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BIOFUEL: A GREEN SUSTAINABLE ALTERNATIVE TO PETROLEUM BASED FUELS - A REVIEW

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ABSTRACT:
It is well known that biofuels can be a viable renewable energy source in contrast to fossil fuel energy, which is finite in nature and its extensive use is responsible for geopolitical instability, and deleterious global effects. Biofuels include energy-enriched chemicals that are generated directly through the biological processes or are derived from the chemical conversion from biomass of prior living organisms. With the ever-increasing rate of energy consumption all over the world and increase in per capita consumption of the energy, both energy demand, and energy security are of major concerns to the economy all around the world. The World today is committed for sustainable and ecofriendly use of the energy sources, which calls for the utilization of biofuels instead of conventional petroleum-based fuels. This review article is based on the results and finding of various researches that have been carried out in the field of biofuels.

Keywords: - Biofuel, renewable energy, sustainable and ecofriendly.

INTRODUCTION :

Energy is crucial for sustainable development of every Country. 80% of the global energy needs are met by using fossil fuels like coal, oil, and gas. Heavy reliance on these fuels for transportation and industries highlights the growing energy crisis [1]. Fossil fuels are widely used for transportation and for running machinery as energy source, due to high burning capacity and availability, but its reserves are exhausting day by day [2]. Biofuels that are made from biomass are solid, liquid and gaseous fuels. Biofuels are mainly classified into three generations i.e. first, second and third generation based on their chemical nature and complexity. first generation biofuels , are made from the starch, vegetable oil and biodiesel it has been produced from the food related source . The second generation biofuel-bioethanol, is produced from the non-food crops and agricultural wastes. Third generation biofuel are biogas, bioethanol and biobutanol which are produced from microorganisms like algae. They create a huge amount of biomass in a specific time period and it does not require land for their growth. The cost of petroleum-based fuels is increasing day by day and demand of transportation is supposed to increase by 60% by 2030. Hence a reliable and cost-effective fuel is prominently required [3]. For modern society the diesel engine is a basic need in the day-to-day life. It is useful for the land and water transport, for providing electric power, for farming, , construction and other industrial activities[4]. Lubricity is the important function of any fuel. In recent decades, strict regulations have been imposed on the emission made by diesel engines due to growing environmental concerns [5].

The microalgae is the only source of renewable biodiesel with the potential to meet the global demand for transportation fuel [6]. In the third and fourth generation of biofuel some common steps are include for the cultivation of microalgae, harvesting , extraction and biomass conversion [7]. Considering the huge land areas required for cultivating biofuel crops, evaluating the probable impact of large scale biofuel production on food supply and the environment is critically important [8]. The production of biofuels from different biomass involves not only their generation but also considerations of cost

effectiveness , environmental sustainability and waste reduction. Its going to happen soon, that biofuels will play a crucial role is managing the growing demand for fuel while supporting global energy security [9].

Biofuels are needed because they can help reduce our dependence on fossil fuels and have many environmental and economic benefits. As traditional fossil fuels continue to deplete and contribute to environmental degradation, alternative source of energy like biofuels is required. Biofuels are important for the future generations because they are renewable energy sources that can help reduce greenhouse gas emission and create more sustainable environment.

This review is based on studies that show how biofuels can replace fossil fuels in an eco-friendly way. It looks at new methods of making biofuels, their benefits for the environment, and challenges like cost and production. Biofuels are important for the future as they offer a renewable solution to growing energy needs.

Literature Review :

Huang, D., Zhou, H., & Lin, L. (2012). Biodiesel: an alternative to conventional fuel. In their study they concluded that, due to the increasing awareness of the depletion of fossil fuel resources and environmental issues, biodiesel became more and more attractive in the recent years and the Biodiesel production is a promising and important field of research because the relevance it has gained from the rising petroleum price and its environmental advantages. In this paper they have reviewed the history and recent developments of Biodiesel, including the different types of biodiesel, the characteristics, processing and economics of Biodiesel industry. The use of biodiesel in the automotive industry and the challenges connected with its development.

Hassan, M. H., & Kalam, M. A. (2013). An overview of biofuel as a renewable energy source: development and challenges. In this paper they have discussed all the advantages and disadvantages of biodiesel and comprehended that, a dedicated biodiesel engine is the ultimate solution for commercializing biodiesel. A similar approach could lead to significant improvement in the commercialization and production of biofuels. However, the development of dedicated biofuel engines remains a key challenge for universal commercialization and utilization.

Luque, R., Lovett, J. C., Datta, B., Clancy, J., Campelo, J. M., & Romero, A. A. (2010). Biodiesel as feasible petrol fuel replacement: a multidisciplinary overview. The study indicated that biodiesel is a sustainable, non-toxic, biodegradable diesel fuel substitute that can be employed in current diesel car infrastructure without major modifications in the engines. It offers huge advantages over petroleum-based diesel, including reduced emissions of carcinogenic particulate matter , enhanced lubricity , and greater biodegradability. In their study they found that it is essential to note that the biodiesel life-cycle is environmentally sustainable, economically viable, and socially acceptable.

V*aruvel, E. G., Mrad, N., Tazerout, M., & Aloui, F.* (2012), Experimental analysis of biofuel as an alternative fuel for diesel engines. In this article the authors claim that the growth of energy demand and limited fossil fuel resources lead to renewable energy development such as vegetable oils and animal fats or their derivatives. In their present work, the waste fish fat was used by the pyrolysis technique in the presence of catalyst to produce biofuel for diesel engines. As a result, fuel undergoes good combustion and hence there is a significant improvement in performance and reduction in emissions. The brake thermal efficiency of neat biofuel is 32.4% at 80% load which is very high compared to neat diesel (29.98%). This leads to efficient combustion of the fuel, resulting in notable performance enhancement and a huge reduction in emissions.

The brake thermal efficiency of pure biofuel reaches 32.4% at 80% load, significantly higher that that of pre diesel, which is 29.98%.

Suarez, P. A., Moser, B. R., Sharma, B. K., & Erhan, S. Z. (2009), Comparing the lubricity of biofuels obtained from pyrolysis and alcoholysis of soybean oil and their blends with petroleum diesel. In this study, a diesel-like fuel, pyrodiesel (PD), was synthesized by a pyrolysis method using soybean oil as starting material. Some physical properties of the materials were studied, both neat and in blends with high-sulfur (HSD) and low-sulfur (LSD) diesel fuels, and compared with blends of biodiesel (BD) with these fossil fuels. They observed using different methods that the lubricity of biobased fuels obtained after the transesterification or pyrolysis of soybean oil is superior to LSD and HSD and also that the lubricity of diesel fuels are enhanced when either BD or PD are added. Based on their results reported herein, PD is a viable alternative to BD for use in compression-ignition engines.

Abou-Shanab, R. A., Jeon, B. H., Song, H., Kim, Y., & Hwang, J. H. (2010), Algae-Biofuel: Potential use as sustainable alternative green energy. In their study they derived that, the production of biofuels from algae is thought to help stabilize the concentration of carbon dioxide in the atmosphere at the present level rather than reducing it to a more healthy level. Also, among algal fuels attractive characteristics are that the biodiesel produced is non toxic, doesn't contains sulfur, highly biodegradable and relatively harmless to the environment if spilled. Algae can produce over 30 times more oil per acre compared to oil and soyabean crops. However, the Commercialization of algal biofuel is currently delay by the high costs of production, harvesting, and oil extraction, through advancements in technology are continuously addressing these challenges.

Dutta, K., Daverey, A., & Lin, J. G. (2014) Evolution retrospective for alternative fuels: First to fourth generation. In their study, several biomass sources have been identified with increasing potential to be used as new alternative sources of energy - the "Biofuels". The evolution of biofuels is classified into four different generations. In this article they overview of the systematic evolution of different biofuel generations with their advantages and disadvantages has been presented. The advancements in technology, reduction in greenhouse gas emission and assessment of commercial production cost of each generation of biofuel have also been highlighted.

Escobar, J. C., Lora, E. S., Venturini, O. J., Yáñez, E. E., Castillo, E. F., & Almazan, O. (2009). Biofuels: environment, technology and food security. In this paper they discussed different vegetable raw materials sources and technological paths to produce biofuels, as well as issues regarding production cost and the relation of their economic feasibility with oil international prices. The environmental effect of programs promoting biofuel production, including farmland requirements and the impacts on food production, are considered environment friendly when evaluated using life cycle analysis (LCA) as a tool.They also concluded that the rise in the use of biofuels is inevitable and that international cooperation, regulations and certification mechanisms must be established regarding the use of land, the mitigation of environmental and social impacts caused by biofuel production and it is also mandatory to establish appropriate working conditions and decent remuneration for workers of the biofuels production chain.

Kumar, M., Sun, Y., Rathour, R., Pandey, A., Thakur, I. S., & Tsang, D. C. (2020). Algae as potential feedstock for the production of biofuels and value-added products: Opportunities and challenges. In their study they studied various processes and pathways through which bio-valorization of algal biomass can be performed.

Different techniques for liquid extraction from algal biomass, as well as transesterification reactions for biodiesel production, are summarized. The processes covered include pretreatment and saccharification of algal biomass, along with methods such as fermentation, gasification, pyrolysis, hydrothermal liquefaction, and anaerobic digestion for generating biohydrogen, bio-oils, biomethane, biochar (BC), and other bio-based products. There are opportunities and challenges related to bio-valorization of algal biomass and the researchers used their own perspective regarding the processes involved in production and the feasibility to make algal research a reality for the production of biofuels and bio-based products in a sustainable manner.

Carraretto, C., Macor, A., Mirandola, A., Stoppato, A., & Tonon, S. (2004). Biodiesel as alternative fuel: Experimental analysis and energetic evaluations. In this his paper they presented the first results of an investigation carried out by the authors on the potentialities of biodiesel as an alternative fuel based on strategic thoughts and field experiences in boilers and diesel engines. The operation of a biodiesel fuelled boiler they have been checked for some months. The performance of a biodiesel-fuel boiler has been monitored over several months. The engines were first bench- tested before being installed in urban buses for regular use. Data on distances , fuel consumption and emissions (CO2, CO, HC and NOX) have been collected, while were and tear of components, the accumulation of dirt in oil and air filters, and lubricant degradation have been evaluated. Further investigations have also been devoted to assess some environmental aspects of bio-diesel. The impact of biodiesel on the overall net CO2 emission throughout its entire life cycle has been analyzed.

Rasool, U., & Hemalatha, S. (2016). A review on bioenergy and biofuels: sources and their production. In this paper, research has focused on the production of biodiesel and bioethanol, as well as on ways to modify the methods used in their formation. Biodiesel and bioethanol come under first generation biofuels. They also address the conversion of non-edible oils into biodiesel through modification in the transesterification process, as well as the transformation of sugars into bioethanol by genetic modification of yeast cells.

Result Analysis :

In their study *Luque, R., et al.* found that the essential to the biodiesel life-cycle is environmentally sustainable, economically viable, and socially acceptable; views that can only be properly analysed by means of a multi-angle approach [3]. In their work *Varuvel, E. G., et al.* analyse, the valuation of waste fish fat by the pyrolysis technique with the presence of catalyst to produce biofuel for diesel engines. As a result, fuel undergoes good combustion and hence there is a significant improvement in performance and reduction in emissions [4]. *Suarez, P. A., et al.* observed that different methods are used that the lubricity of biobased fuels obtained after the transesterification or pyrolysis of soybean oil is superior to LSD and HSD. Based on their results they reported that the herein, PD is a viable alternative to BD for use in compression-ignition engines [5]. It believed that producing biofuels from algae can contribute to stabilizing carbon dioxide levels in the atmosphere. *Abou-Shanab, R. A. et al.* concluded that the algae are capable of producing in excess of 30 times more oil per acre than corn and soybean crops. But currently, algal biofuel production has not been commercialized due to high costs [6]. In their result *Escobar, J. C., et al.* analyse that the rise in the use of biofuels is inevitable and that international cooperation, regulations and certification mechanisms must be established regarding the use of land, the mitigation of environmental and social impacts caused by biofuel production [8]. In their study

Kumar, M., et al. studied various processes and pathways through which bio-valorization of algal biomass can be performed are described. Various lipid extraction techniques from algal biomass along with transesterification reactions for biodiesel production [9]. In their study *Carraretto, C., et al.* show the first results of an investigation on the potentialities of biodiesel as alternative fuel in boilers and ICE. Investigations have also been carried out on ICE using biodiesel pure and in blends with diesel oil [10]. *Rasool, U., et al.* deals with the transformation of non-edible oils into biodiesel through modification in the transesterification process, while bioethanol can be produced from sugars through the genetic modification of yeast cells and by changing the substrates required for ethanol production by yeast [11].

DISCUSSION :

Biofuels represent a promising alternative to fossil fuels, addressing both energy demands and environmental sustainability challenges. The over-reliance on fossil fuels has led to severe environmental issues such as greenhouse gas emissions, climate change, and resource depletion. The development of biofuels, classified into first, second, third, and fourth generations, highlights the advancement of technology in utilizing diverse biomass sources, from food crops to genetically engineered organisms. Each generation offers unique advantages and challenges, with later generations focusing on non-food biomass and microorganisms like algae to enhance sustainability. Despite their potential, biofuels face hurdles, including high production costs, limited feedstock availability, and the need for efficient conversion technologies. Marine and terrestrial biomass offer immense potential, particularly in regions like India, with rich biodiversity and abundant resources. Innovative techniques such as genetic engineering, fermentation, and enzymatic hydrolysis could enhance production efficiency while reducing costs. Additionally, biofuels contribute significantly to reducing greenhouse gas emissions and mitigating climate change. However, integrating biofuels into the global energy mix requires addressing economic, technological, and logistical challenges. A continued focus on research, policy support, and technological advancements is essential to realize the full potential of biofuels in achieving a sustainable energy future.

CONCLUSION :

Biofuels present a promising a green alternative to petroleum-based fuels, including environmental, economic, and energy security benefits. Continued research and innovation in biofuel technologies will be crucial in realizing their full potential as a green energy solution. The production of biohydrogen, biodiesel, biogas and bioethanol offers to fossil fuels, particularly with advancement in cost-effective bioprocesses.

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