Biodiesel Exhaust Emissions and Determination of their Environmental and Health Effects

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Abstract

In Europe, the use of rapeseed oil fuels in diesel engines has been intensively investigated since the energy crisis of the early 1970s. In the beginning, the emphasis was placed on the technical possibilities associated with the use of rapeseed oil as a fuel. However, research has shown that pure rapeseed oil can only be used in specially designed engines. Research that followed indicated that rapeseed oil methylester (RME) was a suitable replacement for petroleum diesel fuel (DF) [30]. After this discovery, research has focused on the engine exhaust emissions that result when fueling with both unmodified rapeseed oil and RME [14]. In the USA research has focused on soybean oil methylester (SME). Both RME and SME are called Biodiesel. In Germany Biodiesel must fulfill the standard DIN V 51606.

Initially, environmental related research concentrated on the federally regulated hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOₓ) exhaust gas emissions [31]. In addition, a series of current publications compare the environmentally important but non-regulated polycyclic aromatic hydrocarbons (PAH), aldehydes, ketones and in some cases, the aromatic compounds.

Introduction

An estimation of the environmental effects caused by emissions from engines fueled with rapeseed oil methylester can be made by a relative comparison with DF. An evaluation of the potential health effects, as presented for gasoline and diesel-powered engines in an environmental assessment of the „Sachverständigenrat für Umweltfragen“ (German Authority Council for Environmental Issues) [23], must be replicated for RME in the future.

The goal of this review is to summarize the published emissions measurements from different authors, to compare these results and, where possible, identify
trends that may exist. In order to classify and evaluate the conclusions, it is necessary to begin with a description of the experimental conditions applied, or in other words, the engine testing procedures.

**Engine testing procedures**

The engine test procedures must be selected carefully. Engines emit different levels of harmful substances depending upon load and engine speed. A comparative evaluation of the engine exhaust emissions is only possible when specific engine testing procedures are employed. For automobiles, test cycles that contain city and highway test conditions should be used. The test cycles that are used most frequently include the American Federal Test Procedure (FTP) and the European ECE-13 Test (ECE = Economic Commission for Europe). The ECE test procedure now includes a section that measures emissions at higher speeds to adjust to the traffic conditions that exist in Europe and is denoted MVEG-A Test (Motor Vehicles Emissions Group). The results of exhaust gas emissions from these test procedures are not directly comparable, as the driving cycles load the engines differently [24].

Worldwide many test procedures are available for trucks. In the EU (EU = European Union), truck emissions are analyzed using the 13-mode steady-state test cycle ECE R49. In contrast to the U.S. transient cycle, this steady state truck test takes into consideration the European driving style and the European engine design of the vehicles [5]. Diagram 1 illustrates the selected operating points used during the engine emissions test procedure and the weighting factors for each part of the test.

![Diagram 1. The load points of the 13-, 8- and 5-mode tests](image-url)