Chapter Four

Marine Fuel Quality Specifications and Quality Requirements

FAQS

Q1. Is 180 cSt fuel 'better' than 380 cSt?

A1. No. The lower viscosity grade is only more expensive because it has a little more low viscosity blend component than the higher viscosity grade. The energy content of the lower viscosity grade should be higher but there is a risk of higher aluminium and silicon, poorer ignition quality and instability. Use the highest viscosity grade that can be heated in storage and injection.

Q2. Why does ISO 8217 give viscosity at 100°C when bunkers are traded based upon viscosity at 50°C?

A2. The standards committee were more concerned with technical issues than commercial and thus considered it more important for users to know the viscosity of the fuel as near as possible to that needed for injection into the engine. As discussed below, the relationship between viscosity and temperature is not linear and the theoretical viscosity at 100°C, based upon calculation from the known viscosity at 50°C, could be inaccurate. However the committee working on the next revision of ISO 8217 has concluded that users would prefer to have the standard viscosity in line with commercial practice and therefore will publish the next revision based on viscosity at 50°C.

Q3. If I order fuel to comply with the current International Standard will this cover all the possible quality characteristics.

A3. No. Although the International Standard includes the main quality parameters it will never cover all the strange contaminants that may find their way into marine fuels. At the end of the day, the Standard provides a good benchmark but a fuel can be unfit for use and still meet the basic quality limits within the tables of the Standard. See later in this book the points on unusual contaminants such as lubricating oils, acids, fats etc.

Q4. Why are ships allowed to use high sulphur fuels whereas land-based industry and motor cars have to comply with very strict emission legislation?

A4. The main environmental impact of burning high sulphur fuel is the production of acid rain. When ships are far out at sea the sulphur emissions fall

into the sea and hence do not contribute to this problem. However when ships are near to land, in busy shipping lanes and in port, they become large contributors to the acid rain problem. Because, of this international and regional legislation will be introduced over the coming years, restricting the use of high sulphur fuels by ships when they are in port or near to land. These issues are discussed in more detail in this chapter.

In earlier chapters the production and characteristics of marine fuels have been discussed and in this section the development fuel specifications and standards will be examined, ending with the current international reference points for fuel purchasers.

Environmental legislation is moving at a fast pace and this will have a major impact on the oil supply and shipping industries over the next few years. The last section of this chapter looks at the current situation. In addition to technical specifications, buyers, users and sellers will need to ensure fuels conform to new legislation, particularly regarding sulphur content.

Fuel Specifications. Development History 1957-2002

It has been suggested earlier in this text that, prior to around 1970, marine fuel quality was fairly predictable and did not seem to be a major cause for concern. Firstly then, let us consider the 'quality demand' at that time.

Residual fuels were being purchased for both boiler and slow speed diesel engine consumption, not only at sea but also on land, in power and cogeneration plants, where it was a viable alternative to solid fuels or gas. Residual fuels at that time were given many titles or 'short' names such as 'Burner Fuel', 'Heavy Oil', 'Boiler Oil', 'Bunker C' and 'Class G'. Marine fuel purchasers probably became more familiar with the term 'Bunker C' which can be related to 'Class G' fuel listed in the British Standard BS 2869 : 1970 (table 4.1). This British

Table 4.1. Extracts from BS 2869: 1970 (including 1972 & 1974 amendments

	Residual Burner fuel grades			
	E	F	G	H
Property				
Viscosity Redwood 1 at 37.8˚C (100˚F). Max	280	1000	4000	7500
Kinematic Viscosity at 82.2˚C (cSt) Max	12.5	30	70	115
Water content % vol. Max	0.05	0.75	1	1
Sediment % mass. Max	0.15	0.25	0.25	0.25
Ash % mass Max	0.1	0.15	0.2	0.2
Sulphur % mass. Max	3.5	4	4.5	5
Flash Point ˚C.Min	66	66	66	66

Standard was given a great deal of attention in the first half of the 1970s with revisions to the original 1957 standard being published in 1970, 1972 and 1974.

The last revision, in 1974, introduced a split between fuels for burners and engines. However, the engine class fuels were basically gasoils or diesel fuels and little attention was given to the growing need for grading of residual fuels which were being used in large diesel engines. To address this need, a working group of the British Standards was set up and after lengthy consultation with interested parties, produced a draft specification for marine fuels. Whilst this work was in progress the International Standards Organization (ISO) was kept informed of progress, as was the International Council on Combustion Engines (CIMAC). It was clear to all these parties that any developments in marine matters would have an impact on the international marine industry and therefore an international marine fuel specification was needed. The draft British Standard was therefore given to a new working group within ISO (ISO/TC 28/SC 4/WG 6), which was to further develop the draft to an International Standard.

The development of any international agreement is of course a complex and slow process and the ISO working group recognised that it would be some years before the ISO Standard would be published. Probably realising that the ISO publication would be some time in the making, the British Standards committee released it's draft fuel specification early in 1981. Subsequently, the official British Standard BSMA 100 : 1982 was published and became the first standard to address marine fuel requirements (see table 4.2).

During the 1980s, BSMA 100 : 1982 became the reference point for both marine fuel purchasers and sellers. In addition, clauses in many charter parties referring to fuel quality were updated to include reference to the British Standard.

At this time the technical departments of shipping companies became more aware of fuel-related engine problems and began to influence the fuel purchasers on their selection of fuels. Slowly, the marine industry began to understand that the practice of ordering fuel by viscosity alone was insufficient if disputes and claims resulting from use of poor quality fuels were to be reduced.

In the late 1970s and early 1980s whilst the British Standards and ISO working group were developing their fuel standards, CIMAC was also active. CIMAC retained a permanent committee, which as early as 1978 set targets to produce heavy fuel specifications for marine and land-based engines using such fuels. The CIMAC recommendations regarding requirements for residual fuels for diesel engines were published and introduced in their final version in 1986, although they had been released earlier in technical papers. The CIMAC recommendations only covered residual fuels and it is important to note that they

Table 4.2 BSMA 100: 1982

Property	Class M1	Class M2	Class M3	Class M4	Class M5	Class M6	Class M7	Class M8	Class M9	Class M10	Class M11	Class M12
Density at 15°C, g/ml, max.	—	0.9000	0.9200	0.9910	0.9910	0.9910	0.9910	0.9910	0.9910	—	—	—
Viscosity, kinematic, at 40°C, cSt*.												
min.	1.50	—	—	—	—	—	—	—	—	—	—	—
max.	5.50	11.00	14.00	—	—	—	—	—	—	—	—	—
Viscosity, kinematic, at 80°C, cSt*, max.	—	—	—	15.00	25.00	45.00	75.00	100.0	130.0	75.0	100.0	130.0
Cetane index, min.	45	35	—	—	—	—	—	—	—	—	—	—
Carbon residue, Ramsbottom, % (m/m), max.	—	0.25	2.5	—	—	—	—	—	—	—	—	—
Carbon residue, Ramsbottom on 10% residue, % (m/m), max.	0.20	—	—	—	—	—	—	—	—	—	—	—
Carbon residue, Conradson, % (m/m), max.	—	—	—	12.0	14.0	20.0	22.0	22.0	22.0	—	—	—
Flash point, closed. Pensky-Martens, °C, min.	43.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Water content, % (V/V), max.	0.05	0.25	0.30	0.50	0.80	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Sediment by extraction, % (m/m), max.	0.01	0.02	—	—	—	—	—	—	—	—	—	—
Ash, % (m/m), max.	0.01	0.01	0.05	0.10	0.10	0.15	0.20	0.20	0.20	0.20	0.20	0.20
Sulphur content, % (m/m), max.	1.00	2.00	2.00	3.50	4.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Cloud point, °C, max.	−16	—	—	—	—	—	—	—	—	—	—	—
Pour point, upper†, °C, max.												
(1 December to 31 March)	—	0	0	24	30	30	30	30	30	30	30	30
(April to 30 November)	—	6	6	24	30	30	30	30	30	30	30	30
Vanadium content, mg/kg, as V, max.	—	—	10	250	350	500	600	600	600	600	600	600

* 1 cSt = 1 mm^2/s.
† The word "upper" does not apply to classes M2 and M3.
Courtesy of British Standards Institution

Designation:			CIMAC A 10	CIMAC B 10	CIMAC C 10	CIMAC D 15	CIMAC E 25	CIMAC F 25	CIMAC G 35	CIMAC H 35	CIMAC K 35	CIMAC H 45	CIMAC K 45	CIMAC H 55	CIMAC K 55
Draft ISO-F- Related to **BS MA 100 1982 CIMAC 1982**			RMA 10	RMB 10	RMC 10	RMD 15	RME 25	RMF 25	RMG 35	RMH 35	RMK 35	RMH 45	RMK 45	RMH 55	—
			M 4 3)		—	M 5	—	M 6	—	M 7	—	M 8	—	M 9	—
Characteristic	Dim.	Limit	4	3	2	5	6	7	—	8	9	10	11	12	—
Density at 15 °C	kg/m³	max	975	991		991	991		991		1010	991	1010	991	1010
Kinematic viscosity at 100 °C	cSt 1)	max	10			15	25		35			45		55	
Flash point	°C	min	60			60	60		60			60		60	
Pour point 2)	°C	max	0 6	24		30	30		30			30		30	
Carbon Residue (Conradson)	% (m/m)	max	10		14	14	15	20	18	22		22		22	
Ash	% (m/m)	max	0.10			0.10	0.10	0.15	0.15	0.20		0.20		0.20	
Water	% (V/V)	max	0.50			0.80	1.0		1.0			1.0		1.0	
Sulphur	% (m/m)	max	3.5			4.0	5.0		5.0			5.0		5.0	
Vanadium	mg/kg	max	150		300	350	200	500	300	600		600		600	
Aluminium	mg/kg	max	30			30	30		30			30		30	
Total sediment after ageing		max	4)			4)	4)		4)			4)		4)	

1) Approximate equivalent viscosities (for information only):

Kinematic viscosity (cSt) at	100°C	10	15	25	35	45	55
Kinematic viscosity (cSt) at	80°C	15	25	45	75	100	130
Kinematic viscosity (cSt) at	50°C	40	80	180	380	500	700
Kinematic viscosity (cSt) at	40°C	14					
Sec. Redwood I at	100°F	80	300	600	1500	3500	5000	7000

2) Where relevant: upper value winter quality
bottom value summer quality

3) Carbon Residue 12 for BS grade M4

4) No standard test method agreed. Fuel shall not cause excessive sludge during normal fuel treatmant, see 7.3 for in-house test methods.

Table 4.3 CIMAC 1986

were based on 'fuels as delivered'. In other words, it was assumed such fuels would be adequately treated before use (see table 4.3).

The main difference between the ISO/BS approach and the CIMAC perspective was that ISO/BS were not only concerned with setting quality standards for different grades of fuel but also they had to ensure that such fuels standards were practical and that suggested grades would be largely available to purchasers in most ports. CIMAC, predominantly representing engine manufacturers and users, concentrated on producing a series of fuel grades which would be suitable for both older and new engines. It took into consideration that older vessels may not be equipped with fuel treatment plant which could adequately deal with some of the lower grade fuels.

The ISO working group completed all its draft document stages and the first International Standard for marine fuels was published in 1987: International Standard ISO 8217 Petroleum Products - Fuels (class F) - Specifications of marine fuels. The tables from this standard are shown in tables 4.4 (a) and 4.4 (b).

At this particular time, a fuel purchaser wishing to refer to a fuel specification or standard may have been rather confused as there were three reference points, BSMA 100 : 1982, ISO 8217 and CIMAC. In addition, ISO standard 8216/1, a classification for marine fuels, was also available. This classification described the fuel types and prescribed the symbols by which the different categories were designated in the ISO 8217.

In 1989, The British Standards Institution withdrew BSMA 100 : 1982 and replaced it with BSMA 100 : 1989 which was identical to the ISO 8217 specifications, thus the situation was eased regarding choice of specifications. In 1990, CIMAC published a third edition of its recommendations regarding fuel requirements for diesel engines. These recommendations are reproduced in tables 4.5 (a) and 4.5 (b).

Therefore, in 1990, there were two main reference points for marine fuel quality: ISO 8217 : 1987 and CIMAC recommendations dated 1990. These two main reference points are considered below and the differences remarked upon. To make this exercise a little easier for the reader, table 4.6 may be referred to. In this figure, the CIMAC 1990 and ISO 8127 residual fuel grades have been set out together with relevant fuel characteristics and specification limits for each grade.

Firstly it can be seen that there were fifteen ISO grades and thirteen CIMAC grades. Looking at the density limits, CIMAC stipulated a maximum density for its grades K35, K45 and K55 of 1.010 kg/m^3. This was included to allow for vessels fitted with 'high density' centrifuges to select a heavier fuel.