Applied Thermal Engineering 49 (2012) 147–153

Contents lists available at SciVerse ScienceDirect

Applied Thermal Engineering

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

Particulate filter behaviour of a Diesel engine fueled with biodiesel

D. Buono[a], A. Senatore[a], M.V. Prati[b,*]

[a] Dipartimento di Meccanica ed Energetica, Università di Napoli Federico II, 80125 Napoli, Italy
[b] Istituto Motori CNR, viale Marconi no 8, 80125 Napoli, Italy

ARTICLE INFO

Article history:
Received 22 October 2010
Accepted 12 August 2011
Available online 10 September 2011

Keywords:
Biodiesel
Particulate filter (DPF)
Emissions
DPF regeneration
BET

ABSTRACT

Biodiesel is an alternative and renewable fuel made from plant and animal fat or cooked oil through a transesterification process to produce a short chain ester (generally methyl ester). Biodiesel fuels have been worldwide studied in Diesel engines and they were found to be compatible in blends with Diesel fuel to well operate in modern Common Rail engines. Also throughout the world the diffusion of biofuels is being promoted in order to reduce greenhouse gas emissions and the environmental impact of transport, and to increase security of supply.

To meet the current exhaust emission regulations, after-treatment devices are necessary; in particular Diesel Particulate Filters (DPFs) are essential to reduce particulate emissions of Diesel engines.

A critical requirement for the implementation of DPF on a modern Biodiesel powered engine is the determination of Break-even Temperature (BET) which is defined as the temperature at which particulate deposition on the filter is balanced by particulate oxidation on the filter. To fit within the exhaust temperature range of the exhaust line and to require a minimum of active regeneration during the engine running, the BET needs to occur at sufficiently low temperatures.

In this paper, the results of an experimental campaign on a modern, electronic controlled fuel injection Diesel engine are shown. The engine was fuelled either with petroleum ultralow sulphur fuel or with Biodiesel: BET was evaluated for both fuels. Results show that on average, the BET is lower for biodiesel than for diesel fuel. The final goal was to characterize the regeneration process of the DPF device depending on the adopted fuel, taking into account the different combustion process and the different nature of the particulate matter. Overall the results suggest significant benefits for the use of biodiesel in engines equipped with DPFs.

1. Introduction

It is well known that no other internal-combustion engine is widely used as the Diesel engine. This is due primarily to its high degree of efficiency and resulting fuel economy. The chief areas of use for Diesel engine are fixed-installation engines, cars and light commercial vehicles, construction and agricultural machinery, and so on. Diesel engine are produced as inline or V-configuration units. They are ideally suited to turbocharger or supercharged aspiration as, unlike the gasoline engine, they are not susceptible to knocking.

To comply with the current regulations on particulate matter emissions, Euro V vehicles need the adoption of Diesel Particulate Filter (DPF), which highly reduces the particulate matter (PM) emissions, but needs to be periodically regenerated. The regeneration procedure [1] can be performed either “on vehicle” by increasing the exhaust gas temperature or by taking off the DPF device from the vehicle. The “on vehicle” regeneration procedure causes several problems [7,11], such as engine oil dilution and high fuel consumption while the external regeneration implies that the vehicle cannot be operational for several hours.

The regeneration process of a DPF [1–3] requires the combustion or the oxidation of the carbon rich particles which have been collected in the filter. Generally an increase of temperature in the filter to the ignition temperature of a certain amount of the particles, together with the supply of oxidizers (oxygen or NO_2), permits the DPF regeneration. There are three important temperature variables for a DPF [3]:

- the "light off" temperature, below which catalyst activity is too low to oxidize HC (ranging around 200 °C);
- the NO to NO_2 conversion temperature range (defined as the minimum and the maximum temperature at which 40% or greater NO conversion is achieved). The highest NO conversion occurs at medium temperatures of about 250–350 °C.

* Corresponding author. Tel.: +39 0 817177210.
E-mail address: m.v.prati@im.cnr.it (M.V. Prati).

1359-4311/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.applthermaleng.2011.08.019