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Study of performance and emissions of a stationary DI variable compression ratio CI engine fueled with n-butanol/diesel blends using Taguchi technique: analytical and experimental analysis

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ABSTRACT

In the current work, n-butanol-diesel blends were tested on a small size agriculture-based compression ignition (CI) engine. Taguchi analysis was carried out to identify the optimum blending ratio and engine operating parameters. Experiments were conducted with n-butanol/diesel blends (10–20% by volume) by varying compression ratio (CR) (17.5–19.5), injection timing (21–25 CA btdc) and injection pressure (200–220 bar). The 20% n-butanol/diesel blend (BU20) showed better results of performance and emissions at increased CR under similar operating conditions. When engine was fueled with BU20, reduction in Smoke, NO_x (Nitrogen-oxides) and CO (Carbon-monoxide) were observed to be 49.03%, 13.68% and 5.88%, respectively, in comparison to diesel. However, HC (Hydrocarbons) were found to be higher by 11.76% for BU20 as compared to diesel.

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Introduction

Increasing environmental pollution and cost of fossil fuels have attracted significant research attention in renewable biofuels for IC engines. The control of smoke emissions from CI engines is a major hurdle in the global aspirations of a clean environment. Use of improved fuels without structural change in engines has been observed to give good results in controlling smoke emissions (Curran et al. 2001; Rahman et al. 2013).

In CI engines, different kinds of unconventional fuels and additives like alcohols (Can, Celikten, and Usta 2004; Chen et al. 2012; Lapuerta, Armas, and Herreros 2008; Putrasaria, Nura, and Muharama 2013; Sayin 2010; Sayin, Ozsezen, and Canakci 2010), biodiesels (Klein-Douwel et al. 2009; Mohsin et al. 2014; Palash et al. 2013; Pathak et al. 2018), vegetable oils (Bayındir, Zerrakki Isık, and Aydın 2017; Corsini et al. 2015; Jain et al. 2017), gaseous fuels (Choudhary, Nayyar, and Dasgupta 2018; Gupta et al. n.d.; Rosha, Dhir, and Kumar 2018) and other oxygenated compounds (Fayyazbakhsh and Pirouzfar 2016a, 2016b; Kumar et al. 2018a, 2018b; Mccreath 1971; Ommi, Nekofar, and Pirozfar 2009; Pirouzfar, Zarringhalam Moghaddam, and Mirza 2012) can be used to control emissions. Improved fuel blends can also be prepared by adding some amount of these compounds in diesel. Out of these alternatives, oxygenated compounds are better suited because of their potential to reduce exhaust emissions without altering engine performance (Choi and Reitz 1999; Rajasekar et al. 2010; Rakopoulos et al. 2014). Most of the oxygenated compounds are renewable and hold up the local agriculture sector (Jang et al. 2012; Tutak

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