

Quality requirements and recommendations for heavy fuel oil

Parameter	Unit	Bunker limit ISO 8217:2005 RMK700	Test method**	Recommended fuel quality	
				Bunker	Engine inlet
Density at 15°C	kg/m ³	max 1010*	ISO 3675/12185	max 1010	max 1010
Kinematic viscosity ¹	mm ² /s (cSt)	-	ISO 3104	-	13 - 17
at 50°C	mm ² /s (cSt)	max 700	ISO 3104	max 730	-
Carbon residue ²	m/m (%)	max 22	ISO 10370	max 15	max 15
Sulphur ³	m/m (%)	max 4.5	ISO 8754/14596	max 3.5	max 3.5
Ash ⁴	m/m (%)	max 0.15	ISO 6245	max 0.05	max 0.05
Vanadium ⁴	mg/kg (ppm)	max 600	ISO14597/IP501/470	max 100	max 100
Sodium ⁴	mg/kg (ppm)		AAS	max 50	max 30
Aluminium + Silicon ⁵	mg/kg (ppm)	max 80	ISO 10478/IP501/470	max 30	max 15
Total sediment, pot. ²	m/m (%)	max 0.10	ISO 10307-2	max 0.10	max 0.10
Water ⁶	v/v (%)	max 0.5	ISO 3733	max 0.5	max 0.3
Flash point ⁷	°C	min 60	ISO 2719	min 60	min 60
Pour point ⁸	°C	max 30	ISO 3016	max 30	max 30

The fuel shall be free of used lube oil, a homogeneous blend with no added substance or chemical waste (ISO8217:2005-5.1)

* Limited to max. 991 kg/m³ if the fuel treatment plant cannot remove water from high density fuel oil (excludes RMK fuel)

** ISO standards can be obtained from the ISO Central Secretariat, Geneva, Switzerland (www.iso.ch).

The values in the column Bunker limit (RMK700) indicate the minimum quality of heavy fuel as bunkered, i.e. as supplied to the ship or installation. Good operating results have been achieved with commercially available fuels within these limits. The column 'recommended fuel quality' is an example of a good quality fuel of the type commonly used in Sulzer diesel engines. The use of this variety of fuel can be expected to have a positive influence on overhaul periods, by improving combustion, wear and exhaust gas composition.

The fuel oil as bunkered must be processed before it enters the engine. For the design of the fuel treatment plant, the relevant Wärtsilä recommendations should be followed. The minimum centrifuge capacity is 1.2 x CMCR x BSFC / 1000 (litres/hour), which corresponds to 0.21 l/kW. The difference between the recommended fuel quality of bunker and at engine inlet is an approximate indication of the improvement that must be achieved by fuel oil treatment. If catalyst fines are present they must be removed. The fuel oil should contain no foreign substances or chemical waste, hazardous to the safety of the ship or detrimental to the performance of machinery.

Notes to "Fuel Oil Requirements"

1. Viscosity

The recommended viscosity range at engine inlet is: 13-17 cSt (mm²/s). The preheating temperature can be estimated from the approximate viscosity vs. temperature chart in the engine instruction manual. For standard 380 cSt fuel (at 50°C), the fuel must be preheated to about 130°C. The maximum viscosity of the fuel that can be used in an installation depends on the heating and fuel preparation facilities available.

2. Carbon residue, asphaltenes, sediment

Asphaltenes are a useful component of the fuel oil and contribute to the energy released when the fuel is burned. High levels of carbon residue and asphaltene can however impair the combustion quality of the fuel oil, promoting increased wear and fouling of engine components. Asphaltenes must be kept solubilised to prevent problems of sludge formation in centrifugal separators, filters and on the tank bottom. Especially the addition of paraffinic distillates could cause the asphaltenes to settle out. To minimise compatibility risks, care should be taken to avoid mixing bunkers from different suppliers and sources in storage tanks on board. A standard heavy fuel oil contains up to 14% asphaltenes and a good quality fuel up to 8% asphaltenes.

3. Sulphur

The alkalinity of the cylinder lubricating oil, i.e. the base number (BN), should be selected with regard to the sulphur level of the fuel oil. When using a heavy fuel oil containing less than 1% sulphur particular care should be given to the correct choice of cylinder lubricant.

4. Ash and trace metals

Fuel oils with low contents of ash, vanadium and sodium are preferable. These components tend to promote mechanical wear, high temperature corrosion and the formation of deposits in the turbocharger and on the exhaust valve. Sodium compounds depress the melting point of vanadium salts, which are very corrosive in the liquid phase. With certain ratios of vanadium to sodium (3:1), a mixed salt (oxide, sulphate) is formed with a minimum melting point; this should be avoided. High sodium levels at engine inlet can cause fouling of turbocharger components. The effect of high temperature corrosion and the formation of deposits can be counteracted by the application of ash modifiers.

5. Aluminium, silicon

Aluminium and silicon in the fuel oil are regarded as an indication of the presence of so-called catalytic fines (cat fines). These are porcelain-like particles used as catalyst in petroleum refining. The particles cause high abrasive wear to piston rings and cylinder liners. In the extreme case, they will become embedded in the ring and liner surface, resulting in increased wear over a prolonged time period. The most dangerous cat fines

are of the size 10 to 20 microns. They tend to be attracted to water droplets and are very difficult to remove from the fuel oil, even more so when used lube oil is present. Practical experience has shown that with proper treatment in the fuel oil separator an aluminium and silicon content of 80 mg/kg, determined using a suitable analysis method (ISO 10478), can be reduced to 15 mg/kg, which is considered as just tolerable. Proper treatment means reduced throughput in the separator and a fuel temperature of as close as possible to 98°C.

The problems which arise due to cat fines in low speed diesel engines are often unexpected. Cat fines are not always evenly distributed in the fuel and are sometimes present even when they do not appear in the analysis results. They can accumulate in the sediment of the fuel tank from previous bunkers and be mixed into the fuel when the sediment is churned up in bad weather. All fuels should be assumed to contain cat fines, even if this is not apparent from the fuel oil analysis.

6. Water

The water content of the fuel oil must be reduced by centrifuging and by the use of proper draining arrangements on the settling and service tanks. A thorough removal of water is strongly recommended, to reduce the content of cat fines and sodium in the fuel oil. Cat fines potentially reside in the water droplets and marine fuel oil is often contaminated with sea water containing sodium, 1.0% sea water in the fuel oil corresponds to 100ppm sodium. To achieve a good separation, the throughput and the temperature of the fuel must be adjusted in relation to the viscosity. With high viscosity fuels, the separating temperature must be increased whereas the throughput must be decreased in relation to the nominal capacity of the separator. For recommended operating data, refer also to the separator instruction manual.

7. Flash point

This is a legal requirement with regard to the fire hazards of petroleum based fuels.

8. Pour point

The lowest operating temperature of the fuel should be kept about 5-10°C above the pour point to secure easy pumping.

9. Ignition quality

Contaminants, unstable fuels and incorrect injection (temperature and timing) are the main reasons for incomplete or improper combustion. Some fuels cause more combustion problems by nature. These can possibly be detected by looking at the unnatural ratio between viscosity and density (CCAI), and with combustion analyzing equipment like FIA tests. Older medium speed engines are most prone to problems with improper combustion.