Journal of Mines, Metals and Fuels, *73(7): 2009-2013; 2025. DOI: 10.18311/jmmf/2025/49144*

Print ISSN : 0022-2755

Journal of Mines, Metals and Fuels

Contents available at: *www.informaticsjournals.co.in/index.php/jmmf*

Optimization of Multi-Cylinder Four-Stroke SI Engine Performance under Magnetic Field Interference Using CNG Fuel

Nilesh R. Pawar[1,2*], Sanjeev Reddy K. Hudgikar[3], Sandeep S. Sarnobat[4], Shylesha V. Channapattana[5] and Kamalkishor G. Maniyar[6]

[1]*Department of Mechanical Engineering, VTU, Belagavi - 590018, Karnataka, India*
[2]*Department of Mechanical Engineering, PVPIT Bavdhan, Pune - 411021, Maharashtra, India; scopusresearch25@gmail.com*
[3]*Mechanical Engineering Department, Sharnbasva University Kalaburagi - 585103, Karnataka, India*
[4]*Department of Mechanical Engineering, D. Y. Patil College of Engineering, Akurdi, Pune - 411044, Maharashtra, India*
[5]*Mechanical Engineering Department, KLS, Vishwanathrao Deshpande Institute of Technology, Haliyal -581329, Karnataka, India*
[6]*Department of Mechanical Engineering, Dr. D. Y. Patil Institute of Technology, Pimpri, Pune- 411018, Maharashtra, India*

Abstract

In this work, a permanent magnet creates a strong magnetic field that enhances Compressed Natural Gas (CNG) combustion, which lowers exhaust emissions and improves IC engine performance. The inlet pipe and manifold of the four-stroke S I engine are designed to allow the CNG fuel to flow through magnetic flux. A powerful magnetic flux is influencing the gasoline flow via the pipe. These tests are regularly carried out with various engine loads and Revolutions Per Minute (RPM). It has been noted that the CNG fuel becomes magnetized when exposed to a high magnetic field, which reduces the fuel's viscosity prior to entering the combustion chamber. Exhaust emissions including incomplete combustion of CNG fuel contain higher levels of carbon monoxide (CO), nitrogen oxides (NOx), and sulfur oxides (Sox). Fuel's robust and stable structure prevents the right quantity of oxygen from being present during combustion, which leads to an excess of carbon molecules, hydrocarbons, and nitrogen oxides being released through exhaust, increasing atmospheric pollution. The steady fuel structure is altered by a strong permanent magnetic flux surrounding the fuel pipe, improving the air-fuel combination and allowing oxygen to fully join with it. Ortho state separated the CNG fuel into fine particles with reduced intermolecular interactions, which improved atomization and allowed for maximal fuel burning. It has been noted that both the observation and the existence of a magnetic field affect the engine's performance.

Major Findings: *It was found that the SI Engine reduces air pollution and produces more energy per unit of CNG fuel when fuel is subjected to a strong magnetic impact. According to the overall data, treating CNG fuel with a high magnetic impact increases fuel burning efficiency while reducing fuel consumption and exhaust pollutants.*

Key words: *Fuel Consumption, Fuel Line, Para and Ortho State, Pollutants, Stable Structure, Strong Magnetic Field*

**Author for correspondence*

1.0 Introduction

As a result of industrialization and modernization, there are a growing number of cars in use worldwide in a variety of sectors, necessitating a massive amount of gasoline[1] . Both the strong demand and the constant daily increase in consumption are expected. In the upcoming year, meeting the increasing fuel consumption of cars and reducing pollution will be extremely challenging[2]. More smoke is produced by stationary and automotive engines when they discharge partially burned hydrocarbons (HC), carbon monoxide (CO), and nitrogen oxides (NOx)[3]. For many years, several research teams have been trying to improve combustion by various means, such as altering the combustion chamber's design[4], changing the engine's design , or raising the fuel's inlet pressure to achieve the highest possible fuel atomization[2].

The goal of the current research is to improve the environmental character of IC engines while increasing the efficiency of fuel combustion. The configuration is really small, easy to use, and dependable. Fuel is processed and changed before being added to the IC engine's combustion chamber[5]. The goal of the current study is to create a regular magnetic field that is perpendicular to the fuel flow direction in order to enhance or create a more laminar fuel flow in the engine's inlet manifold before it is admitted into the combustion chamber. Such a powerful magnetic field's function provides organized constraints on combustion performance as well as a way to minimize incomplete combustion.

According to recent research, the magnetic field may be beneficial to the fuel burning system's operation[6-9]. The fuel molecules that are present in the dipole affect how well fuel burns[10]. The fuel molecules in the dipole are positively and negatively charged, but they are not correctly aligned or combined with oxygen to allow for full combustion[11,12].

Fuels for internal combustion engines are typically found in compound form. Due to their positive and negative charges, magnetic field lines can pass through accessible particles with ease (Dipoles).The fuel particle or hydrocarbons must be ionized[13] and realigned since, because such particles have not been realigned, the fuel did not energetically interlock with oxygen (O_2) molecules during ignition[14]. These mechanisms are accomplished by pre-aligning fuel molecules and ionizing them with the aid of a persistent magnetic field[15].

There are several factors that contribute to atmospheric air pollution, including vehicle exhaust fumes[16]. The cause is incorrect fuel burning, which has an impact on the environment, human health, other living things, and climate change[17]. There are numerous initiatives being made worldwide to improve fuel in order to prevent such inappropriate burning of fuel in the combustion chamber[18]. The results of these efforts include improved combustion, decreased emissions, and increased economy.

1.1 Literature Summary

By aligning the fuel molecules in the Para and Ortho states and creating a strong magnetic field surrounding the fuel lines of the inlet port, some recent studies[19] have shown to increase fuel efficiency by reducing molecular attraction and promoting more proper fuel combustion[20,21] further lessen smoke from an engine's exhaust. Fuel particles are widely dispersed in order to combine as much oxygen as possible with the fuel for optimal combustion[22].

2.0 Methodology

The IC's fuel the majority of engines are liquid, and they don't burn until they atomize. In this experimental setup, powerful permanent magnets with an intensity of 2000 Gauss are employed. The Maruti Suzuki 800cc water-cooled, three-cylinder, four-stroke Multi Point Fuel Injection (MPFI) CNG engine is being tested. It has a fuel-entering mechanism, a self-governing panel box with a fuel container, a digital temperature indicator, a manometer, a fuel-measuring unit, and an air container. A temperature gauge indicates the temperature of the engine's hot water exit and cooling water input. A rota meter is a tool for measuring the flow of cooling water calorimeters. The system makes it possible to evaluate the engine for heat balance, SPA, AFR, Brake Power (BP), Brake Mean Effective Pressure (BMEP), and Brake Thermal Efficiency (BTE).

2.1 Experimental Setup

CNG fuel is adequately filled in the fuel tank. Make sure the calorimeter, engine, and hydraulic dynamometer all have proper cooling water circulation. Launch the engine into its setup and run it at its optimal speed with no load until it reaches a steady state. Five minutes are needed to attain the steady state condition. Following that, readings were taken on time. When the engine was loaded, increase

the throttle. Initially, no magnetic field was applied to the CNG fuel, and all results were obtained by progressively increasing the load. A powerful permanent magnet is positioned in front of the fuel injectors in the second configuration. In addition, the magnetic field's load intensity of 2000 Gauss will grow in relation to CNG fuel.

For the configuration shown above, every reading was recorded. All of the measurements were made using the identical setups for the whole experimental configuration—that is, applying a magnetic field both with and without it—as the load decreased. Carbon monoxide (CO) and hydrocarbons (HC) exhaust gas values were obtained in relation to loads, Revolutions Per Minute (RPM), and magnet count. Continuous readings were taken under various load and magnetic intensity circumstances. The engine takes a varied amount of time to burn fuel at a given load and RPM. Fuel usage is also recorded at the same time. For improved outcomes, each condition was repeated three times. In addition, exhaust gas temperature is monitored under the various situations previously indicated.

Both the amount of fuel used during engine running and the amount left over after it was finished were measured. To examine the exhaust gases, a digital exhaust gas analyzer is supplied. The pollution level of burned fuel can be easily checked with the digital gas analyzer. Repetition was done three times for the same thing. The trials where a permanent magnet is installed on the IC engine's fuel time are displayed in Figure. 1. On an engine, observations were made sporadically at 2000, 3000, and 4000 Gauss, respectively. An additional fuel quantity was measured for every Revolution Per Minute (RPM). Additionally, measurements were obtained using 2000 Gauss magnets.

3.0 Result and Discussion

Strong magnetic flux supplied at the inlet port had an effect on the fuel burning process employed in the SI Engine, and its potential effects on exhaust gas were noted. Figure 1 depicts the engine setup layout.

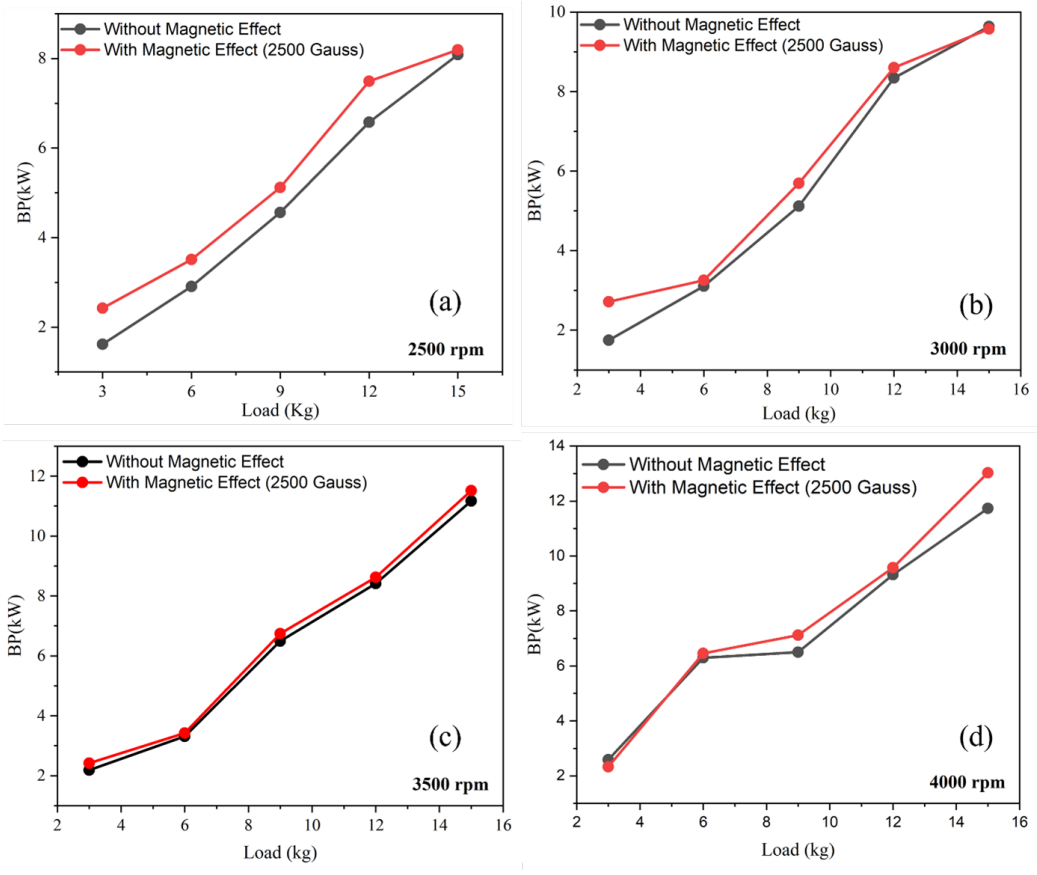


Figure 1. Link between engine RPM and brake thermal efficiency.

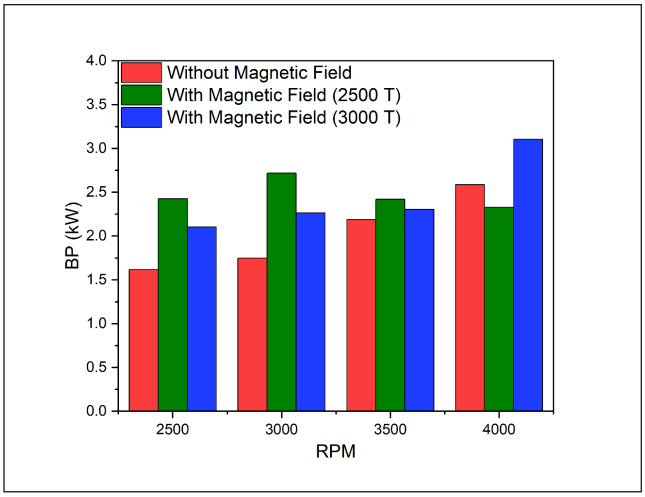


Figure 2. Link between engine RPM and brake specific fuel consumption.

The link between engine RPM and brake thermal efficiency is depicted in Figure 1. According to observations, BTE improves when the combustion chamber temperature rises as a result of the fuel and air chemical reaction during fuel burning.

The link between engine RPM and Brake Specific Fuel Consumption (BSFC) is depicted in Figure 2. After burning the CNG fuel, BSFC measures the efficiency. The fuel supply to the engine is turned into the most amount of useful effort, as seen in the graph. Higher RPM and load will cause the temperature within the combustion chamber to rise and burn fuel more efficiently, gradually improving BSFC.

4.0 Conclusion

Strong permanent magnets with the opposite poles of the south and north magnetized the fuel-passageway, maximizing the amount of fuel burned in the combustion chamber and improving engine output. This also minimizes the amount of fuel that remains unburned, which lowers pollution to the environment and improves fuel efficiency. A further benefit is extending the life of an internal combustion engine by preventing carbon build-up in the combustion area, spark plug, and carburettor/ fuel injector nozzle. The temperature of the combustion chamber rises when the fuel burns chemically. Magnetic flux generally results in improved performance of an IC engine. The temperature of the exhaust rose at the same time that CO and HC emissions were decreased.

5.0 References

1. Ugare V, Dhoble A, Lutade SK, Mudafale K. Performance of Internal Combustion (CI) engine under the influence of stong permanent magnetic field. IOSR J Mech Civ Eng. 2014:11-17.
2. Kumar AR, Raju GJ. Experimental investigation of a magnetic fuel ionization method in a diesel engine to improve the performance and emissions. J Phys Conf Ser. 2021; 1817. https://doi.org/10.1088/1742-6596/1817/1/012028
3. Abdul-Wahhab HA, Al-Kayiem HH, Aziz ARA, Nasif MS. Survey of invest fuel magnetization in developing internal combustion engine characteristics. Renew Sustain Energy Rev. 2017; 79:1392-1399. https://doi.org/10.1016/j.rser.2017.05.121
4. Pathak SK, Nayyar A, Goel V. Optimization of EGR effects on performance and emission parameters of a dual fuel (Diesel + CNG) CI engine: An experimental investigation. Fuel. 2021; 291:120183. https://doi.org/10.1016/j.fuel.2021.120183
5. Wallington TJ, Kaiser EW, Farrell JT. Automotive fuels and internal combustion engines: A chemical perspective. Chem Soc Rev. 2006; 35:335-347. https://doi.org/10.1039/b410469m. PMid:16565750.
6. Gutfleisch O, Willard MA, Brück E, Chen CH, Sankar SG, Liu JP. Magnetic materials and devices for the 21st century: Stronger, lighter, and more energy efficient. Adv Mater. 2011; 23:821-842. https://doi.org/10.1002/adma.201002180 PMid:21294168.
7. Fernandez-Pello AC. Micropower generation using combustion: Issues and approaches. Proc Combust Inst. 2002; 29:883-899. https://doi.org/10.1016/S1540-7489(02)80113-4
8. Slutz SA, HerrmannMC, Vesey RA, Sefkow AB, Sinars DB, Rovang DC, Peterson KJ,Cuneo ME. Pulsed-power-driven cylindrical liner implosions of laser preheated fuel magnetized with an axial field. Phys Plasmas. 2010; 17. https://doi.org/10.1063/1.3333505
9. Bussard RW. Some physics considerations of magnetic inertial-electrostatic confinement. A new concept for spherical converging-flow fusion. Fusion Technol. 1991; 19:273-293. https://doi.org/10.13182/FST91-A29364
10. Faris AS, Al-Naseri SK,Jamal N, Isse R, Abed M, Fouad Z, Kazim A,Reheem N,Chaloob A, Mohammad H, Jasim H, Sadeq J, Salim A, Abas A. Effects of magnetic field on fuel consumption and exhaust emissions in two-stroke engine. Energy Procedia. 2012; 18:327-338. https://doi.org/10.1016/j.egypro.2012.05.044.

11. Al-Khaledy AAJ. High Performance and low pollutant emissions from a treated diesel fuel using a magnetic field. J Eng Sci. 2008; 1:211-224.
12. Weitzel K, Chemie F. Bond-Dissociation Energies of Cations - Pushing the limits to quantum state resolution. WHO Libr Cat Data. 2011; 221-235. https://doi.org/10.1002/mas. PMid:21337598.
13. El Fatih FA, Saber GM. Effect of fuel magnetism on engine performance and emissions. Aust J Basic Appl Sci. 2010; 4:6354-6358.
14. Salvi BL, Subramanian KA. Sustainable development of road transportation sector using hydrogen energy system. Renew Sustain Energy Rev. 2015; 51:1132-1155. https://doi.org/10.1016/j.rser.2015.07.030
15. Dinh KB, Hannaford P,Van Dao L. Phase-matched high harmonic generation for the study of rotational coherence molecular dynamics. Opt Commun. 2011; 284:3607-3611. https://doi.org/10.1016/j.optcom.2011.03.088
16. Amato F, Cassee FR, Denier van der Gon HAC, Gehrig R, Gustafsson M, Hafner W, Harrison RM, Jozwicka W, Kelly FJ, Moreno T, Prevot ASH, Schaap M, Sunyer J, Querol X. Urban air quality: The challenge of traffic non-exhaust emissions. J Hazard Mater. 2014; 275:31-36. https://doi.org/10.1016/j.jhazmat.2014.04.053 PMid: 24837462.
17. Miraglia M, Marvin HJP, Kleter GA, Battilani P,Brera C, Coni E, Cubadda F, Croci L, De Santis B, Dekkers S, Filippi L, Hutjes RWA, Noordam MY, Pisante M, Piva G, Prandini A, Toti L, Van den Born GJ, Vespermann A. Climate change and food safety: An emerging issue with special focus on Europe. Food Chem Toxicol. 2009; 47:1009-1021. https://doi.org/10.1016/j.fct.2009.02.005. PMid:19353812.
18. Mohan B, Yang W, Chou SK. Fuel injection strategies for performance improvement and emissions reduction in compression ignition engines - A review. Renew Sustain Energy Rev. 2013; 28:664-676. https://doi.org/10.1016/j.rser.2013.08.051
19. Patel PM, Rathod GP, Patel TM. Performance and emission analysis of single cylinder diesel engine under the influence of magnetic fuel energizer. IOSR J Mech Civ Eng. 2014; 11:34-39. https://doi.org/10.9790/1684-11283439
20. Geng P, Cao E, Tan Q, Wei L. Effects of alternative fuels on the combustion characteristics and emission products from diesel engines: A review. Renew Sustain Energy Rev. 2017; 71:523-534. https://doi.org/10.1016/j.rser.2016.12.080
21. Bergthorson JM, Thomson MJ. A review of the combustion and emissions properties of advanced transportation biofuels and their impact on existing and future engines. Renew Sustain Energy Rev. 2015; 42: 1393-1417. https://doi.org/10.1016/j.rser.2014.10.034
22. Wei J, Zeng Y, Pan M, Zhuang Y, Qiu L, Zhou T, Liu Y. Morphology analysis of soot particles from a modern diesel engine fueled with different types of oxygenated fuels. Fuel. 2020; 267:117248. https://doi.org/10.1016/j.fuel.2020.117248
23. Zheng Y, Li S, Xing K, Zhang X. Unmanned aerial vehicles for magnetic surveys: A review on platform selection and interference suppression. Drones. 2021; 5. https://doi.org/10.3390/drones5030093