Applied Thermal Engineering 47 (2012) 1–9

Contents lists available at SciVerse ScienceDirect

Applied Thermal Engineering

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

Advantages of converting Diesel engines to run as dual fuel ethanol–Diesel

Alberto Boretti*

Missouri University of Science and Technology, 194 Toomey Hall, Rolla, MO 65409-0050, USA

ARTICLE INFO

Article history:
Received 11 November 2011
Accepted 16 April 2012
Available online 23 April 2012

Keywords:
Diesel
Ethanol
Dual fuel
Engine conversion
Renewable fuels

ABSTRACT

The paper considers the option to convert a Diesel engine to work as dual fuel with Diesel and ethanol following the experience of the Diesel heavy duty truck engines conversion to dual fuel Diesel and LNG. This opportunity requires the development of dedicated dual fuel injectors for the Diesel and the ethanol in small bore applications, or the simple addition of a second ethanol injector in large bore engines. Then, proving a second fuel tank is added, a car or a truck could run with either all Diesel or a small Diesel and the most part ethanol, typically 5% and 95% in fuel energy. For this latter operation, prior, concurrent or post injection of the Diesel may permit operation Diesel-like, mixed gasoline/Diesel or mixed gasoline/HCCI of the engine to achieve even better fuel conversion efficiencies than the Diesel only over the full range of speeds and loads with all the advantages of the renewable ethanol in terms of environment and energy security.

1. Introduction

There are many techniques by which ethanol can be used as a fuel in compression ignition engines. Solution, fumigation, dual injection, spark ignition, ignition improvers and surface ignition are the techniques summarized in [1].

The easiest method by which ethanol could be used is in the form of solutions [2]. But ethanol has limited solubility in Diesel, and therefore the ethanol–Diesel solutions are restricted to small percentages. Emulsions may accommodate larger percentages but have the drawbacks of the cost of the emulsifiers and the poor low temperature properties.

Injection of ethanol in the intake may permit large percentages of ethanol. However, this method requires a second port injector for the ethanol and separate fuel tanks, lines, pumps and controls. Gasoline Port Fuel Injection (PFI) injectors and pumps are available off-the-shelf, but certainly specifically developed ethanol injectors and pumps may be needed. This solution is considered in [3]. Their experimental data shows that the ethanol–Diesel combustion brings relevant benefits in terms of fuel consumption, smoke, nitrogen oxides and combustion noise. This is basically the best solution available at the present time.

The dual fuel direct injection is a method by which only a small amount of Diesel supplements the main injection of ethanol. The drawbacks of this method include the second direct injector plus separate fuel tanks, lines, pumps and control as described above. The dual injector requires space in the combustion chamber where the injector can be effective. Gasoline direct fuel injection (GDI) injectors and pumps are available off-the-shelf, but certainly specifically developed ethanol injectors and pumps may be needed. This technique is a novel technique presented here that is expected to deliver much better performances than PFI in the near future. This technology builds up on the experience gathered converting heavy duty truck Diesel engines to run as dual fuel Diesel and Liquefied Natural Gas (LNG) [4–6].

Many Diesel heavy duty trucks have been converted to LNG by Westport since the 1990s replacing the Diesel direct injector with a single dual fuel injector performing a pilot Diesel and a main LNG direct injection [4–6]. The Diesel-LNG dual fuel injectors certainly simplify the cylinder head design requiring only minor changes. The Westport High-Pressure Direct Injection (HPDI) injector [6] is a common-rail style injector that directly replaces the Diesel injector. Late-cycle, high-pressure direct injection ensures diffusion type combustion for the LNG and therefore retains the high power, torque, and efficiency of the Diesel engine with possibly the advantages of the higher power densities. This injector provides a small Diesel pilot spray and a much larger LNG spray. The Diesel averages only about 5% of the total energy input and is used to start the main combustion of high-pressure directly-injected LNG [4–6]. The major drawback of this solution vs. the two direct injectors that

* Mechanical and Aerospace Engineering Department, 280 Toomey Hall, Missouri University of Science and Technology, Rolla, MO 65409-0500, USA. Tel.: +1 573 341 6073; fax: +1 573 341 6899.
E-mail address: aboretti@mst.edu.

1359-4311/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.applthermaleng.2012.04.037