# Research in Internal Combustion Engine

## 1 Losses in Internal Combustion Engine

Internal combustion engines are often known as heat engines because they utilise the heat energy in the fuel to convert it to mechanical energy in the engine, which is then used to power the vehicle. As a result, it's important to look at how energy is generated and used both within engine and other parts of the vehicle. [1]

Frictional losses are the source of losses in the Internal combustion engines. Overcoming friction consumes around a 1/3 of a car's fuel use. Friction loss does have a direct influence on fuel usage as well as pollutants. According to a joint research by Finland's VTT Technical Research Centre and the United States' Argonne National Laboratory (ANL), new technique can improve friction in various automotive components by 15% to 75%. [2] Until the next 6 to 12 years, it should be able to cut automotive fuel consumption and emissions by 17%, and by up to 62 percent within 16 to 22 years.

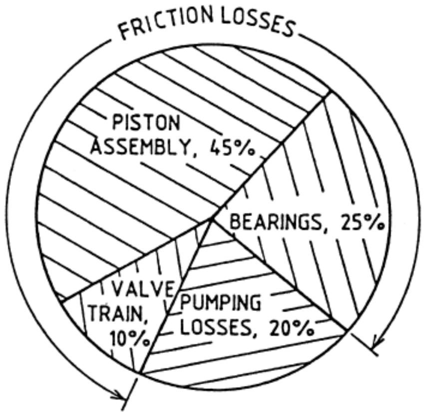


*Figure 1 Losses in the internal combustion engine [2]*

Mechanical losses occur in internal combustion engines owing to relative movements among components such as pistons, crankshafts, and valve trains, as well as bearings. Internal combustion engines have a mechanical performance of 0% during idle and roughly 90% at heavy running loads. Mechanical losses minimization is usually a challenging problem at the early stages of design. [3] The difference between the work completed to push out the flue gas and the work done to introduce the fuel mixture (fuel + air combination) into the intake manifold is referred to as pump losses in internal combustion engines. [4] Because exhaust gases must be forced against air pressure, the greater the intake pressure, the smaller the pressure differential between the inlet and outlet ports will be.

### 1.1 Optimization of the Internal Combustion engine

Engine calibration is the process of fine-tuning engine parameters to achieve ideal engine performance, such as low fuel consumption, low polluting gas emissions, and high power output. With advancements in internal combustion engine technology, current engines now have more changeable characteristics than ever before, making engine calibration a challenging and time-consuming operation. In addition, the environmental concern created by pollution emissions drew international attention, resulting in severe engine performance requirements. As a result, considerable research has been done to address current engine calibration issues. [5]

Chamber design (diameter, length, including connecting rod radius), volumetric efficiency, heat loss via walls, turbo-charging, and weight optimization are all important factors that influence efficiency. [6] Optimization of the internal combustion engines performed on the basis of the recorded data and using the mathematical optimization techniques. Despite the fact that various control devices may be put on an internal combustion engine, optimization techniques, in addition to the current performance of independent control methods, are necessary to efficiently use to optimize engine operating conditions. [7]

# 2 History of ignition system

Despite the fact that ignition systems have changed through time, including more and more electronics, they still exhibit the trademarks of the initial coil ignition systems, which were introduced more than a century ago. [8]

Charles Kettering, an American inventor, is credited with developing very first coil-based ignition system for a major automobile manufacturer circa 1910-1911. For the first time, he designed an entire circuit that simultaneously powered the starting motor and ignition. The battery, a generator, as well as a more comprehensive vehicle electrical system gave a rather consistent electrical supply to the ignition coil.

# 3 Working principle of the ignition system

The igniting system is a mechanism that uses a high voltage generated by the automobile battery to transmit it to another sparkplug in turn, igniting the fuel-air combination in the engine's combustion chamber. Internal combustion engines powered by gasoline requires an ignition source to ignite the explosion that transforms the chemical energy stored of the air-fuel combination into thermal energy, which the engine may then turn into mechanical energy. There are three different types of ignition systems. [9]

### 3.1.1 Magneto (Inductive Discharge) ignition system

A magneto ignition system, also known as a high-tension magneto, is a type of ignition system that employs a magneto to generate high voltage for energy generation. The produced electricity is then utilised to power cars as well as other electrical components throughout the system. The magneto combines a distributor and a generator into a single device, which distinguishes it from a traditional distributor that generates spark energy without the need of external voltage. [10]

### 3.1.2 Battery coil; ignition system

A battery ignition technology is a form of ignition system that powers the spark plug in a spark-ignition drivetrain so that spark may be created to burn the air-fuel combination in the combustion chamber. The engine-driven generator charges a 6- or 12-volt battery that powers the ignition system (alternator). The ignition system is powered by this battery, which is why it's called a battery ignition system. These ignition systems are frequently seen in light - duty vehicles, buses, trucks, and trucks. Its purpose is to create a spark that allows fuel to be burnt. [11]

The battery ignition system works in much the same way as other kinds of ignition systems. It's a lot easier to understand because it runs on a 6- or 12-volt battery that's charged by an engine-driven generator (alternator). The system's ignition coil raises the voltage, and a device interrupts the current flowing through the coil. The spark plug projects the electricity into each cylinder, while the distributors route it to the right cylinder.

### 3.1.3 Electronic ignition system

The primary circuit is the main distinction between contact point and electronic ignition systems. The electronically controlled unit opens and closes the primary circuit in the contacting breaker system. The secondary circuitry are nearly identical to those used in prior systems. [12]

### 3.1.4 Comparison of ignition systems

The magneto ignition technology has various disadvantages. To begin with, while using a strong current, the circuit breaker connections will burn out or burn. Second, the contact breakers is only a piece of machinery that cannot perform accurately at high speeds due to the insufficient dwell duration for fully establishing the magnetic field at such speed. The traditional contact breaker can only produce roughly 400 sparks per second, which restricts the engine's speed. Due to contacts being closed for longer at low speeds, a comparatively significant current is extracted from the battery. As a result, at low speeds, the system becomes inefficient. [13]

By adopting an electronically controlled ignition system with contactless triggers to provide timing, the shortcomings of the traditional contact breaker aided ignition system may be fully avoided.

# 4 Reference


1. Hansdah, M. (n.d.). LECTURE NOTES ON SUB: INTERNAL COMBUSTION ENGINE & GAS TURBINES 8 th SEMESTER, B.TECH MECHANICAL ENGINEERING COURSE CODE -BME 423. [online] Available at: https://www.vssut.ac.in/lecture_notes/lecture1429900545.pdf.

2. EurekAlert! (n.d.). VTT: One-third of car fuel consumption is due to friction loss. [online] Available at: https://www.eurekalert.org/news-releases/765212 [Accessed 11 Apr. 2022].

3. Tormos, B., Martín, J., Carreño, R. and Ramírez, L. (2018). A general model to evaluate mechanical losses and auxiliary energy consumption in reciprocating internal combustion engines. Tribology International, 123, pp.161–179.

4. Ojapah, M.M., Zhang, Y. and Zhao, H. (2013). Part-load performance and emissions analysis of SI combustion with EIVC and throttled operation and CAI combustion. Internal Combustion Engines: Performance, Fuel Economy and Emissions, pp.19–32.

5. Yu, X., Zhu, L., Wang, Y., Filev, D. and Yao, X. (2022). Internal combustion engine calibration using optimization algorithms. Applied Energy, 305, p.117894.

6. www.researchgate.net. (n.d.). Optimization of an Internal Combustion Engine`s Efficiency for Fuel Conservation & Green Environment | Request PDF. [online] Available at: https://www.researchgate.net/publication/316256438_Optimization_of_an_Internal_Combustion_Engines_Efficiency_for_Fuel_Conservation_Green_Environment [Accessed 11 Apr. 2022].

7. Wahono, B. and Ogai, H. (2014). Combustion Model and Control Parameter Optimization Methods for Single Cylinder Diesel Engine. Journal of Optimization, 2014, pp.1–9.

8. DENSO. (n.d.). Back to basics: How an ignition coil works. [online] Available at: https://www.denso-am.eu/news/deneur21_04_ignition-coil-basic-principles.

9. General Technologies Corp. (2021). The Different Types of Ignition Systems. [online] Available at: https://gtc.ca/blog/the-different-types-of-ignition-systems/ [Accessed 11 Apr. 2022].

10. Studentlesson. (2020). Magneto ignition system: definition, function, components, working. [online] Available at: https://studentlesson.com/magneto-ignition-system-definition-function-components-working/ [Accessed 11 Apr. 2022].

11. Mishra, P. (2017). How Battery Ignition System Works? [online] Mechanical Booster. Available at: https://www.mechanicalbooster.com/2017/05/battery-ignition-system.html.

12. www.sluiceartfair.com. (n.d.). Why is electronic ignition system preferred over conventional system? – Sluiceartfair.com. [online] Available at: https://www.sluiceartfair.com/2020/students-help-blog/why-is-electronic-ignition-system-preferred-over-conventional-system/ [Accessed 11 Apr. 2022].

13. Thorat, S. (2019). Electronic Ignition System | Diagram , Construction and Working. [online] Available at: https://learnmech.com/electronic-ignition-system-diagram-construction-and-working/ [Accessed 11 Apr. 2022].

# 5 Reference