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2nd DME Workshop Dimethyl-ether as an automotive fuel
26 & 27 June 1997, Delft, the Netherlands
IEA/AMF Annex XIV

TNO Road-Vehicles Research Institute

Schoemakerstraat 97
P.O.Box 6033
2600 JA Delft
The Netherlands

Phone +31 15 269 69 00
Fax +31 15 262 07 66

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Author(s)
R.P. Verbeek

Client/Sponsor
Participating countries
Alternative Motor Fuels
International Energy Agency
Secretariat
Dr Claës Pilo
Roslagsvägen 54
S-11347 Stockholm

Approved by
R.S.G. Baert
(Head of the section)

Approved by
J.J. Seppen
(Head of the department)

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Abstract

The second workshop "Dimethyl-ether as an automotive fuel" is a part of Annex XIV of the Implementing Agreement: Alternative Motor Fuels of the International Energy Agency. Representatives of practically all companies and research organisations active in the automotive DME field were present.

The objectives of the second workshop were:
* To have an in-depth evaluation of the contents of the DME Annex,
* To exchange know-how via presentations of R&D projects,
* To address funding and participation of additional countries.

The DME Annex consists of 7 separate tasks, in which a varying number of companies and research organisations take place. The subjects of the 7 tasks are related to fuel quality, safety environmental aspects and costs.
In task groups, the tasks were evaluated with respect to objectives, results, activities, planning and co-operation.
Canada, Denmark, Finland, Japan, Norway, Sweden, The Netherlands and US had confirmed their participation in the cost sharing and/or task sharing part of the Annex before the workshop. Austria and France indicated that they would probably join.

It was decided to try to get sufficient funding confirmed in writing in July and August, in order to make a go / no go decision (for the complete Annex) on September 1, 1997.
The next workshop was planned for either December '97 or February '98.

Contents

Appendices

1 Introduction

The first workshop on Dimethyl-ether (DME) as an automotive fuel was held on 14 & 15 November 1996 (also in Delft, the Netherlands). This workshop was organised by TNO on behalf of the Executive Committee of the Implementing Agreement "Alternative Motor Fuels" of the International Energy Agency (IEA/AMF).
In the first workshop, a series of common R&D needs were defined, which let to a proposal for an Annex on DME. This Annex was presented at the IEA/AMF meeting in Charleston, USA in March 1997. The proposal was updated in April 1997.

The proposal for the DME Annex consists of 7 tasks or sub-projects. De primary ojective of the 2nd workshop was to further assess the DME proposal and to have in-depth discussions about the objectives, results, activities and planning of the individual tasks.
The secondary objective was to exchange know-how via presentations of R&D projects.
The agenda and the list of participants are included in respectively Appendix A and B.
The workshop can be split up in the following parts:

- Presentation and discussion of results and activities of the DME proposal
- Discussion of the funding of the proposal
- Assessment of the 7 tasks in discussion groups
- Presentation objectives, activities, work distribution among participants and planning of the tasks by the tasks leaders
- Presentations of latest DME R&D results
- Final remarks and actions.

These parts are described more in detail below.

2 Presentation and discussion of results and activities of DME proposal

Refer to IEA-DME proposal dd April 1997.
The objective of the Annex is the investigation of subjects which are of general importance for the introduction of DME as an automotive fuel.

These subjects were determined during the first DME workshop (14 & 15 November 1996, the Netherlands). Below they are presented as a list of tasks:

1. Trade-off fuel quality versus costs
2. Safety investigation (DME distribution and vehicles)
3. Design guidelines
4. DME from renewable feedstock
5. Life cycle analysis (LCA)
6. Costs of DME infrastructure
7. Operating agent / workshops / newsletters

Compared to the Annex proposal, the following remarks were made:

- Design guidelines: Laboratory safety guidelines and effect of fuel properties should be explicitly included.
- LCA: Co-ordination with IEA - bio-fuels Implementing Agreement.

Also the interface between the different tasks was discussed:

- There is overlap between the safety investigation and design guidelines.

The final result of the tasks 1, 2 and 3 should be a fuel standard definition.

As long as the funding is not solved, the individual tasks cannot start. To get things clear, the following time frame was set-up:

* now to September 1: try to get commitment in writing (for both cost and task sharing part) of all countries involved,
* September 1
  - Go or no go for the individual tasks,
  - Start collection of task sharing funds by operating agent.

4 Assessment of the tasks in discussion groups

The 7 tasks of the Annex were assessed in two discussion groups:

Safety and Design guidelines:
- Fouda, Molag, Berendsen
- Ofner, Webster, Sorenson, Gruson, Lacome

Life cycle analysis, Fuel quality, Bio-DME and Cost infrastructure:
- Hansen, Megas, Sabo, Soerum, v. Walwijk, Elam

The objective of the assessment was to reach an agreement on:
- the objectives and activities of the individual tasks,
- the work distribution among the participants and the planning.

5 Presentation taskes by the tasks leaders

The results of the discussions in groups were presented on overhead sheets. Copies of the overhead sheets were handed out during the workshop. They are also included in Appendix D.
Some notes / remarks are presented below:

Trade-off quality versus costs. J.B.Hansen (Haldor Topsoe):
Three fuel qualities will be evaluated. At the start of the program input will be asked from the companies involved in safety and design guidelines for materials compatibility (corrosions and elastomer behaviour) and health effects.

Safety investigation (DME distribution and vehicles), Verbeek (TNO-WT):
Transport and distribution safety will be investigated by TNO-MEP and NRCan. Vehicle safety and installation guidelines vehicle will be investigated by TNO-WT, Renault and AET. AVL will also assess regulation R67 (for LPG) for input on DME engine aspects.

Design guidelines, H. Ofner (AVL):
Co-operation between AVL, AET, Renault and Technical University Denmark.

DME from renewable feedstock, N. Elam:
Not discussed. Planning will be fitted in with other tasks, such that it does not increase the duration of the Annex.

Life cycle analysis, D. Sabo (Amoco):
Companies involved: Amoco, Statoil, Haldor Topsoe, Volvo and Innas.
Fuels included in comparison: Gasoline, Diesel, DME, Methanol, LPG, CNG, LNG.
Bio-fuels will not be included. The study will be based on existing information of the companies involved.

Costs of DME infrastructure, M. van Walwijk (Innas):
Subject is new to the Annex. Innas will make a proposal by September 1.
Amoco and Statoil will be involved.

6 Presentation of latest DME R & D results

There were three presentations:

Spencer Sorenson: Engine operation on DME in a naturally aspirated, DI diesel engine:
Results test program with 2 cylinder engine:

- NOx reduced from 10 to 5-5.5 g/kWh without EGR, respectively 2 g/kWh with EGR,
- particulates emissions reduced to almost zero,
- same engine efficiency,
- lower noise level,
- max cylinder pressure lower than with diesel fuel at the same start of combustion (ignition delay for DME is shorter).

Results are presented in SAE publication 971665 (available at workshop).

Herwig Ofner: Continuation DME common-rail fuel system development:
The AVL DME fuel injections system for heavy-duty engines is characterised by the following aspects:

- common rail injection system with 3-way valves per cylinder to release rail pressure to feed pressure,
- purge system with buffer at "below saturation" pressure to remove liquid DME from (injector) fuel lines after engine shut down,
- extra DME fuel loop with cooler to prevent heating up of DME fuel tank
- full electronic control.

Gary Webster: Program review on the NRCan DME project with 5.9 ltr Cummins B series engines:
The program is focused on the conversion of a conventional diesel fuel in-line pump. This pump is modified to include a spring loaded transfer valve. The pump uses diesel fuel (which is circulated) to actuate the transfer valve, which on its turn displaces the DME.

John Bogild Hansen and Lucas Megas made some comments on the Danish bus demonstration project:

- Currently Volvo is testing the engine. There is still some work needed on primarily sealing aspects of the DME fuel injection system.
- It is planned to send the engine to the Danish Technological Institute in October.
- Vehicle tests by Volve are planned for first half of 1998.
- NOx emission is approximately 3 g/kWh.
- Aerosol grade DME will be used.

7 Final remarks and actions

Important date is September 1. Hopefully at this date the go decision for the Annex can be made.

The objective of the next workshop is to discuss the progress of the first 6 tasks. This workshop should ideally be held some 3 months after the start of the activities. Conditional to the start of the activities on September 1, the next workshop should be held in the first half of December 1997. Good possibilities are December 4-5, 8-9 or 11-12. Amoco volunteered to host this workshop at their facilities near Chicago, USA. The decision to go ahead with a workshop in December should be made before October 15. If December is to early then February 1998 would be a good possibility.

The schematic of the IEA/AMF meetings is as follows: Jan. 1998, October 1998, July 1999.

Actions:

- TNO:
  letter to National Delegates to ask for confirmation of funding in writing,
  check with IEA if involvement of India and South Korea is possible.

- All workshop participants:
  stimulate funding of DME Annex with their own government.

- Task leaders:
  write detailed proposals of the individual tasks.

Appendix A Participants of DME Workshop

Name	Company	Adress	E-mail	Phone	Fax
Nils Elam	Atrax Energi AB	Ekmansgatan 3 S411 32 Goteborg Sweden	anders.elam@atrax.se	+46 31 167850	+46 31 207460
Martijn v. Walwijk	Innas bv	Nikkelstraat 15 4823 AE Breda The Netherlands	innas@worldaccess.nl	+31 76 5424080	+31 76 5424090
Safaa Fouda	Natural Resources Canada	1 Haanel Drive Nepean, Ontario Canada, K1A 1M1	sfouda@nrcan.ge.ca	+613 995 6392	+613 996 9400
Gary Webster	AET on behalf of Nat.Res.Canada	17-102 Fitzgerald Nepean, Ontario Canada, K2H 9GI	gary@act.ca	+613 721 1234	+613 721 1235
John Bogild Hansen	Haldor Topsoe A/S	Nymollevej 55 DK 2800 Lyngby DK	jbh@htas.dk	+45 45 272459	+45 45 272999
Per Age Soerum	Statoil	Arkitekt Ebbelsvag 10 N 7000 Trondheim Rotvoll Norway		+47 7358 4728	+4773584618
Lucas Megas	Volvo Truck Co	Powertrain division Engine prod.development Dept. 24624 BCI S 40508 Gothenburg Sweden	vtr.24624LM@memo.volvo se	+46 31 664550	+46 31 665520
Herwig Ofner	AVL List Fuel syst.Dept	Kleiststr.48 A 8020 Graz	ofner@atek01.avl.co.at	+43 316 787 613	+43 316 787 14
J Affenzeller	AVL List	Kleiststr.48 A 8020 Graz	affenzeller@pccenavl.co.at	+43 316787713	+43 316787750
Jean Fr.Gruson	IFP/DSEP	1 à 4 Ave de Bois Preau Rueil Malmaison Cedex 92852	j-francois.gruson@ifp.fr	+33 1 47526920	+33 1 4752 7014
Pierre Lacome	Reault Research	9-11 Ave du 18 Juin 1940 92500 Rueil Malmaison		+33 1 41 961647	+ 33 1 41961615
David S Sabo	Amoco	Amoco Research Center Mail code E-IE 150 150 W Warrenville Rd Naperville IL 60563 USA		+ 1 630 420 4614	+ 1 630 420 3848
Ruud Verbeek	TNO WT	Schoemakerstraat 97 P.O. box 6033 2600 JA Delft	verbeek@wt.tno.nl	+31 152696369	+31 15 2612341
Menso Molag	TNO-MEP	P.O.Box 392 7300 AH Apeldoorn	menso.molag@mep.tno.nl	+31 55 5493824	+ 31 55 549390
S.C.Sorenson	Techn.Univ.of Denmark	Building 403 DK 2800 Lyngby		+45 45 25 4170	+ 45 45 93 06 03
Jan Berendsen	TNO WT	Schoemakerstraat 97 P.O. box 6033 2600 JA Delft	berendsen@wt.tno.nl	+ 31 15 2697478	+ 31 15 2612341

Appendix B Program

Workshop "Dimethyl-ether as an automotive fuel"
Date 26 & 27 June, 1997

Day 1

9.00 Opening/introduction
Procedure Workshop

9.15 Presentation IEA/AMF proposal
Discussion

10.45 Discussion in task groups

12.45 Lunch

13.30 Continuation discussion tasks in separate groups

15.30 Presentation tasks (objectives, results, activities, planning and cooperation)

17.00 Conclusions, Agenda day 2

17.30 Presentation Spenser Sorenson

18.00 End of session

Dinner

Day 2

9.00 (Continuation) discussion taskes IEA Proposal

Presentations:

Spencer Sorenson:
Engine operation on DME in a naturally aspirated, DI diesel engine:

Gary Webster:
Program review on the NRCan DME project with 5.9 ltr. Cummins B series engines

Herwig Ofner:
Continuation DME common-rail fuel system development

11.30 Conclusions/final remarks/next workshop

13.20 Lunch/end of workshop

Appendix C Financial overview

Financial overview. Industry and Government contribution to IEA/AMF Annex XIV on DME

	Industry In kind	Cash	Government Task sharing	Cost sharing	Total
US	40	0	0	40	80
Finland	0	0	0	20	20
Norway	55	10		30*	95
Denmark	50	0	15	25**	90
Netherlands	5	0	70	10	85
Sweden	57	43	67	10	180
Canada	0	0	100	10	110
France	?			?	?
Japan				?	?
Austria	?			?	?

* from Statoil

** via Haldor Topsoe

Appendix D Presentation task groups

Task 1: DME fuel quality

Objectives:

To define investment and operating costs as function of water and/or methanol.

Results and timing:

Start November 1, 1997. Report after 12 months leading to fuel standard.

Activities:

Computer simulations of implications of fuel quantity

wt%	MeOH	H_2O
	10	0.01
	0.01	2.5
	2.5	2.5

and furthermore equal amount of MeOh and H_2O from total 5% ---> 0.01.

Participants: Topsøe and Statoil,

Coordination with:

- Materials compartibility/corrosion
- Safety and health effects
- Transportation and storage
- Emissions

Task 2. Safety investigation

Table 1: Schematic participants safety investigation and interface with task 3-design guidelines

	Transport		Distribution	Vehicle system		Engine system	
Activities		TNO-MEP total 300 H			TNO WT 360 H R 67		AVL ? Renault
System definition	2 TNO		2 TNO	2/3		3	
Hazard identification	2 CAN (200 H)		2CAN				
FMEA				2		AET? 3	
Recommendations	2		2	2		3	
Guidelines	2	TNO-MEP Nat.Res. Canada	2		2 TNO-WT Renault AET	3 AVL Renault AET DTU	

2 = task 2 3 = task 3 H = hours

Task 3. Design guidelines

Cooperation between: AVL, AET, Renault, DTV

Coordination: AVL

Objective:

Guidelines for the dsign of DME fuel injection systems

Strategy: (part I)

1) Define (~3) different FIE systems (e.g.PLN, CR, w/wo purge)

2) Define Boundary Conditions (roi, timing, ..)

3. Define Components, Functions, Possible failures,.....

4. FMEA
   - one representative of each partner

- one moderator
(- additional?)

5. Conclusions
- FMEA assessment defines arreas of concern
- Guidelines how to deal with components of concern

Results: Report (written by all partners)
FMEA documents
(conclusions + guidelines)

Part II (optional)

Component task (of general interest) (all partners can make laboratory tests)
Cooperation in - organization
- preparation
- testing

Time Schedule:

- contract between partners + start of work
(sept.Oct 1997)
- FMEA Feb. 1998
- Report March 1998
- Ongoing tests, if any (part II)
finished by December 1998

Task 5 Life Cycle Analysis.

2. LCA

* Fuels
- gasoline, diesel, DME, Methanol, LPG, CNG, (LNG)
- no biofuels

* - Vehicules: passenger car and HD Bus

* Latest existing technology

* Test cycles (certification cycles)
EU 15 + EUDC (Passenger cars)
ECE-R49 (HD)

FTP HD transient

* Energy consumption/efficiency

* Emissions
  - greenhouse effect
  - other (local effects)

* not costs

* based on existing information

Life cycle Analysis

Phases	DME	Diesel	Gasoline	MeOH.	LPG	CNG	LNG
Feed Vent/Flare Feed Production Feed transport	S/A						
Fuel preparation/conversion/ refining	H/T	S/A	S/A	H/T	Can.		
Fuel transportation/distribution	S S	S/A	S/A	Can	A	Houston	
Fuel /vehicle"corrections"	V/R						

Energy Greenhouse Gases CH_4 , CO_2, No_x

Others ?

S Statoil
A Amoco
H/T Haldor Topsoe
V Volvo
R Renault

Planning

2 meetings ... if possible

Timing

0 Start of project (Sept?)

0-2 Exchange data
mail, E-mail, fax, telephone

2 1st meeting

2-5 Exchange data, again

5 2nd meeting

5-8 Clarify results

8 Final report

6. Costs infrastructure

Proposal by September 1st.

Innas will lead .

Amoco & Statoil co-operate