Renewable and Sustainable Energy Reviews 35 (2014) 221–230

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Assessment of emission and performance of compression ignition engine with varying injection timing

S.M. Ashrafur Rahman *, H.H. Masjuki, M.A. Kalam, A. Sanjid, M.J. Abedin

Centre for Energy Sciences, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia

ARTICLE INFO

Article history:
Received 24 April 2013
Received in revised form
27 February 2014
Accepted 21 March 2014
Available online 25 April 2014

Keywords:
Diesel engine
Engine performance
Exhaust emission
Injection timing
Bio-diesel
Ethanol

ABSTRACT

Engine performance improvement and exhaust emissions reduction are the two most important issues to develop a more efficient engine with less environmental impact. For a diesel engine, injection timing is one of the major parameters that affect the engine performance and emissions. Now-a-days, alternative fuels for internal combustion engines have created interest among the researchers around the world due to the limited reserve and rapid depletion of petroleum based fuels. In this paper, studies focused on characterizing influence of injection timing on engine performance and exhaust emissions have been critically reviewed where diesel, biodiesel, alcohol and other alternative fuels are used. In case of diesel fuel, advancement in injection timing results in lower carbon monoxide (CO) and hydrocarbon (HC) emission; though it increases nitrogen oxides (NO_X) emission. Advance injection timing increases brake thermal efficiency (BTE) and decreases brake specific fuel consumption (BSFC). Biodiesel–diesel blends produce more HC and CO emission, but reduce NO_X emission when injection timing is retarded. Advancement in injection timing results in higher exhaust gas temperature with increase of biodiesel percentage in the blends.

Contents

1. Introduction

Diesel engine is one of the major sources of environmental pollution. The emissions produced due to the operation of diesel engine with diesel are highly responsible for several critical problems. Strict measurements and regulations are being imposed to lower these emissions and improve air quality. In order to

* Correspondence to: Department of Mechanical Engineering, University of Malaya, 50603, Kuala Lumpur, Malaysia. Tel.: +60 3 79674448; fax: +60 3 79675317.
E-mail address: rahman.ashrafur.um@gmail.com (S.M.A. Rahman).

http://dx.doi.org/10.1016/j.rser.2014.03.049
1364-0321/

Table 1
Summary of effect of various parameters on engine performance and emission parameters.

Parameters ↓ Factors →	Load	Biodiesel	Torque, compression ratio and injection pressure	Ethanol addition	EGR
Brake specific fuel consumption (BSFC)	Increase in load decreases BSFC [28–31]	Increases in percentages of biodiesel, increases fuel consumption [25,32,33–35] Contrary: Dorado et al. [20] reported biodiesel blends reduced BSFC slightly	Increase in CR decreases BSFC [28,36–38] Increase of injection pressure decreases BSFC [39–41] Contrary: injection pressure increases BSFC [42]		
	BSFC decreases with load when biodiesel is used [25,31,35,43,44]				
Brake thermal efficiency (BTE)	Increased with increase in load [45]	BTE increases with increase in blend percentages [41] Contrary: biodiesel reduces BTE due to having lower heating value and higher viscosity [46–48]	– Increase in torque increases BTE [49] – Increase in compression ratio improves BTE [29] – Injection pressure decreases efficiency [42]	Introduction of ethanol increases BTE [50]	
	BTE improves with load when biodiesel is used [51]				
Exhaust gas temperature (EGT)	Increase in load increases EGT [29,45,53]	BTE increases as biodiesel concentration increases [29]		Increase in ethanol percentages increases EGT [54]	EGR reduces EGT [53,55–57]
Nitrogen oxides (NO_X)	Increase in load increases emission [58,59]	– Biodiesel increases emission [60–73] – Contrary reduces emission [74]	Increase in injection pressure increases emission [75]	– Reduces NO_X emission [76,77] – Contrary increases emission [78]	– Introduction of EGR reduces NO_X [79,80], even when biodiesel is used [81–83]
Hydrocarbon (HC), Carbon monoxide (CO) and Particulate matter (PM)		Biodiesel reduces emission [20–24,26,27,60–73] Contrary: biodiesel increases emission [85,86]	High injection pressure reduces PM emission [87,88]	– Introduction of ethanol Increases HC emission [89] and CO emission [41,89] – Reduces CO emission [90,91] – Reduces CO, HC and soot [92] – Increase in ethanol percentages increases emissions [93,94]	High EGR increases HC emission [95,96]