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Some Studies on Advanced Technologies used in Automobiles

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Abstract

This paper highlights the technical aspects and the working of the advanced technologies used in the present or can be used in the future automobiles. The technologies that are discussed in this paper are variable valve timing, Valvetronic Engines, Downsizing and Turbocharging, Advanced Combustion Modes, Hybrid / Electric Vehicles, Fuel Cells, Weight Reduction Materials, Alternative Fuels, Batteries and Energy Storage, 42 volt system, Drive by wire Technology, Camless engine, Exhaust gas recirculation, Sterling engine opposed piston engine, Split cycle engine, Free piston engine and Wankel rotary engine. A critical analysis with the advantages and disadvantages of these technologies are made in the paper. A final conclusion is drawn that once these technologies are in the market they will not only help in providing better modes of transport but will also help in reducing our dependence on conventional fuels.

Keywords: Engine, Fuel cell, batteries, hybrid vehicles, camless engine.

1. Introduction

The key drivers for new engine technology are changing customer expectations, new environmental regulations & noise, increased fuel costs, availability of alternate fuels, new emerging markets and cut throat competition. These drivers are causing researchers to think in the direction of more efficient and economical technologies.

The above mentioned objectives were obtained by bringing changes in the engines or by fitting it with improved parts in the automobile. This not only improves market value of a vehicle but opens new areas of researches. Working along with advantages and disadvantages of some of the technologies are discussed in the paper.

2. Variable Valve Timing

In this camshafts are cut with a three-dimensional profile that varies along the length of the cam lobe. At one end of the cam lobe is the least aggressive cam profile, and at the other end is the most aggressive. The shape of the cam smoothly blends these two profiles together. A mechanism can slide the whole camshaft laterally so that the valve engages different parts of the cam. The shaft still spins just like a regular camshaft, but by gradually sliding the camshaft laterally as the engine speed and load increase and in this way the valve timing can be optimized (Dobrivoje Popovic et.al 2006)

3. Valvetronic Engines

Valvetronic varies the timing and the lift of the intake valves. The Valvetronic system has a conventional intake cam, but it also uses a secondary eccentric shaft with a series of levers and roller followers, activated by a stepper motor. Based on signals formerly taken mechanically from the accelerator pedal, the stepper motor changes the phase of the eccentric cam, modifying the action of the intake valves. Valvetronic reduces maintenance costs, improves cold start behavior, lowers exhaust emissions, and provides a smoother running engine. (A.M.N.Venkata et.al 2013).

4. Downsizing and Turbocharging

Downsized engines are lighter than conventional engines, thereby reducing vehicle mass and the improving vehicle fuel consumption. In petrol and diesel vehicles, the turbocharger has a centrifugal compressor powered by a turbine that is driven by the engine's exhaust gases. Hot exhaust gases flow through the turbine's wheel blades, accelerating the turbine and driving the compressor. Turbocharging recovers the energy of the exhaust gasses to increase the inducted charge, therefore increasing the power-to-displacement ratio. A downsized and turbocharged engine has the potential to have the same or better performance as a non-downsized, normally aspirated engine, with the advantage of a significant increase of fuel efficiency. (A. Kusztelan et.al 2011).

5. Advanced Combustion Modes

Some of advanced combustion modes are introduction of direct combustion system in both petrol and diesel engine with advance version like CRDI (Common rail diesel injection) in diesel and GDI (Gasoline direct injection) in petrol. Another mode is

called (homogeneous charge compression ignition) HCCI. It use spark ignition for heavy load operation but in light load can ignite a lean mixture throughout a cylinder without a spark. The "homogenous charge" is a uniform mix of air, fuel and up to 70 percent of the already-burned exhaust gas. Compression stroke brings the mixture to a controlled self-ignition state and thus no need for a spark. Because of the uniform mix in the cylinder, there's no hot flame front, and the mixture burns almost instantaneously and completely throughout the cylinder. (Salvador M. et al 2001, Mark Sellnau 2011).

6. Hybrid/ Electric Vehicles

Hybrid vehicles are equipped with both combustion and electric engines. This technology holds great potential, especially for use in smaller vehicles running at lower speeds for short distances, in highly populated urban areas. Honda Civic are Toyota Prius are the two variants recently launched in India. (Noshin et al, 2012).

7. Fuel Cell Technology

A fuel cell works as an electrochemical cell by combining hydrogen and oxygen without combustion to generate electricity. Inside a cell fuel hydrogen is passed over a negatively charged pole, or anode, where electrons are stripped off through catalytic action. The hydrogen ions that result then flow through the conducting substance (known as electrolyte) towards a positively charged pole or cathode. The electron flow produces an electric current. The hydrogen ions are left to combine at the cathode with oxygen, producing heat and water. Ethanol, methanol and hydrogen are the main sources of fuel for the production of electricity from fuel cells. The electricity generated drives the car. (Mehrdad Ehsani, 2005).

8. Weight Reduction Materials

Because it takes less energy to accelerate a lighter object than a heavier one, lightweight materials offer great potential for increasing vehicle efficiency. Replacing cast iron and traditional steel components with lightweight materials such as high-strength steel, magnesium (Mg) alloys, aluminum (Al) alloys, carbon fiber, and polymer composites can directly reduce the weight of a vehicle's body and chassis by up to 50 percent and therefore reduce a vehicle's fuel consumption. A 10% reduction in vehicle weight can result in a 6%-8% fuel economy improvement. The use of lightweight materials could result in needing a smaller and lower cost battery (Ju¨rgen Hirsch, 2011).

9. Alternative Fuels

The alternative fuels being tested at present are Liquefied Petroleum Gas (LPG), Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG), Methanol, Ethanol,

Hydrogen, etc. These are designed to reduce emission and release fewer green house gas emissions. (Brent D. Yacobucci, 2013).

10.Batteries and Energy Storage

Advanced chemistries could allow batteries to operate through greater temperature extremes, last longer, and reduce weight and cost. Other efforts are being made to reduce the cost of the ancillary systems, such as cooling, to further reduce the total cost of the battery system (Mehrdad Ehsani, 2005).

11.42 Volt Systems

All mechanical control system will be electrically controlled in near future. This includes air conditioning systems, steering, suspension systems water pumps, alternators and windshields. start- stop engines are also in the phase of development. There are even projects in place for the implementation of heated catalysts to further reduce vehicle emissions. Conversion of these mechanical systems will allow for further vehicle weight reduction and increased fuel efficiency as well as provide highly desirable and profitable consumer features. (Noshin Omar 2012, Emilian Ceuca 2002).

12.Drive by Wire Technology

Drive-by-wire, or x-by-wire technology in the automotive industry replaces the traditional mechanical control systems with electronic control systems using electromechanical actuator and human- machine interfaces such as pedal and steering feel emulators. These includes Throttle-by-wire, Brake-by-wire, Steer-by-wire (Emilian Ceuca, 2002).

13.Camless Engine

In a camless engine, electromechanical actuators placed directly on the valves, replace the camshaft. This technology makes it possible to optimize the circulation of gases in the engine both for intake and exhaust, and to deploy operating modes that improve fuel consumption, clean exhaust technology and performance (Ashutosh).

14.EGR (Exhaust-Gas Recirculation Systems)

In I.C. engines, NOx formation is a highly temperature-dependent phenomenon and takes place when the temperature in the combustion chamber exceeds 2000 K particularly in diesel engines which have higher combustion temperatures. Thus, to reduce NOx emissions in the exhaust, it is essential to keep peak combustion temperatures restrained. Re-circulating part of the exhaust gas helps in reducing NOx,

but appreciable particulate emissions are observed at high loads.(A.K.Agarwal et al. 2004).

15. Sterling Engine

A Stirling engine is a heat engine operating by cyclic compression and expansion of air or other gas, the working fluid, at different temperature levels such that there is a net conversion of heat energy to mechanical work. It can be classified into three different types Alpha, Beta and Gamma (Fig 1) according to its cylinder and piston arrangement.

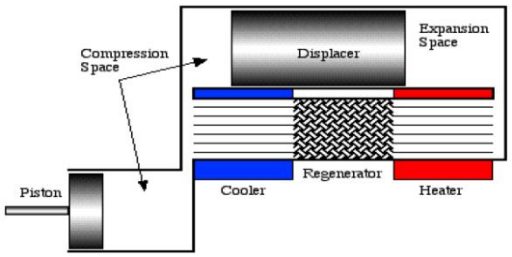

Figure 1: Gamma Engine's Configuration

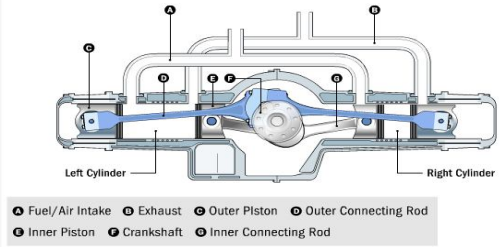

Figure 2: Opposed-Piston Opposed-Cylinder Engine.

They run very silent and they don't need any air supply because it uses always the same body of gas. That's why they are used a lot in submarines. E.g. in the Royal Swedish Navy (Alpesh V. Mehta et al 2012).

16. Opposed-piston Engine (Opposed-piston Opposed-cylinder Engine)

The opposed-piston opposed-cylinder (Fig 2) (OPOC) architecture has drawn considerable attention recently with the emergence of a new company called Ecomotors. This patented design of internal combustion engine will run on a number of different fuels, including gasoline, diesel and ethanol. This eliminates the cylinder-head and valve-train components of conventional engines, offering an efficient, compact and simple core engine structure. The result is an engine family that is lighter, more efficient and economical, with lower exhaust emissions (Laurence Fromm et al 2012).

17. Split-cycle Engine

Split-cycle engines (Fig. 3) separate the four strokes of intake, compression, power, and exhaust into two separate but paired cylinders. The first cylinder is used for intake and compression. The compressed air is then transferred through a crossover passage

from the compression cylinder into the second cylinder, where combustion and exhaust occur (Ford et al 2011)

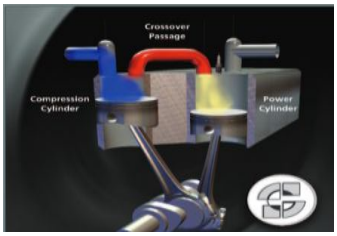

Figure 3: Split-Cycle Engines.

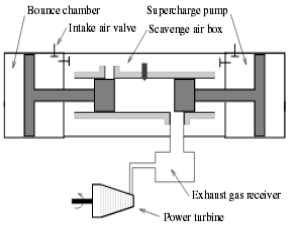

Figure 4: Free Piston Engine.

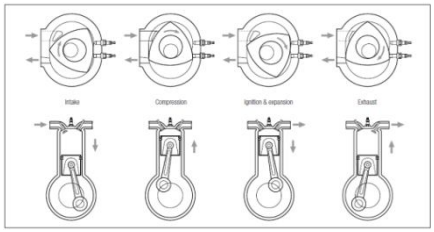

Figure 5: Wrankel engine comparison.

18.Free-piston Engine

The free-piston engine (Fig 4) is a linear, 'crankless' combustion engine, in which the piston motion is not controlled by a crankshaft but is a result of the interaction of forces from the combustion cylinder gases, a rebound device and a load device. Free-piston engines are commonly configured as single piston, dual piston or opposed pistons. As the engine does not have energy storage to drive a gas exchange stroke, so it works on two-stroke operating principle. Advantages are compactness, reduced manufacturing and maintenance costs, and low frictional losses due to the reduced number of moving parts. (R. Mikalsen et al 2009).

19.Wankel Rotary Engine

The Wankel engine (Fig 5) promised higher power output with fewer moving parts than the Otto cycle engine. Asian car manufacturer Mazda developed the RENESIS engine, a first mass produced Wankel engine, featured on model Mazda RX-8 (Kelvin Fu et al 2001).

20.Conclusion

Different future technologies were studies and there benefits were presented along with their working. Once these technologies become fully functional it will not only make the travelling part of human comfortable but also reduce our dependence on conventional fuels. It has been observed that these technologies are also environment and user friendly.

References

[1] A. Kusztelan, Y.F. Yao, D.R. Marchant, Y. Wang, (2011) A Review of Novel Turbocharger Concepts for Enhancements in Energy Efficiency, Int. J. of Thermal & Environmental Engineering Volume 2, No. 2 75-82

[2] A.M.N.Venkata Siva Sandeep, L.Ramesh (2013) Valvetronic Engine Technology International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 5

[3] Alpesh V. Mehta*, Rajdevsinh K. Gohil , Jaydeepkumar P. Bavarva, Biren J. Saradava (2012), Waste Heat Recovery Using Stirling Engine, IJAET Vol.III Issue I pp 305-310

[4] Ashutosh Anand & Ravikant Chakrawarty, Cochin University Of Science And Technology, a paper presentation on "camless engine, Dept. of Mechanical Engg

[5] Avinash Kumar Agrawal, Shrawan Kumar Singh, Shailendra Sinha, Mritunjay Kumar Shukla (2004), Effect of EGR on the exhaust gas temperature and exhaust opacity in compression ignition engines Sadhana Vol. 29, Part 3, pp. 275–284

[6] Brent D. Yacobucci (April 4, 2013) Alternative Fuels and Advanced Technology Vehicles: Issues in Congress,

[7] Dobrivoje Popovic´, Mrdjan Jankovic´, Fellow, IEEE, Steve Magner, and Andrew R. Teel, Fellow, IEEE Extremum (2006) Seeking Methods for Optimization of Variable Cam Timing Engine Operation IEEE Transactions On Control Systems Technology, Vol. 14, No. 3

[8] Emilian Ceuca, Alba Iulia ioan ilieană, (2002) new technology in automotive electronics, 8 th international conference Târgu Jiu,

[9] Ford Phillips, Ian Gilbert, Jean-Pierre Pirault, Marc Megel (2011) Scuderi Split Cycle Research Engine: Overview, Architecture And Operation, SAE International Journal of Engines vol. 4 no. 1 pp 450-466

[10] Ju¨rgen Hirsch, (2011) Aluminium in Innovative Light-Weight Car Design, Materials Transactions, Special Issue on Aluminium Alloys 2010 Vol. 52, No. 5 pp. 818 to 824

[11] Kelvin Fu, Aaron J. Knobloch, Fabian C. Martinez, David C. Walther, Carlos Fernandez-Pello, AI P. Pisano, Dorian Liepmann, Kenji Miyaska, Kaoru Maruta (2001), Design And Experimental Results Of Small-Scale Rotary Engines, Proceedings of 2001 ASME International Mechanical Engineering Congress and Exposition

[12] Laurence Fromm, Dr. Randy Herold, John Koszewnik, Dr. Gerhard Regner (2012), Modernizing The Opposed-Piston Engine For More Efficient Military Ground Vehicle Applications Article in Conference, Proceedings of the Ground Vehicle Systems Engineering and Technology Symposium (GVSETS)

[13] Mark Sellnau, James Sinnamon, Kevin Hoyer and Harry Husted Delphi Corporation, (2011) Gasoline Direct Injection Compression Ignition(GDCI) - Diesel-like Efficiency with Low CO2 Emissions, SAE International 01-1386

[14] Mehrdad Ehsani, Texas A&M University, Yimin Gao, (2005) Texas A&M University, Sebastien E. Gay, Texas A&M University, Ali Emadi, Illinois Institute of Technology Modern Electric Hybrid Electric and Fuel Cell Vehicles, CRC PRESS

[15] Noshin Omar, Mohamed Daowd, Peter van den Bossche, Omar Hegazy, Jelle Smekens,Thierry Coosemans and Joeri van Mierlo, (2012) Rechargeable Energy Storage Systems for Plug-in Hybrid Electric Vehicles—Assessment of Electrical Characteristics, Energies, 5, 2952-2988.

[16] R. Mikalsen, A.P. Roskilly (2009) A review of free-piston engine history and applications, Preprint submitted to Elsevier Volume 27, Issues 14-15, pp 2339–2352.

[17] Salvador M. Aceves, Daniel L. Flowers, Joel Martinez-Frias, J. Ray Smit, (2001) HCCI Combustion: Analysis and Experiments, Society of Automotive Engineers Government/Industry Meeting, Washington, DC,

[18] Thomas Nolte and Hans Hansson, Lucia Lo Bello, Wireless Automotive Communications.