



**SES6-CT-2003-502705**

**RENEW**

**Renewable fuels for advanced powertrains**

**Integrated Project**

**Sustainable energy systems**

*Deliverable: 3.6.3.*

*A tentative fuel specification of engine grade DME*

Period covered from: 2006-01 to: 2007-12 Date of preparation 2008-07-02

Start date of project: 01-01-04 Duration: 48 months

Patrik Klintbom, Fuels and Lubricants

Volvo Technology Corporation

40508 Göteborg Sweden

Project coordinator name: Mr. Frank Seyfried

Project coordinator organisation name: VOLKSWAGEN AG  
Berliner Ring 2

38436 Wolfsburg

Final version

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
<b>PU</b>	Public	<b>X</b>
<b>PP</b>	Restricted to other programme participants (including Commission Services)	
<b>CO</b>	Confidential, only for members of the consortium (including the Commission Services)	
<b>RE</b>	Restricted to a group <u>specified</u> by the consortium (including the Commission Services)	

**Table of contents**

Introduction..... 3  
Results relevant to standardisation in RENEW .....5  
DME properties.....4  
Existing standards for DME.....5  
    IEA AMF standard.....6  
    China .....6  
    Japan.....7  
Results.....8

## **Introduction**

Fuel standardization is essential in order to safeguard the quality of the fuel and to give directions for fuel and vehicle producers, fuel distributors etc. At present there are no agreed standards for DME used as a fuel for vehicles. A process to set up an international ISO-standard started within ISO TC28 in the autumn of 2007 with 24 members from 9 different countries including Swedish representative from Volvo.

A standard for DME used as transportation fuel need to cover several aspects such as technical, health issues, safety etc.

So far chemical grade DME has been used as fuel for testing in DME-engines. The work within RENEW focused on the performance of DME-engines fuelled with chemical grade DME mixed with methanol and water. These impurities are the most likely ones to occur in a future DME market.

## DME properties

DME is the simplest of the ether family with a slightly sweet smell and colourless appearance. The traditional use for DME is as a aerosol propellant.

DME can dissolve up to approximately 5 wt% of water (at 0 wt% methanol) but it is miscible with methanol and a larger fraction of methanol increases the solubility of water, since methanol is miscible with water.

Chemical grade DME (99.9 wt%) mixed with 1 wt% Castor 927 oil, to reduce wear on fuel system components, and different amounts of methanol and water were used in the engine tests for RENEW.

Table 1 Selected chemical and physical properties of DME.

<b>Property</b>	
Chemical formula	CH <sub>3</sub> -O-CH <sub>3</sub>
Molecular weight [g/mol]	46.07
Liquid density [g/cm <sup>3</sup> ]	0.67
Boiling point [°C]	-24.8
Critical Point [bar];[K]	53;400
Vapor pressure [MPa]@293 K	0.53
Lower Heating Value, [MJ/kg]	28.8
Density, 15°C, [kg/m <sup>3</sup> ]	671
Viscosity, 40°C, [m <sup>2</sup> /s]x10 <sup>-6</sup>	0.18
Cetane number	>55

## **Results relevant to standardisation in RENEW**

In RENEW, DME with various amounts of methanol and water contamination was tested. These contaminants are judged to be the most likely ones to occur in DME on a future automotive market. The maximum amount of contamination of water and methanol was tested up to 10% on volume basis. This level is considered to be approximately 10 times larger than the expected impurities on the market. Other impurities that also are of interest are CO<sub>2</sub>, CO, acetic acid, methyl formate, ethyl methyl ether and sulphur.

The work within RENEW covered the impact on engine performance and emissions of a DME fuelled 9-liter Volvo diesel engine. Long term effects were not studied within RENEW.

A DME standard need to cover/safeguard several aspects such as:

- Engine performance
- Impact on emissions (both regulated and unregulated)
- Impact on plastics and rubber
- Impact on metallic materials
- Impact on handling, safety, toxicity etc.
- Impact of impurities on additives in DME
- Additives, lubrication and odour
- Test methods

The work in RENEW covered the two first bullets.

## Existing standards for DME

There are a number of different standards existing for the use of DME as transportation fuel today. These standards are described below. Standards for DME used for other applications are available in Korea and Japan.

### **IEA AMF standard**

A standard for DME as a fuel for vehicles was suggested in a working group of IEA in the year 2000. The specification resulting from this work is specified in Table 2.

Table 2: IEA AMF DME specification

Item	Specification
DME purity (mass %)	99.6 %
Methanol	<0.05 %
Water	<0.01 %
Methyl ethyl Ethanol	<0.2 %
Higher (fatty) alcohol	<0.05 %
Higher (fatty) ether	<0.05 %
Ketone	<0.05 %
Additive (lubricant, viscosity)	<0.2 %

### **China**

China is the world leader in production of DME with currently almost 9 million tons DME of yearly capacity installed.

In China there are currently 15 standards related to DME under development covering the following topics:

- 3 standards for rubber (for sealing material) compatible with DME
- 2 standards for valves
- 1 standard for tank for filling stations
- 1 standard for filling station
- 4 standards for vehicles
- 3 standards for engines
- 1 standard for DME fuel

China is also part of the ISO standardization work.

## **Japan**

In Japan a tentative Japan Industrial Standard (JIS) is available for the use of DME as a fuel. However the use of DME in diesel engines is not included in this standard. The JIS standard is specified in Table 3 below.

Table 3: Tentative JIS standard for the use of DME as a fuel

Item	Specification
DME purity (mass %)	99.0 or more
Methanol (mass %)	1.0 or less
Moisture (mass %)	1.0 or less
Formic acid (mass %)	0.01 or less
Carbon dioxide (mass %)	0.1 or less
Sulfur (mass ppm)	Not to be detected
Remaining (residuals) (mg/kg)	-*1
Vapor pressure (MPa) 40°C	1.05 or less

\*1: Residuals; it depends on the agreement between the concerned parties

## Results

The results from the RENEW project indicate that from an emission and engine performance point of view methanol and water does not pose a short term challenge. However more tests taking into account the longer term effects on the engine and exhaust after treatment systems need to be carried out. Other important areas that need to be studied are impact on additives and storage technologies. Development of additives for lubrication and odour is also of importance since there are no commercial additives available on the market today.

The data from RENEW will be used as input in the ISO standardization work on DME. However it is necessary to get more experience from labs and the field before any standard can be suggested. So far chemical grade DME has been used. Such DME is often produced via dehydration of methanol. In future studies it is also relevant to study the properties of DME produced from different processes. More information about the tests performed within RENEW can be found in deliverable 3.6.1/2