

Green Energy and Technology

Semakula Maroa
Freddie Inambao



Biodiesel, Combustion, Performance and Emissions Characteristics

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Green Energy and Technology


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Preface

Combustion technologies continue to evolve towards greater efficiency and reduced pollution. Therefore, their development requires a comprehensive understanding of the combustion behaviour of fuels, in this case, biodiesels. Biodiesel fuels are gaining prominence as alternative fuels to fossil fuels, and their combustion characteristics therefore need to be studied. In the past, many publications and reviews have been produced to discuss development and control strategies in biodiesel combustion but there is a gap in terms of bringing this large body of knowledge together and looking at it as a whole. This book is an attempt to bring together combustion studies by various researchers in the field of biodiesel combustion into a book format to help research students harness the synergy from a single resource in biodiesel combustion studies. For example, knowledge of chemical kinetics has facilitated strategies to mitigate problematic pressure rises during combustion. The development of homogeneous charge compression ignition engines has been able to maximize the use of different blends of fuels with different ignition and combustion characteristics. Such an application is an example of the type of knowledge that is advantageous in the development of combustors and the refinement of fuels by improving fuel efficiency and acceptability.

Although there has been progress in the defining of fuel specification and fuel quality assurance, biodiesel fuels have inherent differences in their fuel properties and composition compared to petro-diesel. Therefore, the effects of these differences in fuel properties and their interactions have to be carefully studied as well as their impact on the after-treatment system performance. The studies which are contained in this book are all highly researched on important and vital aspects of biodiesel operating systems such as particulate filters. Particular consideration is given in the long-term effects on the performance and service of these operating systems as some of their effects are irreversible such as diesel particulate filter (DPF) clogging which is due to ash accumulation. Therefore, this work will also seek to bring out development in technology in areas of after treatment and reduction in the demerits associated with the widespread use of biodiesel in the auto industry.

Biodiesel fuels have to fulfil a number of quality standards with specific minimum requirements. Density is a key fuel property as injection systems, pumps and injectors depend on it to deliver precise amounts of fuel for proper combustion to occur. Density also affects the amount of mass of fuel injected into the combustion cylinder and the manner in which operation units are designed in combustion reactors and other systems such as distillation units, separation processes, design of storage tanks and process piping. Density is greatly influenced by the type of raw material and the profile of the methyl esters in a particular biodiesel feedstock. In biodiesel production, this factor is critical due to the nature and composition of feedstock sources, of which there is a wide variety all with different character qualities. It is important that the impact of the differences in biodiesel fuels is understood, especially how these fuel properties affect spray behaviour characteristics in engine applications. As such, this work seeks to consolidate experimental and research work findings as reported in various literature on biodiesel combustion development. This is achieved by bringing together studies on various properties of feedstock and their profile. This enables research students to have a wider comparison tool from one source.

Durban, South Africa

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Abbreviations and Acronyms

AC	Air conditioning
ASTM	American Society for Testing and Materials
BSFC	Brake-specific fuel consumption
bTDC	Before Top Dead Centre
BTE	Brake thermal efficiency
CA	Crank Angle
CFC	Chlorofluorocarbons
CI	Compression ignition
CN	Cetane number
CP	Cloud point
CR	Compression ratio
CS	Conventional surfactants
DI-DE	Direct injection diesel engine
DOC	Diesel oxidation catalysts
DPF	Diesel particulate filter
DTBP	Di-t-butyl peroxide
EGR	Exhaust gas recirculation
EOI	End of injection
EPA	Environmental Protection Agency
FAME	Fatty acid methyl esters
FFA	Free fatty acids
HC	Hydrocarbons
HCCI	Homogeneous charge compression ignition
HDD	Heavy duty diesel
HFRR	High-frequency reciprocating rig system
HSDI	High-speed direct injection
HVO	Hydrogenated vegetable oil
IID	Intercooler indirect injection
IT	Injection timing
JOME	Jatropha oil methyl esters

KOH	Potassium hydroxide
LDD	Light duty diesel
LMIC	Low middle income countries
LTC	Low-temperature mode of combustion
MTBE	Methyl tert-butyl ether
NAC	NO _x adsorber catalysts
NaOH	Sodium hydroxide
NO	Oxides of nitrogen
NREL	National Renewable Energy Laboratory
PCCI	Pre-mixed charge compressed ignition
PMBF	Pre-mixed burnt fraction
PP	Pour point
RCCI	Reactivity controlled compression ignition
SCR	Selective catalytic reduction
SMFAE	Single-molecule fatty acid esters
SNCR	Selective non-catalytic reduction
SOC	Start of injection
SOME	Soy oil methyl esters
TC	Turbocharged
TDC	Top dead centre
THC	Total hydrocarbons
UHC	Unburnt hydrocarbon
ULSD	Ultra low sulphur diesel
VNT/VGT	Variable nozzle turbine/Variable gas turbine
VOC	Volatile organic compounds
WC	Water cooled
WCOME	Waste cooking oil methyl esters

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