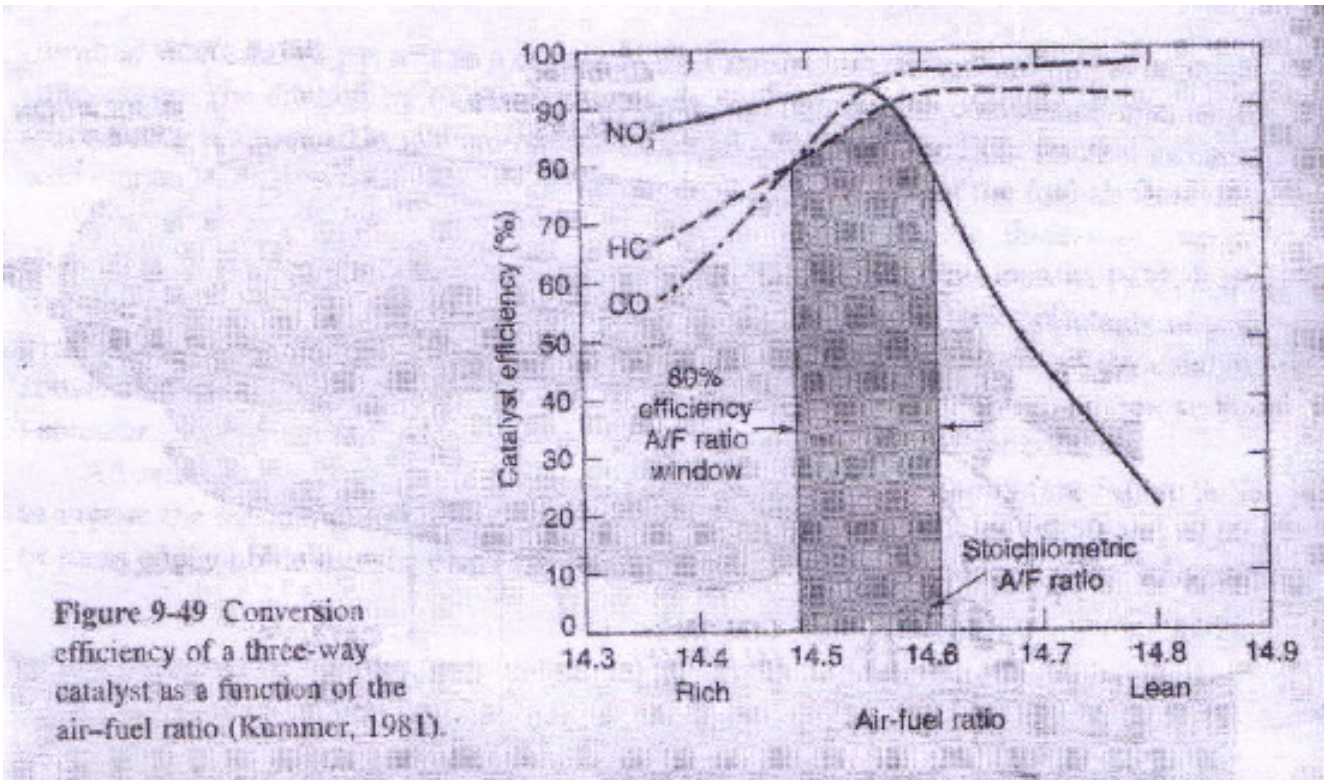


Figure 9-49 Conversion efficiency of a three-way catalyst as a function of the air–fuel ratio (Kummer, 1981).

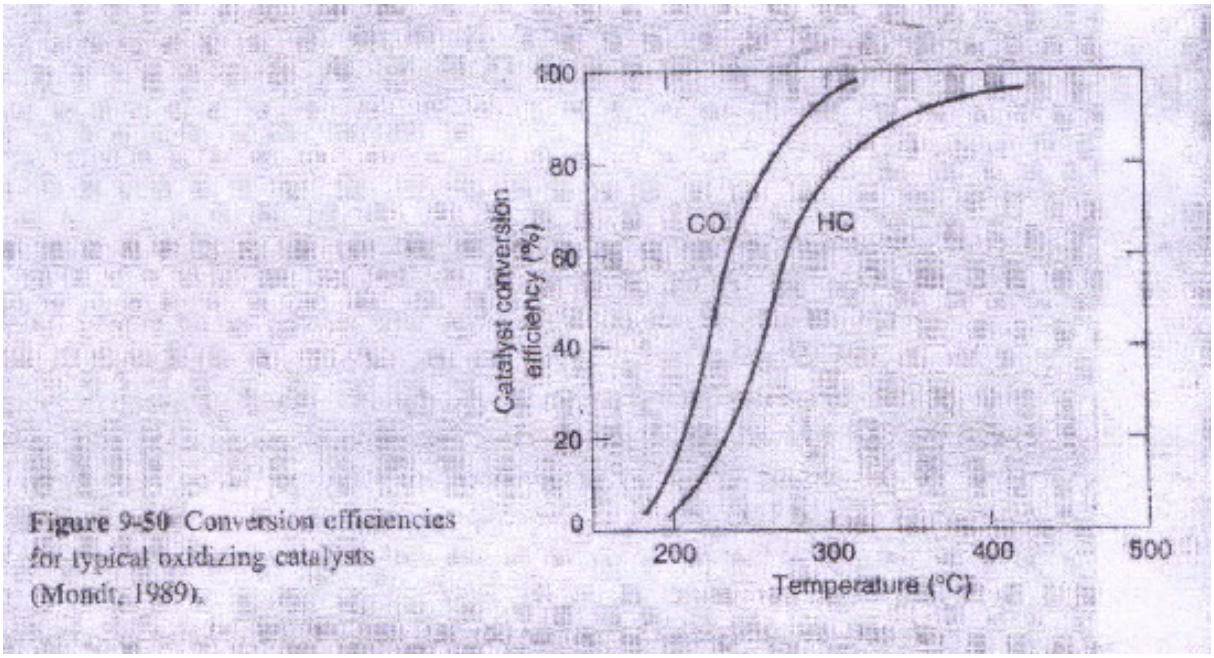


Figure 9-50 Conversion efficiencies for typical oxidizing catalysts (Mondt, 1989).

Dated: 19-11-2020

Prof M Marouf Wani

I/C Advanced Engine Design
Mechanical engineering Department
National Institute of Technology
Srinagar, J&K
India – PIN 190006

Text Books:

Internal Combustion Engine Fundamentals
By John B Heywood
Published By: McGraw-Hill Book Company

Internal Combustion Engines
Applied Thermo-sciences
By Colin R. Ferguson
Allan T. Kirkpatrick
Published By: John Wiley & Sons, UK