Chapter 1

Introductory Chapter: Biofuels - Challenges and Opportunities

Mansour Al Qubeissi

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.84267

1. Background

The climate is undoubtedly experiencing several changes with a global warming, mainly attributed to the carbon dioxide (CO_2) emission. According to NASA [1] and NOAA [2], CO_2 is at its highest in 650,000 years, leading to the warmest decade on record. During recent decades, concerns have arisen regarding climate change, energy security decline, and depletion of hydrocarbon reserves, resulting in a wide interest in renewable alternative fuel resources. Many studies (e.g., [3–7]) have shown that biofuels are generally the most appropriate replacement to the depleting crude oil.[1] They can expand green landscapes, create new economic opportunities, be directly used in standard engines, and they are sustainable and environmentally friendly. There has been a politically motivated claim; however, that biofuel can be harmful with plenty of disadvantages, attributed to some abuse of biomass production and misuse. For example, moving palm oil with fossil fuel-powered trucks and burning peat bogs to prepare biomass can result in significant greenhouse emissions. Also, economic risks are interpreted with financial loss to certain fossil fuel-productive beneficiaries (e.g., the OPEC). Other claims (e.g., [8]) impose that biofuel production competes with food stock although biofuel is not necessarily addible product, or vigorously agricultural-land planted. Such misleading assumptions and debates guided the European Parliament in January 2018 to propose an end to the import and use of palm oil by 2030 [9]. In fact, the EU move to cut imports on palm oil is a suspect of cynical move to protect the EU vegetable oil producers and fossil fuel-reliant industry [10]. There are enough statistics and empirical data to dispute such claims and evaluate the importance of biofuels for future on the expense of the insignificant disadvantages [3, 7]. This book proposes approaches to overcome challenges and achieves some tough targets for alternative fuel production and utilization.

[1]Hereafter, the word "biofuels" refers to biomass fuels, including biodiesel fuels.

Over the past four decades, the data show three distinct periods of food price inflation, and the lowest of which was during 1991–2015 at 2.6%, encompassing the biofuel boom. Comparatively, the inflation rate during 1981–1991 was 3.8%, and the rate during 1973–1981 was 8.3%. There was no noticeable change in the world's average grain and oil price inflation before and after 2000, in reference to the beginning of the biofuel boom. Crude oil prices, however, have had the highest correlation with food price indices. Currently, the main barriers to the spread of biofuel are its relevant cost of production and competition between some types of biofuels and food stock. Therefore, wastes play an important role in reducing these costs and recycling dump materials. Production of biofuels from nonfood biomass has emerged as a sustainable option to tackle the problems associated with growing demand of energy.

2. Contribution of this book

In this work, as well as providing the descriptions on emerging biofuel technologies to mimic the above-mentioned risks, the chemical and thermal properties of biofuels are described. For example, methanol and ethanol are studied as possible alternative liquid fuel candidates to resemble several physical and combustion properties of gasoline. The study shows that such a fuel blend decreases the engine brake power, increases the BSFC, and decreases the CO and HC emissions, compared to those produced using gasoline (fossil) fuel. The pretreated samples are analyzed for mass and energy yields, calorific values, proximate and elemental compositions, and thermal decompositions. This book also provides basic analyses of diesel, gasoline, and various types of biofuels (including biodiesel fuels) and assessment on limited and unlimited emissions (e.g., greenhouse gases, dangerous exhaust gases, and strong carcinogens and their contents) during and after combustion pathways. The results are evaluated in comparison to trusted measurements and numerical standards. The research equipment is adapted with sensitivity measurements to the environmental contamination.

A one-dimensional model of gasoline engine is developed for predicting the effect of various fuel types on engine performance, specific fuel consumption, and emissions. The role of microbial consortium-based biocatalyst strategies that are being developed to address these issues are reviewed and discussed. Microbial co-culture biocatalysts are engineered to specialize the conversion of a general class of substrates present in the biomass hydrolysates into biofuel intermediates, with the capability of adapting them to the variable composition of the feedstock. The techniques being developed to understand the interaction between the members of the bioconversion consortia and the corresponding population dynamics of the engineered co-cultures are also presented. The simulation of transesterification requires in-depth understanding of the chemical reactions that take place inside the reactor. The development of reaction mechanism of the multiple step triglyceride, triglycerides, and monoglycerides and their reversal reaction is beyond the interest of chemical or mechanical engineers, whose main interests focus on the assessment of the overall conversion and the established performance process metrics. The work undertakes all relevant activities by establishing and formulating the overall process kinetics, as far as the rate constant and activation energy. The obtained values are used to carry out high fidelity reactive flow of the multiple species, copresent inside the reactor, and otherwise complex to be captured experimentally. Experimental results, high-fidelity numerical results, and parametric sensitivity studies will be introduced and discussed. Through a reaction of alkaline transesterification of biodiesel, several mixtures of diesel-biodiesel and their characteristics are assessed and prepared for tests. For example, kinematic viscosity and high heating value of pure biodiesel (B100), pure diesel, and four biodiesel-diesel fuel blends, B2, B5, B10, and B20, have been determined.[2] B100, diesel, and their blends are used in full-cycle tests of four cylinder engines. A virtual instrumentation technology has been developed and implemented into the test approaches. Such advancement has allowed monitoring (in real time) the parameters of internal combustion engines and presented the versatility, flexibility, scalability, and capacity to function in equipment that operates with different liquid fuels at a lower cost than that of conventional systems. These characteristics represent significant benefit, in comparison to the classical measurement and monitoring approaches, in present market.

3. Concluding remark

To conclude, the use of biofuels is expected to contribute to the energy sustainability and reduction of global warming. For instance, many efforts have been made to replace gasoline and diesel fuels with ethanol/gasoline and biodiesel/diesel fuel blends, respectively [11–16]. These efforts have been driven mainly by the importance of reducing greenhouse emissions and fossil fuel costs [17–19]. According to the US environment protection agency [20], all gasoline engine vehicles can use a blend of gasoline fuel with up to 10% volume fraction of ethanol without the need for engine modification. The reduction in CO_2 emissions without the loss of engine performance is nontrivial for this mixture [21]. For example, mixtures with up to 15% volume fraction of ethanol and 85% volume fraction of gasoline fuel have been approved for use in 2001 and newer vehicles, under the US federal standards for renewable fuel [22]; while mixtures with up to 85% volume fraction of ethanol and 15% volume fraction of gasoline fuel (i.e., flex fuels) have been defined as qualifying alternative fuels for flex-fuel vehicles [20]. Therefore, it was important to investigate the difference between ethanol and gasoline fuel characteristics and their blends.

Author details

Mansour Al Qubeissi

Address all correspondence to: ac1028@coventry.ac.uk

Coventry University, Coventry, UK

[2]BX refers to X% volume fraction of biodiesel mixed with (100-X)% volume fraction of diesel fuel.

References

[1] NASA. Carbon Dioxide, Climate Change – Vital Signs of the Planet [Internet]. Available from: https://climate.nasa.gov/vital-signs/carbon-dioxide/ [Accessed 2018-12-24]

[2] NOAA. November 2018 was fifth hottest on record for the globe 2018 [Internet]. Available from: https://www.noaa.gov/news/november-2018-was-fifth-hottest-on-record-for-globe [Accessed: 2018-12-25]

[3] Popp J, Lakner Z, Harangi-Rákos M, Fári M. The effect of bioenergy expansion: Food, energy, and environment. Renewable and Sustainable Energy Reviews. 2014;**32**:559-578. DOI: 10.1016/j.rser.2014.01.056

[4] Bullis K. A Biofuel Process to Replace All Fossil Fuels. MIT Technology Review 2009 [Internet]. Available from: https://www.technologyreview.com/s/414492/a-biofuel-process-to-replace-all-fossil-fuels/ [Accessed: 2018-12-28]

[5] Sazhin SS, Al Qubeissi M, Kolodnytska R, Elwardany AE, Nasiri R, Heikal MR. Modelling of biodiesel fuel droplet heating and evaporation. Fuel. 2014;**115**:559-572. DOI: 10.1016/j.fuel.2013.07.031

[6] Walker GM. Bioethanol: Science and Technology of Fuel Alcohol. UK: Bookboon; 2010. 114 p. ISBN 9788776816810. Available from: https://bookboon.com/en/bioethanol-science-and-technology-of-fuel-alcohol-ebook [Accessed: 2018-12-12]

[7] Kirkland G. Why We Need Biofuels For A Green Future. Automotive IQ 2018 [Internet]. Available from: https://www.automotive-iq.com/powertrain/articles/why-we-need-biofuels-green-future [Accessed: 2018-12-21]

[8] Tenenbaum DJ. Food vs. fuel: Diversion of crops could cause more hunger. Environmental Health Perspectives. 2008;**116**(6):A254-A257. DOI: 10.1289/ehp.116-a254

[9] Transport & Environment. Why is palm oil biodiesel bad? In: Food-based biofuels: cure worse than the disease [Internet]. June 2017. Available from: https://www.transportenvironment.org/what-we-do/biofuels/why-palm-oil-biodiesel-bad [Accessed: 2018-12-30]

[10] Klepper G. Winners and losers from the EU's proposed ban on palm oil [Internet]. Eco-Business. 2018. Available from: https://www.eco-business.com/opinion/winners-and-losers-from-the-eus-proposed-ban-on-palm-oil/ [Accessed: 2018-11-30]

[11] Al Qubeissi M, Al-Esawi N, Sazhin SS, Ghaleeh M. Ethanol/gasoline droplet heating and evaporation: Effects of fuel blends and ambient conditions. Energy & Fuels. 2018;**32**:6498-6506. DOI: 10.1021/acs.energyfuels.8b00366

[12] Al Qubeissi M. Predictions of droplet heating and evaporation: An application to biodiesel, diesel, gasoline and blended fuels. Applied Thermal Engineering. 2018;**136**:260-267. DOI: 10.1016/j.applthermaleng.2018.03.010

[13] Al Qubeissi M. Heating and Evaporation of Multi-Component Fuel Droplets. Stuttgart, Germany: WiSa; 2015

[14] Al Qubeissi M, Sazhin SS, Elwardany AE. Modelling of blended diesel and biodiesel fuel droplet heating and evaporation. Fuel. 2017;**187**:349-355. DOI: 10.1016/j.fuel.2016.09.060

[15] Al Qubeissi M, Al-Esawi N, Kolodnytska R. Atomization of bio-fossil fuel blends. In: Nageswara-Rao M, editor. Advances in Biofuels and Bioenergy, Chapter 4. InTech; 2018. pp. 59-81. DOI: 10.5772/intechopen.73180

[16] Al Qubeissi M, Sazhin SS, Crua C, Turner J, Heikal MR. Modelling of biodiesel fuel droplet heating and evaporation: Effects of fuel composition. Fuel. 2015;**154**:308-318. DOI: 10.1016/j.fuel.2015.03.051

[17] Járvás G, Kontos J, Hancsók J, Dallos A. Modeling ethanol-blended gasoline droplet evaporation using COSMO-RS theory and computation fluid dynamics. International Journal of Heat and Mass Transfer. 2015;**84**:1019-1029. DOI: 10.1016/j.ijheatmasstransfer.2014.12.046

[18] Bader A, Keller P, Hasse C. The influence of non-ideal vapor-liquid equilibrium on the evaporation of ethanol/iso-octane droplets. International Journal of Heat and Mass Transfer. 2013;**64**:547-558. DOI: 10.1016/j.ijheatmasstransfer.2013.04.056

[19] Corsetti S, Miles REH, McDonald C, Belotti Y, Reid JP, Kiefer J, et al. Probing the evaporation dynamics of ethanol/gasoline biofuel blends using single droplet manipulation techniques. The Journal of Physical Chemistry A. 2015;**119**:12797-12804. DOI: 10.1021/acs.jpca.5b10098

[20] EPA U. US Environmental Protection Agency 2014. http://www.epa.gov/ [Accessed: June 23, 2017]

[21] Masum BM, Masjuki HH, Kalam MA, Rizwanul Fattah IM, Palash SM, Abedin MJ. Effect of ethanol-gasoline blend on NOx emission in SI engine. Renewable and Sustainable Energy Reviews. 2013;**24**:209-222. DOI: 10.1016/j.rser.2013.03.046

[22] US Department of Energy: Energy Efficiency and Renewable Energy. Alternative Fuels Data Centre n.d. Available from: http://www.afdc.energy.gov [Accessed: June 23, 2017]