Deep Lip Twin Chamber: Diesel Engine Combustion Bowl (DLTCCB)

IITM Technology Available for Licensing

Problem Statement

- The combustion bowl is one system which plays an important role in providing the right kind of air motion with respect to the fuel sprays and also in **ensuring that the combustion process will be complete with low levels of pollutants** being emitted.
- In order to achieve these**, the air or fuel in the combustion bowl should not remain stagnant**. Instead, they must be moved around the bowl with **enough turbulence to prevent the fuel from forming over-rich and under-lean pockets** thereby improving fuel utilization and reducing in-cylinder pollutants. This can be achieved by charge motion within the cylinder, which is of **two main types; swirl and squish** in any engine. The combustion bowl should also divide the fuel so that it reaches all areas so that the air inside is utilized well.
- The combustion bowl of the type shown in Fig. 1, **is called the re-entrant bowl**. Currently, variants of the re-entrant type of combustion bowl are widely used across all industrial and automotive diesel engines.
- However, it is widely believed that the **re-entrant bowl has reached its full potential and cannot cater to future emission norm requirements**. Thus, the time has come to rethink and come up with a new combustion bowl that can outperform the current design.

Technology Category/ Market

Energy – Internal Combusion Engines, Diesel Engines
Applications – Automotives, Engine manufacturing

Market - The Global **Diesel Power Engine Market** size was estimated at **USD 9.37 Billion in 2021** and is anticipated to grow at a **CAGR of 4.81%** from 2023 to 2030 to reach USD 14.30 Billion by 2030.

Technology

- The invention present a solution with **a novel deep lip twin chamber diesel engine combustion bowl (DLTCCB)** design for improved combustion and performance of a direct injection (DI) diesel engine.

DESIGN

The novel combustion bowl design includes:

- A lower chamber forming a primary combustion zone and;
- An upper chamber forming a secondary combustion zone.
- The lower chamber has a first curved profile that ends in a first inward curved lip-like projection of a wall of the bowl.
- The upper chamber has a second curved profile (112) that ends in a second inward curved lip-like projection of the bowl.
- The second lip-like projection has a smaller radius than the first lip-like projection.

Intellectual Property

- IITM IDF Ref. **2227**
- **IN 427136 - Patent Granted**

Key Features / Value Proposition

1. **The deep lip: A curved lip like projection of the bowl wall towards the axis of the bowl that shall be placed approximately at half the total bowl depth.**
2. **The upper chamber as shown in Fig. 2, shall be pushed further into the bowl wall similar to the lower chamber.**
3. **The bowl radius (distance between the centre of the axis and the bowl wall) shall be lower at the bowl mouth than at the deep lip. That is r1<r2.**
4. **The pip region at the centre of the bowl: The surface of the bowl at the centre is raised towards the top of the bowl like a cone, as shown in the Fig. 2.**

Graphical representation of the design

- The most important feature is the **deep lip that divides the DLTCCB into two bowls**, one over the other. This deep lip splits the fuel plume into two halves. Half of the fuel, in a spray plume, goes into the upper bowl and rest goes into the lower bowl.
- This **helps in better spreading of the fuel** and in increasing its contact with the air inside the bowl. It eventually helps in **better air utilization** and enables the formation of leaner mixtures than with the re-entrant bowl.

TRL (Technology Readiness Level)

TRL - 4, Technology experimentally validated in lab scale.

Research Lab

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Industrial Consultancy & Sponsored Research (IC&SR)

Advantages

- The **DLTCCB design forms more homogeneous and lean mixtures**, is thus able to simultaneously **reduce NOx, Soot, HC and CO emissions**, better than the existing re-entrant bowl using optimized injection timings.
- The comparison of HC and CO emissions between the re-entrant and DLTCCB, shown in Table 1 indicates **very high reductions in both HC and CO emissions.**
- The combustion bowl may be incorporated into the **piston of a diesel engine.**
- The **DLTCCB** can **substitute the existing combustion bowls in all diesel engines** across all industrial and automotive applications**.**

Images

Fig. 1. Re-entrant bowl

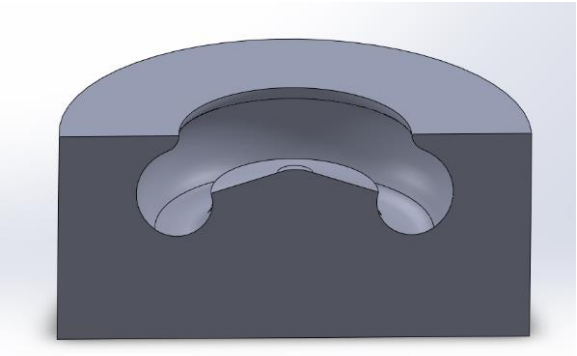

Fig. 2. The deep lip twin chamber (DLTCCB)

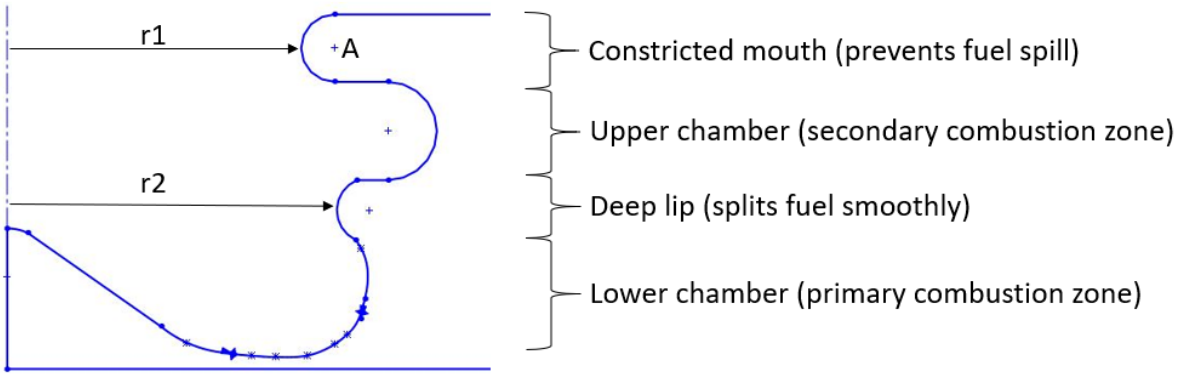

Table 1: HC and CO emission comparison between base bowl and DLTCCB at 100% load of base bowl

Bowl	HC	CO
Base re-entrant bowl	0.111 mg	6.62 mg
DLTCCB	0.013 mg	2.2 mg
Percentage reduced by DLTCCB	88.2%	66.7%

Table 2: Efficiency Comparison between the Base Re-Entrant Bowl and DLTCCB

Load (%)	Base bowl (%)	DLTCCB (%)	Percentage change (%)
100	27.7	29.2	+5.4
80	28.9	28.8	NA
60	26.4	25.6	-3
40	21.1	21.1	NA
20	11	11.9	+8

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