Scienxt Journal of Mechanical Engineering & Technology
Year-2023; Volume-1; Issue-1, pp. 47- 58

Future of the internal combustion engines

Manoj Mishra*[1], Balbir Nayak[2]

[2]Assistant Professor, Department of Mechanical Engineering, Muzaffarpur Institute of Technology, Muzaffarpur, Bihar, India

*[*1]Department of Mechanical Engineering, Muzaffarpur Institute of Technology, Muzaffarpur, Bihar, India*
E-mail: manoj_mech@yahoo.co.in
https://zenodo.org/deposit/8054603

*Corresponding author: Manoj Mishra

Table of Contents

List of Figures

Abstract:

In this study, we have proposed a method for improving the overall performance of internal combustion engines. When it comes to future combustion engines used in light-duty vehicles, there are many factors to consider. Customer expectations for improved long-term durability, dependability, mobility, and fuel efficiency have been raised as a result. The law requires significant reductions in emissions and fuel usage. To maintain or improve the company's position in a highly competitive environment, further reductions in production costs will be required. Components of a modern internal combustion engine should be listed succinctly. The engines presented here have a variety of benefits over typical IC engines.

Keywords:

Internal Combustion Engine (IC Engine), Compressibility, Motor Vehicle

1. Introduction:

Internal combustion engines are used in a wide range of scientific and technological disciplines nowadays, thanks to a huge number of successful designs. There are some regions where IC engines rule the roost without the presence of other engine types. To put it another way: today's combustion engines were highly advanced. A thermodynamic and mechanical principle that is inefficient is used to build piston cycle internal combustion engines currently in use (Ayres and Nair, 1984). It can be claimed that today's engines have a low coefficient of efficiency, which means that they do a tiny amount of work for the amount of fuel they consume. Diesel construction uses roughly 30% of input energy, while Otto engines utilize about 25% (though a little more is possible in specific situations) (Gordon and Orlov, 1993).

1.1. Research questions:

1) Is there a bright future for internal combustion engines including transportation power trains?
2) Is just the end of internal combustion engines including the use of petroleum in transportation truly upon us?
3) How can we improve the IC engine's efficiency?

1.2. Aim:

For the project to be successful, a comprehensive research program combining experimental work with theoretical analysis and computer simulations is required.

1.3. Objective:

- To develop combustion-related predictive computational models.
- At high pressures and temperatures associated with new engine designs, to identify the major big molecule radicals present in such fuels
- When competing technologies show efficiency and carbon reductions, real-world data should be used to allow them to flourish and be given as quickly as possible.

1.4. Problem statement:

Particulate emissions through tire & brake wear are becoming more of a problem than engine emissions because of the enormous developments in IC engine technology over the past few decades. Perhaps the most difficult challenge for experimentalists is to grasp the entire complexity of a turbulent and multiphase reactive flow of an evaporating jet of liquid fuel. Spray combustion is a complex subject that necessitates an understanding of the fuel's physical and chemical properties in both its liquid and vapor. Some scientists believe that sophisticated imaging capabilities could concurrently capture the change of droplet sizes with a resolution of submicron and microseconds.

2. Literature Review:

2.1. Conventional I.C. engine:

The slider-crank mechanism underpins most standard integrated circuit (IC) engines, as is well known. Using piston motion in this manner, a thermodynamic cycle for generating mechanical power can be achieved quite simply and quickly (Ge, Chen, Sun, and Wu, 2006). According to theory, the Otto cycle (Gonca, 2016) seems to be the most effective thermodynamic cycle in IC engines due to constant volume heat addition. A linkage called either a crank-slider mechanism is found in most reciprocating engines (Fathi, 1993). Figure 1 depicts a slider-crank system, which is one of the various mechanisms that can provide reciprocating motion. Friction between the crankshaft and the piston and cylinder accounts for more than half of mechanical losses in a typical engine (Batini and colleagues 2017).

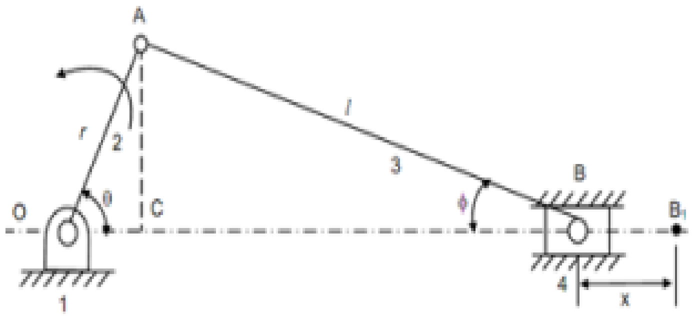

Figure.1: Slider-crank mechanism [source: (Todd, 2021)]

2.2. New I.C. engine:

A real engine can't add heat at constant volume since it can't do it in real-time. Piston movement may only occur constantly between TDC and BDC at a rate that is directly related to the engine's revolutions per minute (RPM). It takes a fixed amount of time for the chemical reaction involved with combustion events to complete, regardless of engine speed. To give the combustion process more time to complete, you can reduce the engine's crankshaft rotation speed at the top dead center (TDC). An entirely new combustion cycle, known as quasi-constant volume (QCV), will then be created that falls somewhere in between the current IC engine combustion cycle as well as the idealized Otto constant pressure combustion loop. Figure 2 depicts an unusual SI engine of this type.

2.2.1. Main engine parts:

Some of the key components of a brand-new design are displayed in the following images. According to Fig. the two primary components of an automobile's powertrain are its engine block and its engine head (which contains both the piston and the valvetrain as well as the camshaft), as well as its flywheel and crankshaft.

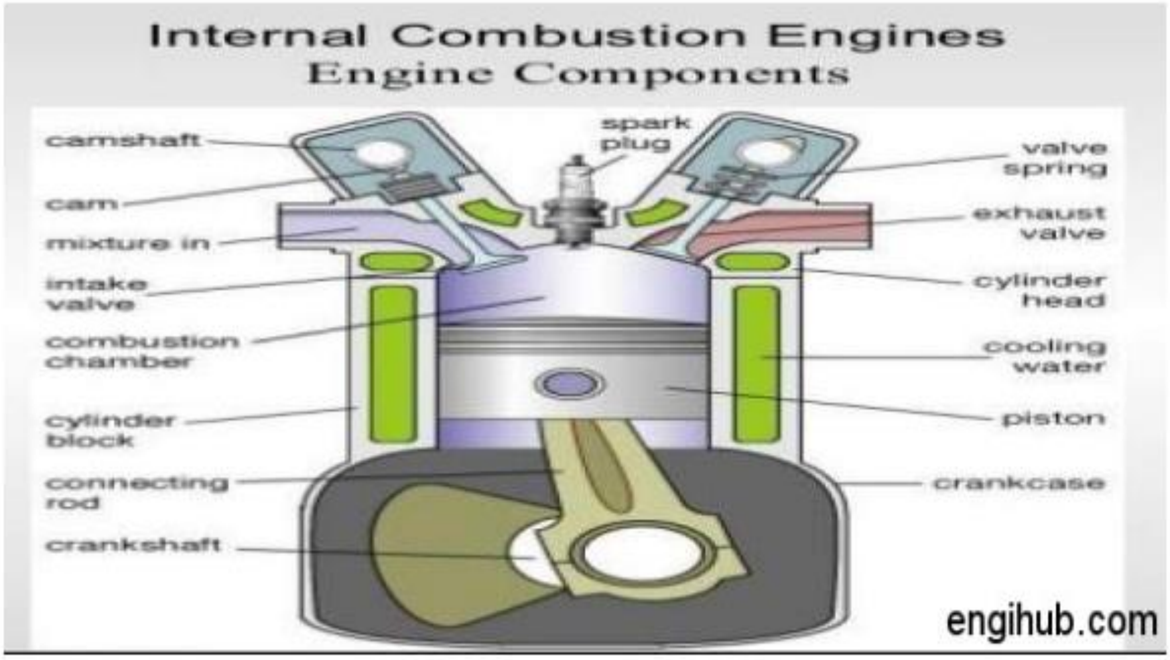

Figure.2: Main engine parts [source: (idzior, 2021)]

2.2.2. Advantages:

One of the main causes of engine wear is indeed the crankshaft's sideways strain just on the piston through its connecting rod, which wears its cylinder into such an oval cross-section instead of a circular one, making it impossible for piston rings to seal properly. Adding length to the connecting rods will extend the life of an engine by reducing the amount of sideways force. While the length of a connecting rod and piston stroke is fixed for any given engine block, the actual distance between both the crankshaft and the top of a cylinder block is not, and hence the length of a connecting rod and piston stroke cannot be varied.

2.3. Challenges for internal combustion engines:

- Rising Fuel Consumption Regulations
- Environmental Standards that are more stringent
- New Technologies that pose new challenges

2.4. Potential of internal combustion engines:

From the standpoint of Arbogast et al. (2020), the potential for internal combustion engines must not be underestimated despite the many obstacles that they face.

- Internal Combustion Engine Cars Could Reach Near-Zero Emissions
- Carbon Emissions from Internal Combustion Vehicles aren't Necessarily Higher as Battery Electric Vehicles
- Changes Brought with Electrification

2.5. Engine performance map:

Plotting brake fuel economy (BSFC) so over the engine's complete load and the speed range is a standard approach to displaying engine operating conditions (McPherson, 2003). For example, the upper envelope of this map is the full load (or wide-open throttle) map, as well as the points underneath this curve, indicate typical partial load operating circumstances. An absolute fuel consumption map versus engine speed or torque can be used to show how much brake-specific fuel consumption increases with breaking mean effective pressure (BMEP). Fig. 3 shows an example.

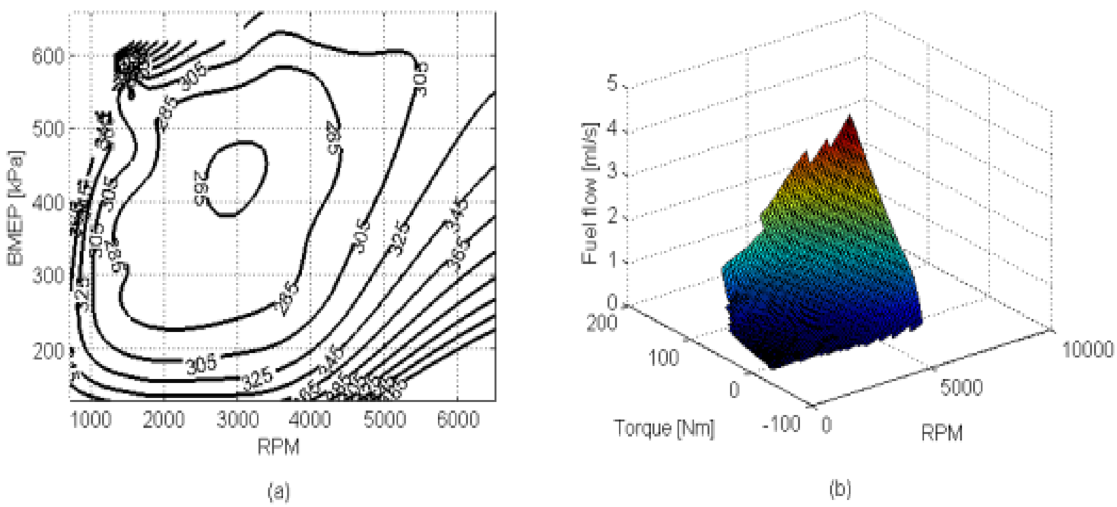

Figure.3: Engine performance map: (a) BSFC versus BMEP and engine speed and (b) absolute fuel consumption versus [source: (Duclos and Colin, 2001)]

A polynomial equation is used to approximate an engine performance map regarding absolute fuel consumption as a function of both engine torque as well as engine speed:

Theorem (1)

$$f_c - a_{00} + a_{01}.w_e + a_{10}.T_e + a_{11}.w_e.T_e + a_{02}.w_e^2 + a_{20}.T_e^2$$

Mathematical relationships between fuel consumption and operating circumstances will be established by the determination of a coefficients A00 a 00, a 01, a 10, an 11, a 02, and A20.

3. Methodology:

The methodology for this project has been taken from books, articles in newspapers, journals and websites, and secondary data has been gathered.

3.1. Data acquisition:

Many samples for engine torque, engine speed, and fuel consumption data are needed to calculate the polynomial coefficients in Eq. (1). In addition to the transmission efficiency, the vehicle employed for data collection includes f0 and f2 coefficients that have been determined. The track grade and speed are measured using a GPS. CAN Network provides data on engine speed and fuel usage. The CAN network is indeed a module in charge of overseeing the flow of data between various parts of the vehicle (Blanco et al., 2016). The OBD-II connection can be used to interrupt this information flow (Mira et al., 2021).

3.2. Data analysis:

These tests will be conducted in two ways to ensure that the technique is sound. To begin with, this fuel economy cycle (reference route) is used to define the first route (FUJII, 1979). To determine its polynomial coefficients in Eq., this test is carried out on a chassis dynamometer (14). During real-world testing, we discovered a second path (the validation route). The driver was told to follow the flow of traffic without any additional guidance. Real-world conditions, including traffic, weather, and other factors, were not taken into consideration when designing the route. Figure 4 shows the validation route's speed as just a function of time.

It's easy to see how the vehicle is performing during each cycle. Environmental Protection Agency (EPA) provides a breakdown of operating modes (FUJII, 1979). There are four fundamental modes of operation: idling, acceleration, cruise, and deceleration, according to this classification. Figure 5 depicts the underlying circumstance for each mode.

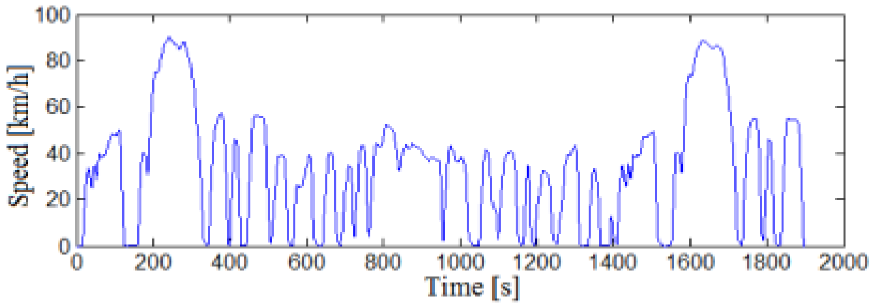

Figure.4: Reference route speed as a function of time [source: (Duclos and Colin, 2001)]

Operating mode	Condition
Acceleration	$\bar{a}_t > 0.086\ m/s^2\ v_t > 0.6\ km/h$
Cruise	$\lvert\bar{a}_t\rvert, \lvert\bar{a}_{t-1}\rvert, \lvert\bar{a}_{t+1}\rvert < 0.086\ m/s^2;\ v_t > 0.6\ km/h$
Deceleration	$\bar{a}t < -0.086\ m/s2\ vt > 0.6\ km/h$
Idle	Any other condition.

Figure. 5: Characterization of each operating mode [source: (Duclos and Colin, 2001)]

It is determined that for each instant t (Te (t) and e (t)), both engine operating conditions and the engine power [Pe (t)] are determined.

4. Result and Discussions:

Reference and validation tests used the same operating parameters. Compared to the reference tests, the validation test does have a disproportionately high number of data points inside the 800-1750 RPM range. Furthermore, the reference test has higher overall power than the validation test.

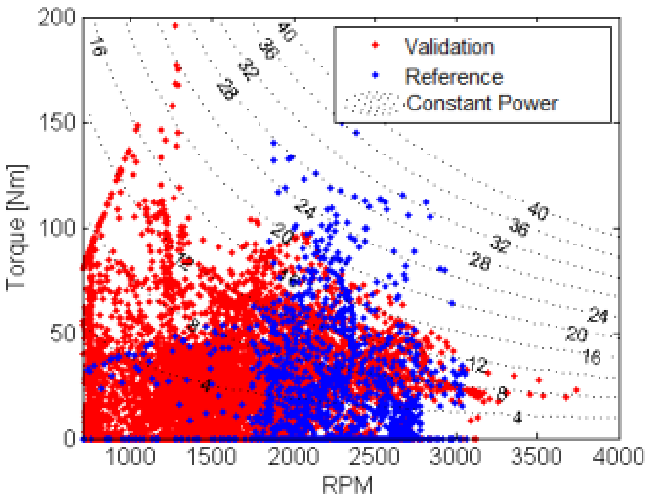

Figure.6: Engine operating conditions [source: (Duclos and Colin, 2001)]

To validate the methodology, this difference proves that it can be effective even under scenarios that were not tested on the polynomial coefficients test. According to the reference test data, and engine performance map is shown in Fig. 7.

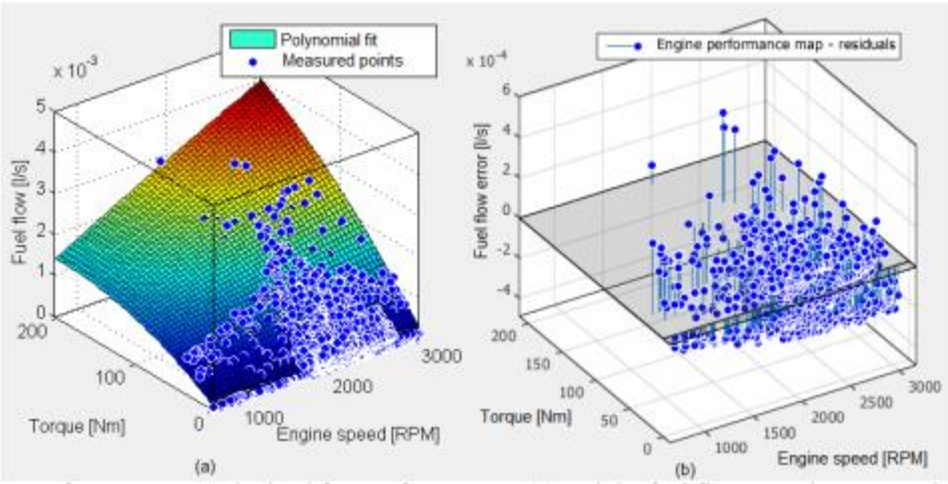

Figure.7: Engine performance map obtained from reference test (a) and the fuel flow error between polynomial surfaces [source: (Duclos and Colin, 2001)]

In the validation test, fuel consumption is estimated based on the performance map generated during the reference test. When the validation test results are applied to Eq. (1), the relationship between fuel consumption and engine operating conditions is established. In Fig. 8, you can see the results.

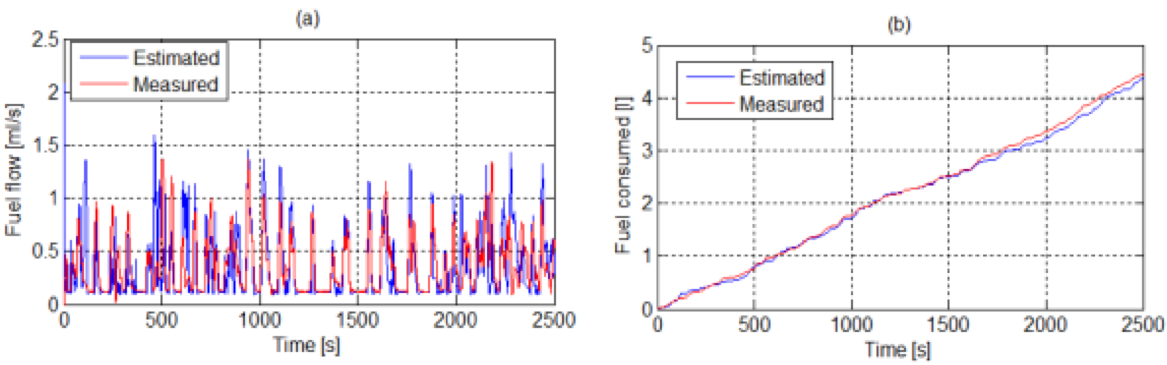

Figure.8: Comparison of the validation test between estimated and measured data for fuel flow (a) and fuel[source: (Duclos and Colin, 2001)]

An engine performance map measurement error of less than 10% was found, showing that the methodology used to calculate fuel consumption is highly accurate in measuring actual fuel consumption. It's vital to note that this study relies solely on GPS as well as OBD-II data. If more exact measurement techniques are used to gather longitudinal acceleration, engine torque, and oxygen sensor readings, the results can be even better (to determine if the air-to-fuel ratio is stoichiometric).

5. Conclusion:

In this study, a method for increasing the efficiency of a spark-ignition engine was given. Compared to conventional SI engines, the described idea offers significant advantages. All of these advantages suggest that the SI engine circumstances still have a lot of room for improvement in terms of efficiency. An internal combustion engines fuel usage performance map can be measured utilizing on-board acquisition of the vehicle's characteristics and speed and acceleration levels, as well as the estimation of needed engine torque based on the vehicle's characteristics. Engine speed and torque are treated as independent variables in a second-order polynomial model to determine fuel consumption. R 2 is 0.96, and the calculated fuel consumption differs from the actual fuel usage by less than 10%. As long as there is still no viable alternative to the current engine technology, even a small improvement will have a global impact at a time when the globe produces an enormous number of vehicles each year.

6. References

1. Arbogast, j., schaller, r., lindemann, s., schilder, b., rohde, m. and seifert, h., 2020. thermal wave interferometry measurements and microstructural analysis of twin wire arc spray cylinder coatings for passenger car engines. infrared physics & technology, 105, p.103216.
2. A yres, r. and nair, i., 1984. thermodynamics and economics. physics today, 37(11), pp.62-71.
3. Batinić, b., rodić, d., gostimirović, m., kulundžić, n. and laković, n., 2017. monitoring of the discharge current by hall-effect sensor. journal of production engineering, 20(1), pp.39-42.
4. Blanco, k., inada, n., silva, a., furusho, m. and bagnato, v., 2016. photodynamic therapy for the treatment of skin cancer in patients with idiopathic thrombocytopenia: a case report. dermatology - open journal, 1(1), pp.27-29.
5. Duclos, j. and colin, o., 2001. (2-25) arc and kernel tracking ignition model for 3d spark-ignition engine calculations((si-7)s. i.c engine combustion 7-modeling). the proceedings of the international symposium on diagnostics and modeling of combustion in internal combustion engines, 01.204(0), p.46.

6. Fathi, y., 1993. a review of: "engineering reliability: fundamentals and applications"by r. ramkumar prentice-hall, englewood cliffs, new jersey 1993, xiii + 482 pp. isbn: 0-13-1767597. list: $70.00. the engineering economist, 39(1), pp.101-103.
7. Fujii, t., 1979. separation of nitrogen, oxygen, nitric oxide, nitrous oxide, carbon monoxide, carbon dioxide, sulfur dioxide, and water by gas chromatography. bunseki kagaku, 28(6), pp.388-390.
8. Ge, y., chen, l., sun, f. and wu, c., 2006. performance of an atkinson cycle with heat transfer, friction, and variable specific heats of the working fluid. applied energy, 83(11), pp.1210-1221.
9. Gonca, g., 2016. comparative performance analyses of irreversible omce (otto miller cycle engine)-dimce (diesel miller cycle engine)-dmce (dual miller cycle engine). energy, 109, pp.152-159.
10. Gordon, j. and orlov, v., 1993. performance characteristics of endo reversible chemical engines. journal of applied physics, 74(9), pp.5303-5309.
11. Idzior, m., 2021. aging of engine oils and their influence on the wear of an internal combustion engine. combustion engine.
12. Mcpherson, b., 2003. d. deming: introduction to hydrogeology, 1st edition. hydrogeology journal, 11(3), pp.413-414.
13. Mira, p., bem, j., vieira da silva, a., santos de carvalho, m., azenha, m., oliveira-santos, c., stuani, m. and torres, c., 2021. composite odontoma with 23 denticles in a paediatric patient: a case report. contemporary pediatric dentistry, pp.50-56.
14. Savković, t., miličić, m., pitka, p., milenković, i. and koleška, d., 2019. evaluation of the eco-driving training of professional truck drivers. operational research in engineering sciences: theory and applications, 2(1).
15. Todd, r., 2021. from net surfers to net seekers: the www, critical literacies and learning outcomes. IASL annual conference proceedings, pp.231-242.

Cite as

Manoj Mishra[1], Balbir Nayak[2]. (2023). Future of the Internal Combustion Engines.*

https://doi.org/10.5281/zenodo.8054603