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A STUDY OF MULTI FUELS FOR ACHIEVING HIGH THERMAL EFFICIENCY

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ABSTRACT

There are a number of compelling reasons why it is necessary to create a new type of free piston engine that can run on a variety of fuels to simultaneously improve thermal efficiency and lessen pollution output. These draw attention to the restrictions imposed by traditional internal combustion engines and underscore the critical need for alternative, greener energy sources in the automotive sector. The thermal efficiency of conventional internal combustion engines is poor; much of the fuel's energy is lost as heat. In order to lessen the negative effects of transportation on the environment, it is essential that energy efficiency be increased. By refining combustion processes and adapting them to various fuel qualities, the developers of a new free piston engine hope to increase the engine's thermal efficiency. Greenhouse gas emissions and air pollution are both exacerbated by the transportation industry. Pollutants such carbon dioxide (CO2), nitrogen oxides (NOx), and particulate matter (PM) are released by conventional engines, especially those that use fossil fuels. The negative effects of transportation on the environment can be reduced by using a free piston engine that uses several fuels and optimizes combustion. Because they can only run on one fuel type, traditional engines are incredibly restrictive. Utilizing conventional fuels like gasoline and diesel, as well as alternative fuels like natural gas, biofuels, and hydrogen, is made possible by multi-fuel capabilities. This adaptability allows the engine to use a wide variety of fuels, minimizing its need for fossil fuels while increasing its usage of renewable, low-carbon alternatives.

KEYWORDS: Multi Fuels, High Thermal Efficiency, thermal efficiency, particulate matter, optimizes combustion, low-carbon alternatives

INTRODUCTION

Engines have been crucial to human development. Due to its high energy to weight ratio, higher fuel efficiency, and reduced breakdown costs, it plays an important role in transportation, agricultural energy generation, and industrial activities. They are the most efficient and trustworthy way to generate electricity. However, these engines pose a serious threat to human and environmental health due to their excessive exhaust emissions and low engine efficiency. The need for cleaner and more efficient engines is heightened by both concerns about greenhouse gas emissions and the steep rise in fuel prices. Researchers in the automotive industry's powertrains and biofuels continue to face one of the most challenging issues: how to improve engine efficiency and fuel economy while meeting increasingly stringent emission norms in the face of rising greenhouse gas emissions from burning fossil fuels. As a result, there has been a shift away from conventional engines toward those that run on unconventional fuels like biofuels. Since alternative gaseous fuels are clean, cheap, and plentiful, they motivate efforts to improve the efficiency of internal combustion engines. When combined with air, gaseous fuels generate homogenous mixes that facilitate full combustion and have high ignition limits. Energy is essential to human survival.

It's ripe for changes that raise living standards everywhere. Rapid population expansion, technological advancements, and increased industrialisation have all contributed to a worldwide increase in the need for energy. The estimated global population in 2040 is 9.1 billion people, up from 7.7 billion in 2018. The rising population seen in Figure 1.1 will require more power in the not-too-distant future. The rapid growth of India's population has led to predictions that it may soon overtake China as the world's most populous nation.

Gross domestic product (GDP) is projected to increase by nearly 175% by the year 2040 as a result of the predicted 30% global population growth, as shown in Figure 1.2.According to Outlook for Energy (ExxonMobil, 2007), India's proportion of global GDP has doubled due to rapid economic growth. This trend indicates that significant energy savings will result from increased efficiency, with the predicted global energy demand increasing by almost 25% by 2040 compared to the demand in 2015.

Figure 1 shows that by 2040, global energy demand is estimated to reach 700 quadrillion British Thermal Units (BTU), representing an increase of almost 25% from 2015 demand levels. In the year 2040, India and China may account for about 45 percent of the world's energy demand. From 2012 to 2040, non-OECD Asian countries like China and India are forecast to account for the lion's share of the world's projected increase in energy consumption (International Energy Agency, 2016).

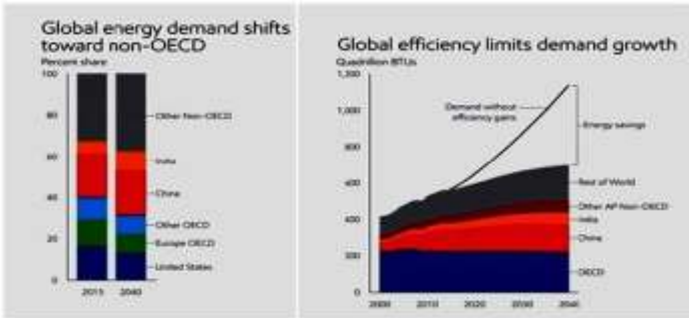

Figure 1. Projected Energy Growth

Coal, fossil oil, and natural gas provide the vast majority of the world's energy needs. Up until the year 2040, oil will continue to supply roughly a third of the world's energy needs. Coal, which is crucial in some parts of the world, is losing its market share, however, as the focus shifts to cleaner energy sources. One-fourth of total energy demand is met by natural gas, making it the dominant energy source. The nuclear and renewable energy sectors show robust expansion, contributing approximately 40% of new energy supplies to meet rising energy demands. The internal combustion engine is the single largest consumer of petroleum and natural gas in the world. The transportation sector of the global economy is particularly reliant on crude oil. The transportation sector's energy demand is rising at a normal annual rate of 1.4%, from

104 quadrillion BTU in 2012 to 155 quadrillion BTU in 2040. Source: (Independent Energy Office of the United States, 2016).

Train and bus travel are integral parts of Indian popular culture. The majority of India's transportation needs are being met by road transport, which accounts for 86% of passenger traffic and 70% of the country's cargo. Road freight transportation continues to account for a sizable portion of total energy demand growth through the year 2040.

BIOGAS AS A FUEL FOR ENGINES

Since biogas produces no greenhouse gas emissions, its usage as a fuel alternative is highly desirable. It can be used as an alternative to fossil fuels in the generation of heat and electricity, and as a fuel for internal combustion engines. The use of biogas has the advantage of reducing reliance on fossil fuels. Digester gas, created in an anaerobic digester, is one type of biogas. Methane is the most abundant component, with other gases present in much smaller concentrations, including carbon dioxide and nitrogen. Biogas primarily derives its energy from methane. Both mobile and stationary power plants can benefit from using biogas as a fuel source. Vehicles powered by biogas would make use of gas storage and refueling technology already developed for compressed natural gas (CNG) vehicles. The environmental benefits of biogas have recently been met with additional obstacles, including as stricter engine exhaust pollution limits for both mobile and stationary engines. However, in the context of this application, the composition of biogas significantly fluctuates with time and space. Changes in the operating parameters and/or quality of the input feed material can have a significant impact on the methane and carbon dioxide contents of the biogas produced. Biogas composition, however, is dynamic and changes over time in response to anaerobic bacteria activity. When using biogas with a CO2 content of more than 40%, the engine's performance becomes highly unstable. By burning biogas in an internal combustion engine (Peter Weiland 2009; Chandra et al. 2011; Shrestha & Narayanan 2008), the methane content is released as carbon dioxide gas into the environment.

LPG SUPPLY AND DEMAND SCENARIO

The global market for LPG is divided into three subsegments: those derived from refineries, associated gas, and other non-associated gas. About 38% of the world's LPG comes from refineries, while 27% comes from associated gas and 35% comes from non-related gas. Analysts, however, believe that shale gas and coal bed methane will drive growth in the non-associated gas segment of the global LPG market over the next few years. The United States (U.S.) is now completely independent of foreign natural gas supplies thanks to recent developments in shale gas exploration and production. The United States reportedly has enough shale gas to supply its gas demands for the next ninety years. As a result of the shale gas boom, the United States became a net exporter of LPG in 2016. Since China is preparing for a shale gas revolution, the domestic market for LPG in Asia and the Pacific is also likely to expand. Overall, these variables point to a projected trend of falling LPG prices in the

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Asia-Pacific region. Future energy consumption trends point for natural gas rather than liquid propane gas (LPG) in countries with an abundance of natural gas and an established distribution pipeline system. However, outside of a select few locations, this replacement threat is rather low elsewhere. As a result, there is a lot of buzz about importing LPG around the world, and in India in particular, where it is cheaper than importing crude oil.

FREE-PISTON ENGINE

Without a crankshaft or other rotating components, the piston in a linear engine like the Free-Piston Engine can move freely and in a straight line. In order for the engine to function, the longitudinal forces operating on a single, movable translator, which can be coupled with a load device, must be dynamically balanced. As an alternative to conventional internal combustion engines and gas turbines, FPEs were put into service between the years 1930 and 1960 in the form of air compressors and gas generators. It's well knowledge that their thermal efficiency is 40–50% higher than that of a comparable, traditional engine's 30–40%.

Conceptually, the free-piston engine can be traced back to the 1867 Otto-Langen atmospheric free-piston engine. Rack and pinion systems allowed this early version of a free-piston engine to be used in rotary applications. The difficulty in maintaining the cyclic functioning was one of the key issues with this setup. Eventually, a crank-slider mechanism with a flywheel for energy storage was integrated to alleviate this problem by allowing for continuous cyclic operation. This arrangement resulted in the prototype of the modern internal combustion crankshaft engine. (Stone, 1999). The free-piston engine is attractive because of its many potential benefits, such as its high power-to-weight ratio, its ability to use several fuels, its low manufacturing cost, and its low maintenance cost, all of which stem from its few moving parts and mechanical simplicity. By combining it with linear load devices like a linear generator and energy storage system, this technology can meet the basic needs of an EV or APU (Callahan & Ingram, 1995).

The FPE concept has been proposed for use in contemporary hybrid electric vehicles for the generation of electric, hydraulic, and pneumatic power. There have been reports of FPEs working in tandem with hydraulic pumps (Nguyen Ba Hung & Ocktaeck Lim, 2016). The elimination of the crank mechanism greatly reduces the complexity of FPEs by reducing the number of moving parts. This has a number of benefits, including lower frictional losses as a result of the design's mechanical simplicity and the elimination of the piston side force in crankshaft engines; lower heat transfer losses and NOx generation as a result of the power stroke's quicker expansion; potentially lower maintenance costs and higher reliability as a result of the design's compactness and simplicity; and the possibility of operating in multiple fuel/combustion modes as a result of the combustion optimization flexibility afforded by the variable compression ratio. Several labs around the world are currently investigating FPE technology. This is a fascinating idea because of the tremendous efficiency of electrical generators, as well as its adaptability and manageability. The growing popularity of hybrid-electric vehicles in the automotive industry has stoked demand for free-piston engine generators. Numerous research teams from all around the world have put in a lot of time and effort.

CONCLUSION

Numerical modeling and simulations are at the center of a large body of literature on free-piston engine technology. There is a dearth of literature on functional prototypes. This study adds to the literature by creating a functional model of a multi-fuel, free-piston engine. This research examines the effects of oxygen enrichments and exhaust gas recirculation on the performance and emission characteristics of a single-cylinder spark-ignited two-stroke free piston engine with a spring system as a rebound device. The aforementioned considerations underscore the constraints associated with traditional internal combustion engines and underscore the pressing need for environmentally friendly and sustainable energy alternatives within the automobile sector. Conventional internal combustion engines exhibit poor thermal efficiency, since a considerable proportion of the fuel's energy is dissipated as heat, resulting in inefficiency. Enhancing energy efficiency is of paramount importance in order to mitigate fuel use, promote sustainability, and mitigate the environmental repercussions associated with transportation. The primary objective of the research and development of a unique free piston engine is to enhance thermal efficiency via the optimization of combustion processes and their customization to suit various fuel qualities.

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