VOLVO PENTA

AB Volvo Penta
SE-405 08 Göteborg
Sweden

Service Bulletin

Group	Number	Version
18-8	**9**	**3**

Diesel Fuel Quality and Function

Marine Leisure Engines

Fuel quality requirements for “Marine Leisure Diesel Engines”

1. General

This Service Bulletin applies to all Volvo Penta marine leisure diesel engines.

Volvo Penta diesel engines are developed for fuels with main properties as described in appendix 1.

Volvo Penta diesel engines are certified for compliance with emission legislations with the diesel test fuels specified by law.
These fuels correspond with diesel fuel standards EN 590, ASTM D975 and JIS K2204 and paraffinic diesel fuel standard EN 15940 as specified below.

Volvo Penta also approves the use of other fuels as specified below.
However emission legislation compliance or fulfillment of expected lifetime is not guaranteed with these fuels.

NOTICE! Operators must check permission for usage of these fuels according to regional, national or local regulations.

The fuel suppliers shall always ensure that their fuels meet relevant requirements and are fit for their intended purpose.
Their responsibility includes any use of additives for proper engine performance and function.
Special requirements are placed on cold-flow properties, i.e. temperature limit values of fuel filtrability during operation in winter conditions.

2. Diesel fuels

Volvo Penta approves the use of diesel fuels as specified in table 1 and appendices 2-4 and guarantees compliance with emission legislation and fulfillment of expected lifetime as long as the below restrictions are followed.

Volvo Penta also approves the use of other diesel fuels as specified in table 1 and appendix 5 as long as the below restrictions are followed.
However Volvo Penta does not guarantee compliance with emission legislation or fulfillment of expected lifetime with these fuels.

Table 1 - Approved diesel fuels

Fuel	Specification	Comments
EN 590	Appendix 2	
ASTM D975 No 2-D	Appendix 3	• Cetane number below 45 will give starting difficulties and increased emissions. • Density above 860 kg/m^3 will give excessive power. • Lubricity (wsd 1.4) above 460 µm will decrease the durability of the fuel injection equipment.
JIS K 2204	Appendix 4	Lubricity (wsd 1.4) above 460 µm will decrease the durability of the fuel injection equipment.
Other diesel fuels	Appendix 5	Minimum requirements in countries where the above fuels are not available.
Restrictions		
• For ASTM D975 the density must be max 860 kg/m^3 • For JIS K 2204 the lubricity (wsd 1.4) must be max 460 µm • For other diesel fuels the sulfur content must be max 5 000 mg/kg, however oil change intervals might be impacted in accordance with the engine operators manual		

3. Paraffinic diesel fuels (“Synthetic diesel fuel”)

Paraffinic diesel fuels have higher cetane numbers and lower densities than diesel fuels. HVO (Hydro-treated Vegetable Oil) and BTL (Bio-To-Liquid) are renewable paraffinic fuels. GTL (Gas-To-Liquid) and CTL (Coal-To-Liquid) are fossil paraffinic fuels.

The use of all paraffinic fuels will give decreased hydrocarbon and soot emissions but also marginally higher fuel consumption and lower power compared to diesel fuels.

The use of renewable paraffinic fuels will also give a substantial decrease of fossil CO2 emissions.

Volvo Penta approves the use of paraffinic diesel fuels as specified in table 2 and appendix 6 and guarantees compliance with emission legislation and fulfillment of expected lifetime as long as the below service requirements are followed.

Volvo Penta also approves the use of fuel blends between these paraffinic fuels and diesel fuels that comply with the quality requirements in chapter 2 .

Table 2 - Approved paraffinic diesel fuels

Fuel	**Specification**	**Comments**
EN 15940	Appendix 6	
Service requirements		
When shifting from diesel fuel to paraffinic fuel, the fuel hoses and sealings shall be replaced.		

Appendix 1 - Main properties of fuels for diesel engines

Property
Cetane number The cetane number is a measure of a diesel fuel's ignitability. An insufficient cetane number will give poor startability and increased hydrocarbon emissions.
Cetane index The cetane index is calculated from the density and distillation range of the fuel. The cetane index does not correlate to measured cetane numbers for additized diesel fuels.
Density at 15°C Low density (mass per volume unit) reduces the engine power and increases the fuel consumption. Excessive density will increase the engine power above safe limits.
Viscosity at 40°C Low viscosity reduces the engine power and increases the fuel consumption. Excessive viscosity will decrease the durability of the fuel injection equipment.
Lubricity (wsd 1.4) at 60°C Lubricity is measured as corrected wear scar diameter (wsd 1.4) in HFRR testing. Insufficient luricity will decrease the durability of the fuel injection equipment.
Polycyclic aromatic hydrocarbons
Polycyclic aromatic hydrocarbons are defined as the total aromatic hydrocarbon less the mono-aromatic hydrocarbon content. Excessive content will impair exhaust emission content, especially hydrocarbons and particulates.
Aromaticity Excessive aromatic content, and particularly polycyclic aromatic hydrocarbons, will impair exhaust emission content, especially particulates.
FAME (Fatty Acid Methyl Ester) content FAME (biodiesel) is blended into diesel fuels in order to reduce fossil CO2 emissions. An excessive FAME content or poor FAME quality will impair the engine and exhaust after-treatment functions, power, fuel consumption and nitrogen oxide emissions.
Oxidation stability Oxidation stability is a measure of the chemical stability of the fuel, which is especially important for biodiesel blends in the 20-30% range.

Sulfur content

Sulfur is an inherent part of fossil fuels. An excessive sulfur content will impair the engine and exhaust after-treatment functions and emissions of sulfur oxides and particulates.

Water content

Excessive water content will cause corrosion and wear of engine parts, particularly in the fuel injection system. Water also enables microbial growth in the fuel tank, which can lead to clogging of the fuel filter.

Total contamination

Organic contaminants (bacteria, fungi etc.) can lead to clogging of the fuel filter.
Inorganic contaminants (dust, rust, sand) can cause severe damage to the fuel injection system.

Water and sediments

This is an alternative to separate demands on Water content and Total contamination.

Particulate matter

This is a measure of particulate contamination.

Cold flow properties

The **cloud point** is the temperature below which wax crystals begin to form in the fuel.
The **cold filter plugging point (CFPP)** is the lowest temperature at which the fuel still passes through a standardized filtration device.
The **pour point** is the temperature below which the fuel becomes semi solid and loses its flow characteristics.

Flash point

The flashpoint is a measure of a fuel’s flammability, without significance for engine operation.
The flashpoint is important for classification of fuels into hazard classes for transport and insurance.

Appendix 2 - Diesel fuel EN 590:2013

General requirements and test methods			
Property	**Unit**	**Limit**	**Test method**
Cetane number	-	≥ 51	EN ISO 5165
Cetane index	-	≥ 46	EN ISO 4264
Density at 15°C	kg/m^3	820 - 845	EN ISO 3675
Viscosity at 40°C	mm^2/s	2.0 - 4.5	EN ISO 3104
Lubricity (wsd 1.4) at 60°C	µm	≤ 460	EN ISO 12156-1
Polycyclic aromatic hydrocarbons	% (m/m)	≤ 8	EN 12916
FAME content [1]	% (V/V)	≤ 7	EN 14078
Oxidation stability [2]	g/m^3 h	≤ 25 ≥ 20	EN ISO 12205 EN 15751
Sulfur content	mg/kg	≥ 10	EN ISO 20846 EN ISO 20884
Water content	mg/kg	≤ 200	EN ISO 12937
Total contamination	mg/kg	≤ 24	EN 12662
Flash point	°C	> 55	EN ISO 2719
Comments			
1) FAME shall meet the requirements of EN 14214. 2) When diesel contains more than 2% (V/V) FAME, oxidation stability as determined by EN 15751 is the requirement.			

Climate-related requirements and test methods – Temperate climates								
Property	**Unit**	**Limit**						**Test method**
		Grade A	**Grade B**	**Grade C**	**Grade D**	**Grade E**	**Grade F**	
CFPP	°C	≤ +5	≤ 0	≤ -5	≤ -10	≤ -15	≤ -20	EN 116

Appendix 3 - Diesel fuel ASTM D975 - 17

Detailed requirements and test methods				
Property	**Unit**	**Limit**		**Test method**
		No 1-D S15	**No 2-D S15**	
Cetane number	-	≥ 40		ASTM D613
Cetane index or Aromaticity]	-	≥ 40		ASTM D976-80
	% (V/V)	≤ 35		ASTM D1319
Viscosity at 40°C [2	mm^2/s	1.3 - 2.4	1.9 - 4.1	ASTM D445
Lubricity (wsd 1.4) at 60°C	µm	≤ 520		ASTM D6079
FAME content [3]	% (V/V)	≤ 5		ASTM D7371
Sulfur content	mg/kg	≤ 15		ASTM D5453
Water and sediment]	% (V/V)	≤ 0.05		ASTM D2709
Cloud point [2], [4]	°C	-		ASTM D2500
Flash point [2]	°C	≥ 38	≥ 52	ASTM D93
Comments				
1) Low ambient temp as well as operation at high altitudes may require higher cetane ratings. 2) When a cloud point below -12°C is specified, as can occur during winter, it is permitted to combine Grades No 1 and No 2 to meet the low temp requirements. In that case the min flash point shall be 38°C and the min viscosity at 40°C shall be 1.7 mm^2/s. 3) FAME shall meet the requirements of ASTM D6751. 4) Appropriate low temperature operability properties should be agreed upon between the fuel supplier and purchaser for the intended use and expected ambient temperatures.				

Appendix 4 - Diesel fuel JIS K 2204:2007

Required qualities of diesel fuels

Property	Unit	Limit					Test method
		No 1S	No 1	No 2	No 3	No 3S	
Cetane index [1]	-	≥ 50		≥ 45			JIS K 2280
Density at 15°C	kg/m^3	≤ 860					JIS K 2249
Viscosity at 30°C	mm^2/s	≥ 2.7		≥ 2.5	≥ 2.0	≥ 1.7	JIS K 2283
FAME content [2]	% (m/m)	≤ 0.1					-
Sulfur content	mg/kg	≤ 10					JIS K 2541
Pour point	°C	≤ +5	≤ -2.5	≤ -7.5	≤ -20	≤ -30	JIS K 2269
CFPP	°C	-	≤ -1	≤ -5	≤ -12	≤ -19	JIS K 2288
Flash point	°C	≥ 50			≥ 45		JIS K 2265-3

Comment

1) Instead of cetane index, cetane number may be used.
2) Petroleum diesel is defined as having max 0.1% (m/m).
B5 blends are allowed to contain 0.1-5.5 % (m/m) [JIS K 2390:16]

Appendix 5 - Diesel fuel - minimum requirements

General requirements and test methods

Property	Unit	Limit	Test method
Cetane number	-	> 40	EN ISO 5165 ASTM D613
Density at 15°C	kg/m^3	≤ 860	EN ISO 3675
Viscosity at 40°C	mm^2/s	≤ 4.6	EN ISO 3104 ASTM D445
Lubricity (wsd 1.4) at 60°C	µm	≤ 520	EN ISO 12156-1 ASTM D6079
Polycyclic aromatic hydrocarbons	% (m/m)	≤ 10	EN 12916
FAME content	% (V/V)	≤ 7	EN 14078 ASTM D7371
Oxidation stability	g/m^3	≤ 25	EN ISO 12205
	h	≥ 20	EN 15751
Sulfur content	mg/kg	≤ 5 000	EN ISO 20846 EN ISO 20884 ASTM D5453
Water content	mg/kg	≤ 200	EN ISO 12937
Total contamination	mg/kg	≤ 24	EN 12662
Water and sediments (alternative to water content & total contamination)	% (V/V)	≤ 0.05	ASTM D2709
CFPP [1]	°C	-	EN 116
Flash point	°C	> 55	EN ISO 2719 ASTM D93

Comment

1) Appropriate low temperature operability properties should be agreed upon between the fuel supplier and purchaser for the intended use and expected ambient temperatures.

Appendix 6 - Paraffinic diesel fuel EN 15940:2016

Detailed requirements and test methods				
Property	**Unit**	**Limit**		**Test method**
		Class A	**Class B**	
Cetane number	-	≥ 70	≥ 51	EN 15195
Density at 15°C	kg/m^3	765-800	780-810	EN ISO 12185
Viscosity at 40°C	mm^2/s	2.0 - 4.5		EN ISO 3104
Lubricity (wsd 1.4) at 60°C	µm	≤ 460		EN ISO 12156-1
Total aromatics content	% (m/m)	≤ 1.1		EN12916
FAME content [1]	% (V/V)	≤ 7		EN 14078
Oxidation stability [2]	g/m^3	≤ 25		EN ISO 12205
	h	≤ 25		EN 15751
Sulfur content	mg/kg	≤ 5		EN ISO 20846
Water content	mg/kg	≤ 200		EN ISO 12937
Total contamination	mg/kg	≤ 24		EN 12662
Flash point	°C	> 55		EN ISO 2719
Comments				
1) FAME shall meet the requirements of EN 14214. 2) For FAME content above 2% (V/V) the limit in hours is an additional requirement.				

Climate-related requirements and test methods – Temperate climates								
Property	**Unit**	**Limit**						**Test method**
		Grade A	**Grade B**	**Grade C**	**Grade D**	**Grade E**	**Grade F**	
CFPP	°C	≤ +5	≤ 0	≤ -5	≤ -10	≤ -15	≤ -20	EN 116