Recommendations for the Blending of
Dimethyl Ether (DME)
with
Liquefied Petroleum Gas (LPG)
for
Commercial, Household, and Industrial
Cooking and Heating Applications

Prepared by a Joint Working Group of the
International DME Association and the World LP Gas
Association

2011
1. Scope of Recommendations

The recommendations in this document cover the quality, manufacturing, packaging, labelling, marking, accessories, filling, transport, storage, safe handling, and quality control for DME-LPG blends.

The recommendations are applicable to LPG-DME blends used for cooking and heating applications in households, commerce, and industry. While the wording of this first edition of recommendations is aimed primarily at DME producers, DME-LPG blenders, and end-users in China, it is generally applicable and relevant for all other regions.

2. Reference Documents

The following documents, standards or regulations contain provisions, which, through reference in this text, constitute provisions of these recommendations. Those using these recommendations are encouraged to ensure that the most recent version of these documents is used as reference.

2.1 GB 11174 Liquefied Petroleum Gas (液化石油气)
Chinese standard (1997)

2.2 GB 25035 DME as Town Gas (城镇燃气用二甲醚)
Chinese standard (2010)

2.3 CJ/T 259 DME as Town Gas (城镇燃气用二甲醚)
Chinese standard (2007)

2.4 ISO (No. to be determined) Draft of DME Specification Standard
Currently being drafted by ISO workgroup TC28/SC4/WG13

2.5 ISO 8973 Liquefied Petroleum Gas – Calculation Method for Density and Vapour Pressure

2.6 ISO 3993 Liquefied Petroleum Gas and Light Hydrocarbons – Determination of Density or Relative Density – Pressure Hydrometer Method

2.7 EN 27941 Analysis of Commercial Propane and Butane by Gas Chromatography (ISO 7941:1988)

2.8 ISO 7941 Commercial Propane and Butane – Analysis by Gas Chromatography
2.9 ASTM D5305 *Standard Test Method for Determination of Ethyl Mercaptan in LP Gas Vapor*

2.10 ASTM D2158 *Standard Test Method for Residues in Liquefied Petroleum (LP) Gases*

2.11 EN 15470 *Liquefied Petroleum Gases. Determination of Dissolved Residues. High Temperature Gas Chromatographic Method*

2.12 EN 15741 *Liquefied Petroleum Gases. Determination of Dissolved Residues. High-Temperature Gravimetric Method*

2.13 EN 24260 *Petroleum Products and Hydrocarbons. Determination of Sulfur Content. Wickbold Combustion Method*

2.14 ISO 4260 *Petroleum Products and Hydrocarbons – Determination of Sulfur Content – Wickbold Combustion Method*

2.15 ISO 29945 *Refrigerated Non-Petroleum-Based Liquefied Gaseous Fuels – Dimethyl Ether (DME) – Method of Manual Sampling Onshore Terminals*

### 3. Technical Requirements

3.1 The raw material for DME-LPG blends should be Dimethyl Ether and Liquefied Petroleum Gas.

The quality of DME should be consistent in China with the standard GB 25035 (formerly with the standard CJ/T 259 which has been replaced by GB 25035), which defines the quality of DME for City Gas. The quality of LPG for China shall conform to the provisions of GB 11174.

At a worldwide level, the quality of DME should be consistent with the DME standard prepared by the Working Group 13 (WG13) of the ISO TC28 / SC4 and the quality of LPG must meet the national requirements and/or standards.
3.2 The technical requirements of DME-LPG blends should be consistent with those stated in Table 1:

Table 1. Technical Requirements of DME-LPG Blends

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Units</th>
<th>Limit</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass fraction of DME in DME-LPG blends</td>
<td>%(w/w)</td>
<td>Less than</td>
<td>20</td>
</tr>
<tr>
<td>Vapor pressure at 40°C</td>
<td>Kpa</td>
<td>Less than</td>
<td>1380</td>
</tr>
<tr>
<td>Components of C5+ (see Note 1)</td>
<td>%(w/w)</td>
<td>Less than</td>
<td>1</td>
</tr>
<tr>
<td>Ethyl Mercaptan (odorant)</td>
<td>ppm</td>
<td>More than</td>
<td>10</td>
</tr>
<tr>
<td>Evaporation Residues</td>
<td>%(v/v)</td>
<td>Less than</td>
<td>0.05</td>
</tr>
<tr>
<td>Total Sulfur</td>
<td>ppm</td>
<td>Less than</td>
<td>40</td>
</tr>
<tr>
<td>Corrosion (copper strip)</td>
<td></td>
<td>Less than</td>
<td>1</td>
</tr>
<tr>
<td>Free water</td>
<td>ppm</td>
<td>Less than</td>
<td>60</td>
</tr>
</tbody>
</table>

Note 1: Limits for these components are recommendations only; actual limits should be as specified in the governing LPG quality standard.

4. Test Methods for DME-LPG Requirements

Test methods should be consistent with national regulations and standards for DME and LPG. In the case of an absence of national regulations or standards, the standards or methods below may be used.

4.1 **Mass fraction of DME**: Gas chromatography method

4.2 **Vapor pressure**: Visual inspection by pressure gauge or ISO 8973 and 3993

4.3 **Content of C5+:** Gas chromatography with EN 27941 or ISO 7941

4.4 **Ethyl mercaptan**: ASTM D5305

4.5 **Evaporation residues**: ASTM D 2158 / EN 15470 & 15471

4.6 **Total sulfur**: EN 24260

4.7 **Corrosion**: EN 6251

4.8 **Water**: Visual inspection by sedimentation and measurement of the volume of water extracted from the bottom of the tank.
5. Inspection Rules

5.1 Inspection Objectives

5.1.1 To guarantee the quality of the product, i.e. compliance of the product with the characteristics in Table 1;

5.1.2 To guarantee that the product quantity in the cylinder or the tank is correct;

5.1.3 To guarantee accuracy in product quantity and quality to prevent customers from being defrauded, and to protect manufacturers, blenders and dealers from unfair competition.

5.2 Inspection Checklist

5.2.1 Perform an inspection of every delivery of raw material;

5.2.2 Inspect every batch of blended DME-LPG;

5.2.3 Inspect cylinders filled with DME-LPG blends at least once in the morning and once in the afternoon;

5.2.4 If the filling process has been changed or the production has been shut down for maintenance or following an incident, inspections should be carried out every 10 minutes until all the inspected containers are satisfactory for half a day;

5.2.5 The relevant authorities should have the power to order inspections when deemed necessary.

5.3 Inspection Location

Inspections should be made at the filling station for both the inbound raw materials and, after blending and before delivery from the plant.
5.4 **Inspection Type**

5.4.1 Quality of the gas in the container according to Table 1;

5.4.2 Quantity of the gas in the container – the quantity must be controlled by statistical means and randomness inspection of cylinders according to national standards;

5.4.3 Compliance of the container with the type of gas filled inside;

5.4.4 Labels and warnings on the container showing the compliance of cylinders and gas with DME-LPG blends;

5.4.5 Sleeves and/or caps to prevent the container from being modified;

5.4.6 All the controls must fulfil the requirements of the present standard and of the various other standards involved in the production as, for example, the standards for the quality and compliance of containers with the gas

5.5 **Inspection Responsibility**

Traceability of the product is essential for assigning responsibility and accountability for the product in relation to customers. The quality manager or supervisor is responsible for all inspections. In the absence of a quality manager or supervisor, the plant's general manager must appoint one or assume responsibility for the inspections. All tests, methods, and conclusions should be recorded and should be part of the data record for every specific product.
6. Equipment Requirements

6.1 Manufacturing and Filling methods

6.1.1 The filling of DME-LPG blends is done by weight. LPG must be filled first, followed by DME. Filling in bulk must follow the same method, but as bulk filling is typically made with a volumetric nozzle, the volumetric percentage of LPG and DME must be calculated according to the expected weight percentage of DME and to the density of the LPG mixed with DME:

If \( \rho_{\text{DME}} \) is the density of DME (pure DME \( \rho=0.67 \text{ g/cm}^3 \)) and \( \rho_{\text{LPG}} \) the density of LPG, with 20% weight of DME in the mixture, the volumetric percentage of DME is \( \frac{1}{1+4*\left( \frac{\rho_{\text{DME}}}{\rho_{\text{LPG}}} \right)} \).

If the percentage of DME in the mixture is \( \alpha \) - with \( \alpha \) lower than or equal to 20% - the volumetric percentage of DME is given by:

\[
\frac{1}{1+\left(1-\alpha\right)/\alpha}*(\frac{\rho_{\text{DME}}}{\rho_{\text{LPG}}})
\]

All the filling station equipment must be DME-LPG compatible, particularly concerning the seals.

6.2 End-User Accessories

DME-LPG cylinders must be equipped with appropriate non-adjustable regulators containing seals and materials compatible with DME-LPG blends. The pressure of the regulator must be adjusted to 38 mbar. Equipment used by end-users must be compatible with DME-LPG blends. Most existing end-user accessories and equipment for use with LPG are compatible with DME-LPG blends containing a weight percentage of DME not exceeding 20%.

6.3 Packaging

6.4 Propane cylinders used for DME-LPG blends should have appropriate seals made of HNBR (depending on additives and characteristics) or Teflon. Viton, the material usually used with LPG, is not compatible for use with DME-LPG blends containing DME at 20% weight.

6.5 The packaging should clearly state the kind of gas that can be contained inside. The markings and the colors used in the markings must confirm that the packaging is suitable for use with DME-LPG blends, and must confirm the proportion by weight of LPG and DME in the mixture according to the existing national standards.
6.6 Storage

Over-filling of tanks or cylinders presents a high risk to safety and must be avoided when storing DME-LPG blends. Cylinders and tanks must be compatible for use with DME-LPG blends, particularly for:

6.7 the material used for seals and gaskets;

6.8 the acceptable weight in the tank or cylinder especially if storing DME-LPG blends in LPG containers, because DME-LPG is heavier than LPG alone. With 20% weight DME, we can increase the weight by a maximum of 7.4 % when we replace LPG by DME-LPG.

6.9 Labelling

Labelling must be accurate and reflect the specific nature of the gas in the cylinder: e.g. “20% DME – 80% LPG”. Cylinders should be clearly and easily identifiable, using specific colored bands for example.

6.10 Transport

In China, transportation should follow the Orange Book standard signed and agreed by the People’s Republic of China. According to this procedure, LPG is identified with the following UN numbers: 1011 (Butane), 1075 (LPG mixture), 1965 (Liquefied hydrocarbons gas mixtures), 1978 (Propane) and 1033 for DME. The conditions of DME and LPG are the same for transportation; same Emergency Action Codes (or Hazchem codes); same Hazards Class (2.1 Flammable Gases); same Hazard Identification Numbers (23 – 2) for emissions of gas due to pressure or to chemical reaction (3) for Flammability of solids (vapors) and gases or self-heating liquids.

The sealing materials of cylinder valves, the bodies of road tankers, the storage tanks accessories and pipeline flanges shall be resistant to dissolution and corrosion of DME-LPG blends. If they made of metal, the main compatibility problem will lag in the seals.
7. Safety and Safe Handling

The MSDS (Material Safety Data Sheet) of LPG and DME are very similar with regard to Hazards Identification, First Aid Measures, Fire-Fighting Measures, Accidental Release Measures, Handling and Storage, and Personal Protection.

Following are handling and storage recommendations for DME-LPG blends:

7.1 Use only in well-ventilated areas;
7.2 Avoid breathing dust, vapour, mist or gas;
7.3 Avoid contact with skin and eyes;
7.4 DME-LPG mixtures are extremely flammable at all times;
7.5 Use appropriate certified respirators when facing concentrations above the exposure limit;
7.6 Keep away from sources of ignition, including heat, fire, sparks or flame;
7.7 No smoking;
7.8 Take precautionary measures against static discharges;
7.9 Valve protection caps must remain in place unless container is secured with valve outlet piped to use point;
7.10 Do not drag, slide or roll cylinders;
7.11 Use a suitable hand truck for cylinder movement;
7.12 Use a pressure reducing regulator when connecting to lower pressure piping or systems;
7.13 Do not heat cylinder by any means to increase the discharge rate of product from the cylinder;
7.14 Use a check valve or trap in the discharge line to prevent hazardous back flow in the cylinder;
7.15 Vapours are heavier than air and may spread along floors;
7.16 Vapours may travel to a source of ignition and flash back;
7.17 Store in a cool, dry place;

7.18 Do not expose cylinders filled with DME-LPG mixtures to a temperature above 50°C (or 120°F);

7.19 Do not store in underground;

7.20 Protect cylinders from physical damage;

7.21 Store away from heavily trafficked areas and emergency exits;

7.22 Cylinders should be stored upright and firmly secured to prevent falling or being knocked over;

7.23 Full and empty cylinders should be segregated;

7.24 Use a “first in – first out” inventory system to prevent full cylinders being stored for excessive periods of time;

7.25 Post “No Smoking or Open Flames” signs in the storage or use area;

7.26 Earth-ground and bond all lines and equipment associated with DME-LPG system;

7.27 Electrical equipment should be non-sparking or explosion proof;

7.28 Compressed gas cylinders should not be refilled except by qualified producers of compressed gases.

8. Quality Control Procedures

8.1 Controls must be reinforced at the local level, notably in China.

8.2 It is fundamental that relevant government authorities at all levels take an active and leading role in quality control in order to prevent breaches of existing regulations.

8.3 Unless relevant government authorities enforce existing regulations and controls on the LPG business (in China generally, and specifically in the application of DME-LPG blending regulations), there is a significant risk that breaches of these regulations could lead to the occurrence of dangerous incidents, accidents, and fraud.