


Info. No.: <b>316800</b>		Item Name: <b>FUEL GAS SPECIFICATION</b>			Item Id.: <b>5741441-7</b>	
Scale:	Size: <b>A4</b>	Product Type: <b>ME-LGIP</b>			Projection: 	Page No.: <b>1 (2)</b>
Date	Des.	Chk.	A.C.	Revision Change	Chg. Not.	Rev.
20160427	JUSV	TFPE				00
20161216	JUSV	JESP	Z4	General revision		01
20180119	CSMO	TFPE	X3	Maximum Ethane content changed to 12%.		02
20190506	JUSV	JESP	X3	Max. ethane content changed to 25%; general rev.		03

### Guiding Fuel LPG Specification for MAN B&W ME-LGIP Engines

Liquefied petroleum gas (LPG) is a hydrocarbon gas mixture consisting of various compositions of propane, n-butane and iso-butane with minor amounts of other hydrocarbons. Generally LPG contains less than 5% by liquid volume of material higher carbon number than 4, and has a gauge vapour pressure not exceeding approx. 1600 kPa at 40°C.

The values in the guiding fuel gas specification for the ME-LGIP engines (Table 1) refer to the hydrocarbon mixture at engine inlet.

Liquid or solid contaminants such as metal shavings, welding debris, insulation (i.e. perlite), sand, wood, cloth and oil must be removed from the LPG. It is generally considered as good engineering and operating practice to have LPG cargo strainers in the loading and discharge lines in order to minimize particulate contamination of the LPG and subsequent tanks and equipment. It is recommended that the filter is inspected after the bunkering to establish the contamination degree.

It is important to note that the quality and impurity degree can vary among the suppliers due to production and handling differences and the type of bunkering/transfer process.

LPG in semi-refrigerated and fully-refrigerated tanks will change composition and properties over time. This is due to the unavoidable heat-influx from the surroundings, which will cause vaporisation of lighter compounds, like ethane. This process is called ageing and the gas produced is referred to as boil-off gas (BOG). BOG contains a higher amount of ethane compared to the LPG bunkered. The remaining LPG will have an increased percentage of propane, butane and higher hydrocarbons. The composition of the LPG bunkered will, hence, not necessarily be the same as the composition of the fuel gas delivered to the engine.

In case the engine will be operated on LPG with a higher content of ethane than what is specified in Table 1 a number of additional requirements will need to be satisfied to make it suitable for operation on ME-LGIP engines. Please contact your MAN Energy Solutions two-stroke representative for more information.

In case a pressurized service tank configuration is chosen, in which nitrogen from engine purging will continuously mix into the LPG fuel to the engine, the requirements to such system needs to be assessed in relation to the expected LPG fuel composition and design of the blow-off system. This assessment should be performed in cooperation with MAN Energy Solution. Please contact your MAN Energy Solutions two-stroke representative for more information.


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Date	Des.	Chk.	A.C.	Revision Change		Chg. Not.
20190506	JUSV	JESP	X3	Max. ethane content changed to 25%; general rev.		03

Table 1: Guiding fuel LPG specification for MAN B&W ME-LGIP engines. Values refer to the hydrocarbon mixture at engine inlet.

Designation	Unit	Limit	Value	Test Method Reference <sup>1</sup>
Lower calorific value (LCV)	MJ/kg	min.	46	ISO 6976
Density at 15°C	kg/m <sup>3</sup>	-	report	ISO 8973
Gauge vapour pressure at 40°C	kPa		report	ISO 4256 or ISO 8973
Methane (CH <sub>4</sub> )	% (mol)	max.	0.1	ISO 7941
Ethane (C <sub>2</sub> H <sub>6</sub> )	% (mol)	max.	25	ISO 7941
<b>Propane and/or butane (C<sub>3</sub>H<sub>8</sub>+C<sub>4</sub>H<sub>10</sub>)</b>	<b>% (mol)</b>	<b>min.</b>	<b>75</b>	ISO 7941
Higher order hydrocarbons (C <sub>5</sub> H <sub>12</sub> and higher)	% (mol)	max.	3	ISO 7941
1,3-Butadiene (C <sub>4</sub> H <sub>8</sub> )	% (mol)	max	0.1	ISO 7941
Unsaturated hydrocarbons	% (mol)	max.	11	ISO 7941
Total evaporation residue	mg/kg	max.	20	ISO 13757
Free water at 15°C	-	-	negative	DIN 51614 <sup>2</sup> or ASTM D2713
Hydrogen sulphide (H <sub>2</sub> S) + carbonyl sulphide (COS)	mg/Nm <sup>3</sup>	max.	5	ASTM D2420
LPG Method of sampling	-	-	-	ISO 4257

1. latest edition to be applied. ISO standards methods are the highest level of international methods and are therefore recommended. Equivalent methods from ASTM, GPA and IP can also be used.  
 2. Tested periodically once every three months. ASTM D2713 Standard Test Method for Dryness of Propane (Valve Freeze Method).