PM World Journal
Vol. VII, Issue V – May 2018
www.pmworldjournal.net

Review of Literature to aid in Management & Forecasting of Technology: A Case of Petrol Engines
Featured Paper
by Kharola, A., Nikam, Y., Patil, H.

A Review of Literature to aid in Management and Forecasting of Technology: A case of Petrol Engines

Ashwani Kharola, Yadnyesh Nikam, Hitesh Patil

Department of Mechanical Engineering
Tula's Institute, Dehradun, India

Abstract

In this paper a brief review of past 30 years literature has been conducted on four-stroke petrol engine. The study would help in analysing different approaches and analysing them for effective management of such complex technologies and forecasting future trends of such technologies. Review of past literature can be used to create a roadmap for future technologies. This review can be utilised by researchers to conduct technology management and forecast innovative technologies for future needs.

Keywords: Technology Management, Forecasting, Four-stroke petrol engine, I.C. engine, spark ignition

1. Introduction

An Engine is a device which converts chemical energy of a fuel into mechanical energy. Four stroke petrol engines are very popular engines widely used in vehicles operating on Otto-cycle and using petrol as a fuel. Four stroke petrol engines are very popular spark ignition engines widely used in automobiles. These engines are keen source interest for researchers working in the field automobile sector. Various researchers have proposed different techniques for optimising performance characteristics of these engines. These engines uses electric spark for burning the fuel thereby moving movable parts of the engine. The first four stroke engines was demonstrated by Nikolaus August Otto in 1876, hence it is also called Otto cycle. In 1885, German Mechanical engineer, Karl-Benz built the world's first automobile powered by an internal combustion engine. In the past 150 year's world has seen fast and innovative advancements in the design of four-stroke petrol engine. Many different designs have been suggested and built keeping in mind the basic objective of compact size, price, quality of combustion products, power output etc. This study highlights in brief various techniques and approaches being adopted by researchers in the past few decades to improve the performance and efficiency of four-stroke petrol engine. A survey has been carried out on the research work by different authors and some significant contribution has been beautifully highlighted in this study.

PM World Journal
Vol. VII, Issue V – May 2018
www.pmworldjournal.net

Review of Literature to aid in Management & Forecasting of
Technology: A Case of Petrol Engines
Featured Paper   by Kharola, A., Nikam, Y., Patil, H.

2. Literature review

Melgaard et al. [1] identified an engine model from a linearized version of a mean value model for a four-cycle spark ignition (SI) engine. The approach demonstrated a physical understanding of the engine throughout the identification stage. The techniques which were adopted by authors includes a classical step response approach and modern statistical methods like Kalman filtering and Maximum Likelihood estimation. The results helped in identification of the most important parameters and time constants of the engine which can be used for the construction of engine simulation models, control studies and condition monitoring applications. Hwang [2] simulated a digital engine speed display and an advance ignition system for designing a microcontroller-based electronic control system for a four stroke and single cylinder engine. The author utilised a DC motor whose speed can be adjusted by a voltage transformer and numerated by a photo sensor, 8751 H microcontroller, and digital readout is used as an engine. A timing light is used to identify the advanced ignition angles of the spark plug. The simulation results showed that some mechanical hardware can be replaced by electronic components to make automobile engines more efficient and inexpensive.

Kurniawan & Abdullah [3] carried out a numerical study to simulate and analyze the combustion process occurring in a compressed natural gas direct injection (CNG-DI) engine using a multi-dimensional computational fluid dynamics (CFD). The investigation was performed on a single cylinder 1.6-liter engine running at wide open throttle at a fixed speed of 2000 rpm. The mesh generation was established via an embedded algorithm for moving meshes and boundaries thereby providing a more accurate transient condition of the operating engine. The natural gas employed is considered to be 100% methane (CH_4) with three global step reaction scheme. The results of CFD simulation were then compared with the data obtained from the single-cylinder engine experiment and showed a close agreement. Wong et al. [4] proposed a novel design called dual-mode electrohydraulic fully variable valve train (EHFVVT) for both engine intake and exhaust. The system is controlled by either proportional flow control valves or proportional pressure relief valves. The author's demonstrated a mathematical model of the valve train system and its dynamic analysis in their paper. Experimental and simulation results show that the proposed valve train was capable of achieving fully variable valve timing and lift control, and has the potential to eliminate the traditional throttle valve in the gasoline engines.

Rebhan & Stokes [5] demonstrated the combinability of two and four stroke operations in a single internal combustion engine equipped with a demonstrator vehicle. The proposed engine operating mode opens the gateway for downsizing the complete system beyond the conventional technical limits. Donitz et al. [6] presented a novel hybrid pneumatic engine configuration that entails fixed camshafts for both intake and exhaust valves while utilizing variable valve actuation for one charge valve per cylinder only. This configuration is operated entirely in four-stroke modes and requires a careful optimization of its operating strategy to achieve its fuel

PM World *Journal*

Vol. VII, Issue V – May 2018

www.pmworldjournal.net

Review of Literature to aid in Management & Forecasting of
Technology: A Case of Petrol Engines

Featured Paper   by Kharola, A., Nikam, Y., Patil, H.

economy potential. The results showed small efficiency losses compared to a full two-stroke operation using four-stroke modes. Finally initial measurement results were obtained from the engine system which confirmed the validity of proposed approach. Senthilkumar et al. [7] conducted various tests on horizontal single cylinder variable speed Greaves engine with various blends of cottonseed oil (B5, B10, B15, B20, B40 & B100) and further compared the performance of cottonseed oil with diesel. The results shows that B20 diesel with blend 20% yielded optimum value, with less fuel consumption and higher efficiencies than diesel and it is feasible us it in the diesel engine with no modification.

Shiao & Dat [8] proposed a dynamic model of an unthrottled SI engine to simulate the engine cycle. The model uses an Electromagnetic valve train (EMV) system that allows valvetrain control and provides optimal valve timing for different engine speeds. Additionally, the study also highlighted that cylinder deactivation modes can be successfully applied in improving engine efficiency at different engine loads. It was observed that the two-cylinder deactivation mode (50% CDA) considerably improves fuel consumption at low engine load. Meanwhile, one-cylinder deactivation (25% CDA) is an optimal fuel economy mode at medium engine load. With proper uses of CDA strategies, the efficiency of an SI engine can be increased more than 30% at low engine load and 11.7 % at medium engine load. Noga & Sendyka [9] demonstrated a design of five-stroke engine developed at Cracow University of Technology. The authors identified the effect of implementing five-stroke cycle into the engine with spark ignition in order to reduce toxic emissions and increase total efficiency. A test engine has been built having different design of timing system, four valves per cylinder and petrol direct injection. The study presented a detailed description of the engine design and the results of the tests of the five-stroke engine confirm an increase of specific torque and power and improved the total efficiency of the engine.

Zareei & Kakaee [10] determined the effect of variable ignition timing on exhaust emission and performance of an SI engine. The study analysed the ignition timing at a speed of 3400 rpm and in the range of 41° BTDC to 10° ATDC. The results showed that optimal power and torque is achieved at 31° BTDC and volumetric efficiency, BMEP have increased with rising ignition timing. It was also observed that O_2, CO_2, CO remains almost constant, but HC with advance of ignition timing increased and the lowest amount NO_x is obtained at 10° BTDC. Moizuddin et al. [11] highlighted upon the benefits of using twin-spark technology for ignition of fuels in four stroke petrol engines. The study illustrated in brief how this technique is useful in increasing the power output and reducing the unburnt gases waste by increasing the number of spark plugs. Finally the study introduced a novel approach based on triple-spark technique which can be successfully introduced in four stroke engines. Woo & Lee [12] reviewed most of the successful free piston engine generator developments studies by various researchers. Free piston engine generators utilises a free piston and a linear generator that gives power output in a more efficient way when compared to conventional crankshaft engines. The study also presented a prototype free piston system with different mixture preparation strategies.

PM World *Journal*
Vol. VII, Issue V – May 2018
www.pmworldjournal.net

Review of Literature to aid in Management & Forecasting of
Technology: A Case of Petrol Engines
Featured Paper   by Kharola, A., Nikam, Y., Patil, H.

Gao et al. [13] proposed constant speed control models of four-stroke micro internal combustion swing engine (MICSE). The study considered a two-level Petri net based hybrid model to model the four-stroke MICSE engine cycle. The continuous sub-models, including breathing dynamics of intake manifold, thermodynamics of the chamber and dynamics of the torque generation, are investigated and integrated with the discrete model in MATLAB Simulink. Through the comparison of experimental data and simulated DC voltage output, it was demonstrated that the hybrid model is valid for the four-stroke MICSE system. Thirumalvallan et al. [14] implemented a CO absorption mechanism inside the exhaust pipe of vehicle in a single cylinder four stroke spark-ignition engine. The authors proposed a new post-combustion emission control device called cobalt scrubber to reduce the emission of CO during idling which absorb and later release it under transient conditions. The results showed that emission of CO when the engine runs with petrol is reduced from 6.24% to 3.02%. It was also observed that mixture of Methanol (40%) and petrol (60%) gives a better emission result of 0.98% of CO emission.

Dabrowski et al. [15] conducted combined tests on a four-stroke engine spark ignition engine and a mechanical oscillator with pneumatic support called pneumatic energy accumulator (PAE). The authors studied the possibility to control the thermodynamic processes that occur at the end of a compression stroke and at the beginning of an expansion stroke and also carried out a preliminary assessment of a simulation model of a PAE (US 872039-B2). Lande & Kongre [16] conducted a study to identify the effect of variable ignition timing on engine performance and exhaust emission of a spark ignition engine. The authors used a single cylinder four stroke engine with eddy current dynamometer and artificial ignition system to investigate the effect of variable ignition timing on performance and exhaust emissions. The test engine was operated with different blend of ethanol-gasoline (E5, E10, E15 and E20). The results showed considerable performance improvement in brake thermal efficiency and decrease in break specific fuel consumption as well as reduction in HC, CO emission.

Chitragar et al. [17] carried out experiments to evaluate the combustion and emission performance of a Maruti Suzuki spark ignited four cylinders four stroke engines at idle condition by using pure hydrogen, LPG and gasoline. The engine was adjoined with Electronic Control Unit (ECU) assisting hydrogen and LPG injector system keeping gasoline line unchanged. Tests were carried out by using compressed hydrogen gas regulated by two stage pressure reduction from cylinder to atmospheric value and by using vaporizer pressure for LPG. For comparison engine was run first by gasoline and then by pure hydrogen and LPG. The results showed that there was increment of 13% cylinder pressure for pure hydrogen and decrement of 4.5% cylinder pressure for LPG when compared to gasoline. The burn duration for pure hydrogen, LPG and gasoline were found to be increasing respectively which infers that hydrogen has very short combustion duration and gasoline higher. It was observed that toxic emissions like Carbon monoxide (CO), Hydrocarbons (HC) and Oxides of Nitrogen (NO_x) were improved for pure hydrogen than LPG and gasoline. Karthikayan et al. [18] examined the various trends and

PM World *Journal*

Vol. VII, Issue V – May 2018

www.pmworldjournal.net

Review of Literature to aid in Management & Forecasting of
Technology: A Case of Petrol Engines

Featured Paper   by Kharola, A., Nikam, Y., Patil, H.

innovations in field of metal coating in automobile engine application. The authors examined the effect of ceramic coating which acts as a barrier thereby reducing the heat loss from the engine. The studied highlighted that survival from adverse of emissions can be significantly controlled by attaining technological advancements in emission reduction.

Bapiri et al. [19] determined the cylinder pressure for valve event angles in order to optimise the strategy for timing of valves when independently-actuated valves are available. The authors applied an artificial neural network to create a prediction matrix to anticipate the best variable valve timing approach according to rotation speed. Mohammed et al. [20] studied the performance and combustion characteristics of a novel internal combustion four-stroke, spark-ignition, and single-curved cylinder engine, called the crank-rocker engine. The tests were performed at six different engine speeds of 1800, 2000, 2200, 2400, 2600 and 2800 rpm, with each one operating at wide open throttle. The results obtained from the crank-rocker engine were compared with the experimental results obtained from the conventional engine (benchmark engine). The results showed indicated torque and power increased by about 6.28 %, while the indicated specific fuel consumption is lower by 4.69 % using crank-rocker engine. It was also observed that the combustion rate and mixture of the novel crank-rocker engine burned faster, resulting in shorter combustion duration and ignition delay period than the conventional slider-crank engine.

3. Conclusion

Technology Management and Technology Forecasting are two important perspectives which needed to be considered while developing any new technique or subsystem. Technology forecasting involves creating of a technology roadmap which can be only done if proper review of literature has been done. This paper gives a glimpse of research work which has been carried out on four-stroke petrol engines in different parts of the world. The study highlights some significant contributions in this field by different researchers. A brief review of past 30 years literature has been conducted and beautifully aligned together. The study discusses in brief the achievements and conclusions coming out from the study of different researchers. The initial conclusion coming out from this study shows a trend to develop different alternative fuels which are cheaper and leads to less pollutants. Secondly it has been observed that many researchers are focussing on developing different techniques which can improve the efficiency of four-stroke petrol engine at different loads. Lastly, it has been concluded that many researchers are incorporating various soft-computing learning techniques for predicting and enhancing the performance of four-stroke petrol engines.

PM World Journal
Vol. VII, Issue V – May 2018
www.pmworldjournal.net

Review of Literature to aid in Management & Forecasting of
Technology: A Case of Petrol Engines
Featured Paper   by Kharola, A., Nikam, Y., Patil, H.

References

[1] Melgaard, H., Hendricks, E., & Madan, H. (1990). Continuous Identification of a four-stroke SI Engine. In Proceedings of IEEE American Control Conference, 23-25 May 1990, San Diego, CA, USA.

[2] Hwang, S. (1992). Simulation of advance ignition system for a four stroke and single cylinder engine using photo sensor and 8751 H microcontroller. In Proceedings of 1st IEEE International Conference on Control Applications, 13-16 Sept. 1992, Dayton, USA, doi: 10.1109/CCA.1992.269801.

[3] Kurniawan, W.H., & Abdullah, S. (2008). Numerical analysis of the combustion process in a four-stroke compressed natural gas engine with direct injection system. Journal of Mechanical Science and Technology, 22(10): 1937-1944, doi: 10.1007/s12206-008-0737-6.

[4] Wong, P.K., Tam, L.M., & Li, K. (2008). Modeling and simulation of a dual-mode electrohydraulic fully variable valve train for four-stroke engines. International Journal of Automotive Technology, 9(5): 509-221, doi: 10.1007/s12239-008-0061-2.

[5] Rebhan, M., & Stokes, J. (2009).Two stroke/four stroke multicylinder gasoline engine for downsizing applications. MTZ Worldwide, 70(4): 40-45, doi: 10.1007/BF03226944.

[6] Donitz, C., Vasile, I., Onder, C.H., & Guzzella, L. (2009). Modelling and optimizing two and four stroke hybrid pneumatic engines. Journal of Automobile Engineering, 223(2): 255-280, doi: 10.1243/09544070JAUTO972.

[7] Sethilkumar, R., Ramadoss, K., & Prabu, M. (2012). An effective experimental investigation on 4-stroke single cylinder C.I. engine using cotton seed biofuels. In Proceedings of IEEE International Conference in Advances in Engineering, Science and Management (ICAESM), 30-31 March 2012, Nagapattinam, Tamil Nadu.

[8] Shiao, Y., & Dat, L.V. (2012). Efficiency improvement for an unthrottled SI engine at part load. International Journal of Automotive Technology, 13(6): 885-893, doi: 10.1007/s12239-012-0089-1.

[9] Noga, M., & Sendyka, B. (2013). New design of the five stroke engine. Journal of KONES Powertrain and Transport, 20(1): 239-246.

[10] Zareei, J., & Kakaee, A.H. (2013). Study and the effect of ignition timing on gasoline engine performance and emissions. European Transport Research Review, 5(2): 109-116, doi: 10.1007/s12544-013-0099-8.

[11] Moizuddin, S., Ahmad, N., & Asim, Md. (2014). Recent trends in four-stroke internal combustion engine of two-wheelers. Journal of Mechanical and Civil Engineering, 11(2): 37-41.

PM World *Journal*

Vol. VII, Issue V – May 2018

www.pmworldjournal.net

Review of Literature to aid in Management & Forecasting of
Technology: A Case of Petrol Engines

Featured Paper   by Kharola, A., Nikam, Y., Patil, H.

[12] Woo, Y., Lee, Y.J. (2014). Free piston engine generator: Technology review and an experimental evaluation with hydrogen fuel. 15(2): 229-235, doi: 10.1007/s12239-014-0024-8.

[13] Gao, D., Lei, Y., Zhu, H., & Ni, J. (2015). Constant speed control of four-stroke micro internal combustion swing engine. Chinese Journal of Mechanical Engineering, 28(5): 971-982, doi: 10.390/CJME.2015.0512.070.

[14] Thirumalvalavan, S., Malliga, P., Arulraj, P., & Udayakumar, G. (2016). Emission characteristics of single cylinder 4 stroke SI engine using cobalt scrubber. Management of Environmental Quality: An International Journal, 27(1):79-92, doi:10.1108/MEQ-06-2015-0116.

[15] Dabrowski, A., Glogowski, M., & Kubaik, P. (2016). Improving the efficiency of four-stroke engine with the use of pneumatic energy accumulator-simulations and examination. International Journal of Automotive Technology, 17(4): 581-590, doi:10.1007/s12239-016-0058-1.

[16] Lande, B.V., & Kongre, S. (2016). The effect of advanced ignition timing on ethanol-gasoline blended spark ignition engine. In Proceedings of IEEE International Conference on Electrical, Electronics and Optimization Techniques (ICEEOT), 3-5 March 2016, Chennai, India, doi: 10.1109/ICEEOT.2016.7755071.

[17] Chitragar, P.R., Shivaprasad, K.V., Nayak, V., Bedar, P., & Kumar, G.N. (2016). An Experimental study on combustion and emission analysis of four cylinder 4-stroke gasoline engine using pure hydrogen and LPG at idle condition. Energy Procedia, 90: 525-534, doi: 10.1016/j.egypro.2016.11.220.

[18] Karthikayan, S., Ganesan, S., Vesanthakumar, P., Sankaranarayanan, G., Dinakar, M. (2017). Innovative Research Trends in the application of thermal barrier metal coating in Internal combustion engines. Material Today Proceedings, 4(8): 9004-9012, doi: 10.1016/j.matpr.2017.07.253.

[19] Bapiri, S., Chaghaneh, O., Ghomashi, H. (2017). Variable Valve Timing Scheduling in a 4-Stroke Internal Combustion Cylinder Utilizing Artificial Neural Networks. Advances in Science and Technology Research Journal, 11(3), 114-121. doi: 10.12913/22998624/75968

[20] Mohammed, S.E., Baharom, M.B., & Aziz, A.R. (2017). Performance and combustion characteristics of a novel crank-rocker engine. Journal of Mechanical Science and Technology, 31(7): 3563-3571, doi: 10.1007/s12206-017-0643-x.

PM World *Journal*
Vol. VII, Issue V – May 2018
www.pmworldjournal.net

Review of Literature to aid in Management & Forecasting of
Technology: A Case of Petrol Engines
Featured Paper   by Kharola, A., Nikam, Y., Patil, H.

About the Authors

Ashwani Kharola

Tula's Institute
Dehradun, India

Mr. Ashwani Kharola received B.Tech (with Honors) in Mechanical Engineering from Dehradun Institute of Technology, Dehradun in 2010 and M.Tech in CAD/CAM & Robotics from Graphic Era University, Dehradun in 2013. Presently he is working as Assistant Professor in Department of Mechanical Engineering at Tula's Institute, Dehradun. Earlier he has worked as a Research Fellow in Institute of Technology Management (ITM), One of premier training institute of Defence Research & Development Organisation (DRDO), Ministry of Defence, Govt. of India. He is pursuing PhD in Mechanical Engineering from Graphic Era University (Deemed University), Dehradun. He has published many Research papers in National/International peer reviewed ISSN Journals and IEEE Conferences. His current areas of work includes Fuzzy logic reasoning, Adaptive Neuro-fuzzy inference system (ANFIS) control, Neural Networks, PID, Mathematical Modeling & Simulation. He can be contacted at ashwani.kharola@tulas.edu.in

Yadnyesh Nikam

Tula's Institute
Dehradun, India

Mr Yadnyesh Sanjay Nikam is presently pursuing B. Tech in Mechanical Engineering from Tula's Institute (affiliated to Uttarakhand Technical University), Dehradun. Tula's is one of the best engineering colleges in Dehradun. His current areas of interest include Automobile engineering, Thermodynamics, CAD, etc. He can be contacted at yadnyeshnikam004@gmail.com

PM World *Journal*
Vol. VII, Issue V – May 2018
www.pmworldjournal.net

Review of Literature to aid in Management & Forecasting of Technology: A Case of Petrol Engines

Featured Paper

by Kharola, A., Nikam, Y., Patil, H.

Hitesh Patil

Tula's Institute
Dehradun, India

Mr Hitesh Dinesh Patil is presently pursuing B. Tech in Mechanical Engineering from Tula's Institute (affiliated to Uttarakhand Technical University), Dehradun. Tula's is one of the best engineering colleges in Dehradun. His current areas of interest include Automobile engineering, Robotics, CAD etc. He can be contacted at hp622907@gmail.com