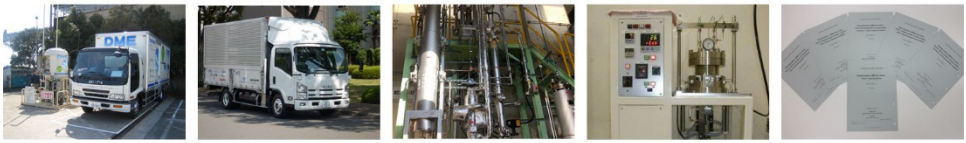
Annex 47



A Report from the Advanced Motor Fuels Technology Collaboration Programme

Reconsideration of DME Fuel Specifications for Vehicles

Mitsuharu Oguma
National Institute of Advanced Industrial Science and Technology (AIST)

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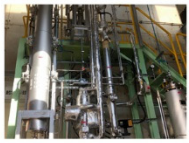

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Mitsuharu Oguma
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December 2018

Summary

(1) The following ISO's DME fuel specifications for basic fuel (not for vehicles only, but included for diesel engines), and the test methods were published completely in 2015.
- ISO16861:2015, "Petroleum products -- Fuels (class F) -- Specifications of dimethyl ether (DME)", 2015.5.15
- ISO17196:2014, "Dimethyl ether (DME) for fuels -- Determination of impurities -- Gas chromatographic method", 2014.11.15
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- ISO17198:2014, "Dimethyl ether (DME) for fuels -- Determination of total sulfur, ultraviolet fluorescence method", 2014.11.15
- ISO17786:2015, "Dimethyl ether (DME) for fuels -- Determination of high temperature (105°C) evaporation residues -- Mass analysis method", 2015.5.1

(2) The idea for DME fuel specifications for vehicles is that ISO16861: 2015 will be based with revision of "Residue after evaporation" for lubricity improver. Test methods of lubricity will be explained in the annex (informative) because it is hard to standardize the test method of lubricity by special HFRR at this moment. Japanese Industrial Standard (JIS) will be also revised with the same way. It's necessary to discuss continuously with VOLVO regarding the lubricity test method.

(3) A new set of Round-Robin Test for test methods of DME fuel specification was started by three laboratories in Japan first, then the other laboratories included a few foreign countries will be join in 2016. These data will be used for future's regular revision of the ISO test methods.

(4) Good relationship between IEA-AMF and ISO/TC28/SC4/WG13 was established (The operating agent, "Mitsuharu OGUMA" is a convenor of WG13). However, the activities were not enough (This is a repentant point of the operating agent). The operating agent will

continue the convenor of WG13 in another three years, so, information exchanging can be continued.

(5) The Annex 47 is closed, however, further discussion will be continued in ISO/TC28/SC4/WG13 and WG14.

Authors

Mitsuharu Oguma, National Institute of Advanced Industrial Science and technology (AIST)

The author would like to thank all participants of the Annex 47.

Contents

Introduction

Although the price of crude oil has come down to a stable level, continuous energy security is still imperative worldwide. In the view for reduced environmental impact from vehicles and for relieved oil dependence, the expectation for DME (Dimethyl ether) is still large. Currently, DME is produced from coal and natural gas. If the techniques to produce DME using synthetic gases from waste paper fluid (black liquor) or wood-based biomass from unused wood including thinned wood can be realized, dramatic Well-to-Tank reduction of greenhouse gases would be achieved, and DME could be the most attractive next generation bio-fuel.

IEA/AMF had investigated the potential of DME as an alternative fuel for diesel engines through some Annexes such as Annex XIV, Annex XX and Annex XXVII from 1997 to 2004. Since there was no DME market for vehicles at that time, the investigations had made with some supposition that the DME market for vehicles would be established in the near future.

At the moment, China developed the DME market for vehicles and the production capacity reached 13 million tons. They are currently operating a field test of ten DME city buses on a commercial bus line in Shanghai city. Sweden is now operating BioDME project in which 14 DME trucks will be run for the field test. In Japan, two DME trucks are running with business license plate to build a technical regulation of DME vehicles. The situation has been changed and commercialization of DME fuel is being accelerated.

ISO has started to discuss standardization of DME fuel through TC28/SC4/WG13 from 2007. The proposer of this new Annex is convenor of the WG13. The scopes of DME standardization can be classified as three categories: 1) feedstock for home and industrial use, 2) blend stock with LPG and 3) alternate of diesel for power systems including vehicles. The WG13 has a draft value of DME fuel specifications. However, it is not for final DME product for vehicles but for the base fuel to make any kinds of utilizations. Therefore, it is necessary to standardize the DME

specifications for vehicles and it is the time to do by a new annex of IEA-AMF considering the current situation of DME fuel commercialization.

Objectives

The subject of this annex is "Investigation of DME fuel specifications for vehicles". The basic specifications are referred from the draft value of ISO/TC28/SC4/WG13 (shown in Table 1). The main issues of the annex are as follows:

- Investigation on the effect of fuel impurities on DME diesel engine systems
- Investigation on the effect of additives (e.g., lubricity improver, odorant, and others, if any) on DME diesel engine systems

Table 1 DME fuel specifications for base fuel (draft value of ISO/TC28/SC4/WG13)

Characteristic	Unit	Limit	ISO/ DIS16861	Mutual agreement value of AMF Annex (1998)
Purity	mass %	min.	**98.5**	**99.6**
Methanol	mass %	max.	**0.050**	**0.05**
Water	mass %	max.	**0.030**	**0.01**
Hydrocarbons (up to C_4)	mass %	max.	**1.00**	**Others** **Methyl ethyl ether <0.2** **Higher alcohol <0.05** **Higher ether <0.05** **Ketones <0.05** **Lubricity Improver <0.2** **Odorant <0.002**
CO_2	mass %	max.	**0.10**	
CO	mass %	max.	**0.010**	
Methyl formate	mass %	max.	**0.050**	
Ethyl methyl ether	mass %	max.	**0.20**	
Residue after evaporation	mass %	max.	**0.0070**	
Sulfur	mg/kg	max.	**3.0**	

Methodology

Participants investigate the effect of fuel impurities and additives on DME diesel engine systems and/or DME vehicles in their country individually, and then share the data and opinion each other. Especially, some critical issues such as limit of hydrocarbon number (up to C_4 currently) and use of odorant will be discussed to gain consensus among participants. The information is referred to discuss the standardization of DME fuel specifications for vehicles (as a final fuel) which will be proposed as a new work item on ISO/TC28/SC4/WG13 in the near future. Examples of investigation items are as follows;

- Materials immersion test: To evaluate the effects of fuel specifications on tolerance of materials for fuel supply and injection system
- Engine performance and emission test: To evaluate the effects of fuel specifications on engine performance and emission characteristics
- Durability test: To evaluate the effects of fuel specifications on durability of engine system

  - Operating agent interview and discuss with the DME vehicle developers in Sweden, Korea and China to investigate the effect of fuel impurities on DME diesel engine systems.
  - Emission tests are performed with fuel-grade of DME if necessary.
  - Establish a draft of DME fuel specifications for proposal of ISO new work item.

Description of activities and results

1. Discussions

Effects of fuel impurities and additives on DME diesel engine systems were discuss by face-to-face meeting and phone meeting with Japan, Sweden and Korea as follows.

Date: 20 March, 2014 by face-to-face meeting (Sweden, Japan and Korea)
9 December, 2014 by phone meeting (Sweden and Japan)

Minutes:

- A potential way forward can be to connect the lubricity test evaluation proposal to a work towards a "final fuel for engine" standard.
- In Japan they are working towards such a standard including
  - specification of lubricity improver and its concentration range
  - a description of MPT-HFRR lubricity test in an Annex
- Participants should connect the work towards regional final fuel standards in Japan, EU, US.
- For lubricity test participants can start working on:
  - Description of the three methods, which could be included as annex in a final fuel standard.
  - After that, a testing round of the three methods with the same lubricity improver concentrations. Results could be included in a final fuel standard annex.

2. A new set of Round-Robin Test for test methods of DME fuel

From 2011 to 2012, ISO/TC28/SC4/WG13 and 14 have done the Round-Robin Test of the four drafts of test method for DME fuel specifications. The results were using for the precision analysis for the four drafts of test method. A precision analysis was performed based on only single sample analysis result on the round robin test last time. However, TC28 pointed out insufficiency numbers of the samples.

Although the ISO has been issued, AIST would like to proceed the precision analysis by increasing the number of samples. Therefore, I would like to collect data with your analysis using three samples varying in impurity concentrations.

AIST is preparing test samples and asking the tests individually to world-wide laboratories who are interested in DME fuel. The draft schedule of new set of round-robin tests are shown in Fig.1. Three laboratories from Japan have finished the tests who are AIST, Mitsubishi Gas Chemical Co., Inc. and Nippon Kaiji Kentei Kyokai (NKKK). Minimally five more laboratories are need for the precision analysis. AIST will ask some laboratories to join the tests.

These data of precision analysis will be used for future's regular revision of the ISO test methods.

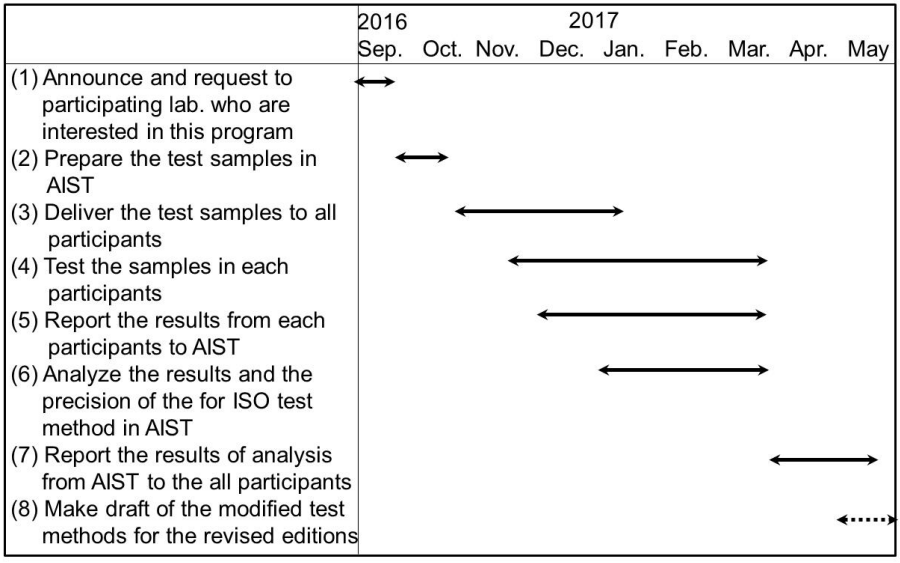

Fig. 1 Draft schedule of new set of round-robin tests

Conclusions

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