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GUIDELINE FOR SHIP OWNERS AND OPERATORS ON MANAGING DISTILLATE FUELS UP TO 7.0 % v/v FAME (BIODIESEL)

The International Council
on Combustion Engines

Conseil International
des Machines a Combustion

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CIMAC Working Group 7 –Fuels (WG7) Guidline for Ship owners and Operators on Managing Marine Distillate Fuels Containing up to 7.0 % v/v FAME (Biodiesel)

1 Background to this document

As a result of regulatory requirements to reduce emissions, use of biodiesel (FAME- Fatty Acid Methyl Esters being the most predominant) for road transport is increasing rapidly. Government mandates or incentives are now in place in various parts of the world and serve to encourage inclusion of biodiesel into the conventional diesel fuel pool. Biodiesel meeting the pertinent national standards for pure or neat biodiesel referred to as B100 has been incorporated as a fungible, un-labelled component in both the ASTM specifications for conventional diesel fuel (ASTM D975 up to 5% by volume biodiesel) as well as the European specifications (EN590 up to 7.0% by volume (7.0% v/v) biodiesel). Conventional diesel fuel can sometimes be the source of marine distillate fuels i.e. marine diesel oil (MDO) or marine gas oil (MGO) under ISO specification 8217. As such, use of these diesel fuels may result in marine diesel fuels on-board ship containing biodiesel up to 7.0% v/v.

Due to limited experience with biodiesel blends in the marine sector, in 2010 the ISO marine fuel specification was modified to require marine fuels to contain no more than de minimis (i.e. less than approximately 0.1% v/v) levels of biodiesel. Additional information, both from historical use of biodiesel blends in conventional diesel fuel as well as some on-board ship testing, has become available to the marine community over recent years. ISO TC28/SC4/WG6 are therefore now considering to develop an option in ISO 8217 for marine fuel containing biodiesel.

2 Purpose

In the current absence of an officially accepted specification for marine fuel containing more than 0.1% v/v biodiesel, this CIMAC publication provides background information and guidance to petroleum fuel distributers, ship operators and on-board personnel on the best approach to handling and precautions that need to be taken in the use of marine diesel fuels that may end up containing up to 7.0% v/v biodiesel if and when received. This guide is based on the assumption that the distillate fuels are being stored in the ship's designated distillate storage tanks, often termed as the MDO and or MGO tanks. The pressure on ships to carry more distillates to remain compliant to tighter environmental legislation, may result in ships switching their currently assigned low sulphur fuel oil tanks to storing distillate fuels, which may not be so suited to the more stringent housekeeping procedures addressed in this document. As more relevant information becomes available, this guide will be updated accordingly.

3 Definitions and Specifications for Pure Biodiesel and Biodiesel Blends in Diesel Fuels

3.1 Biodiesel

For purposes of this document, biodiesel is defined as the methyl esters of long chain fatty acids from renewable fats and oils such as soybean oil, rapeseed oil, used frying oils, or animal fats meeting pertinent national or international specifications for a B100. Examples of specifications for B100 include ASTM D6751 (United States and other countries), EN14214 (Europe), and ANP ACT nº 14/2012 (Brazil), among others. Some - though not all - of these specifications also permit ethyl esters (FAEE), although FAEE is <u>not</u> widely used today nor is it expected to be in the near future. Raw

vegetable oils or animal fats which have not been reacted to the methyl esters are not biodiesel and these have caused a variety of issues in the past, and are not covered by this CIMAC guide.

3.2 Biodiesel Blends

Biodiesel blends are defined as a blend of biodiesel (B100) and conventional diesel such that the final blended fuel would meet all other technical requirements of the conventional diesel grades. The biodiesel (B100) used for blending must meet a pertinent national or international specification prior to blending. The volume fraction of biodiesel contained in the blend is designated by a capital 'B' and a number indicating the biodiesel level (e.g., B7 is a finished diesel containing 7.0% v/v biodiesel with the remainder being conventional diesel). Biodiesel blends of differing concentrations can also be produced through the mixing of biodiesel blends with conventional diesel or marine distillates, or with other biodiesel blends.

4 Status regarding marine distillate fuels and Biodiesel

In the case of marine distillate fuels specified in ISO 8217 there is currently no grade that permits the presence of biodiesel. As it may not be possible to guarantee a totally biodiesel free fuel, the current ISO 8217 standard sets the maximum de-minimis level at less than approximately 0.1% v/v.

The expected increase in demand for marine fuel with sulfur content <0.10% m/m as a result of marine exhaust regulatory controls, may in part be met by fuel suppliers drawing from the road transport diesel fuel pool which could contain un-labelled biodiesel blends of up to B5 and B7 in the USA and the EU respectively, as well as in other countries. In some countries, B5 or B7 may be mandated, incentivised, or otherwise encouraged. It is for this reason marine operators need to be aware that whilst they may order a marine distillate fuel grade they may, in some bunkering locations, only be offered a distillate containing biodiesel.

5 Recommendations to be considered when using marine distillate fuels containing Biodiesel up to B7

The following general guidelines are recommended when it is known or suspected that the marine distillate fuel supplied contains biodiesel. Operators should ask their fuel suppliers to inform them if they know or suspect biodiesel is present and to what level when supplying the fuel.

5.1 If purchasing marine distillate fuel with up to a B7 blend:

The fuel should contain no more than 7,0% v/v biodiesel (B7). The biodiesel content can be relatively easily measured using ASTM test method D7371 or EN test method EN14078 (for clear and bright distillates). The fuel supplier should specify that the blend contains no more than B7. The fuel should meet the same ISO 8217:2012 technical specifications and requirements of marine distillate fuels containing no biodiesel.

It is advised marine distillate fuels containing over 2.0% v/v biodiesel should be tested for stability using EN15751 induction period in addition to the stability method currently in ISO 8217 (ISO 12205) for marine distillate fuels containing no biodiesel (Note EN 15751 is not suitable for testing stability of B2 or below).

5.2 Storage and handling of marine distillate fuels containing up to B7

In general B7 or lower blends are expected to be able to be stored and handled in the same storage and machinery as that used for conventional ISO 8217 marine diesel fuel.

Marine distillate fuels containing biodiesel blends should, as a minimum, be treated with the same attention as that of conventional marine diesel in all aspects of storage and handling, since these blends are still predominantly marine distillate fuels. It is recommended however, in view of the potential oxidation of biodiesel, its biodegradable nature, and the potential for cleaning old deposits, additional precautions should be observed as follows:

5.2.1 **Check with the engine and other equipment manufacturers** to confirm the compatibility of biodiesel blends, up to B7, with their auxiliary and main machinery plants. This should include manufacturers of the oily water separator plant; overboard discharge monitors, filters and coalescers.

5.2.2 **Avoid storage periods over six months.** Most specifications containing biodiesel are formulated on the expectation that the biodiesel blends will be consumed in a short term, recommendations being within approximately four to six months. Longer term storage, of up to and over one year, has been achieved in some instances through careful selection and monitoring of the fuel and use of stability additives, as well as through careful attention to storage conditions. It is, however, very important to integrate into the fuel management programme a plan to ensure the distillate fuel is consumed and renewed regularly to limit the presence of aged fuel.

5.2.3 **A fuel condition monitoring programme** should be put in place if the fuel is intended for long term storage of 6-12 months or more to insure the fuel has not degraded to the point it will be problematic. This will involve drawing samples periodically (recommended every 3 months) and having an onshore laboratory check the acid number and oxidation stability of the fuel. It is possible in some instances to increase the stability value of a biodiesel blend that has lost some of its oxidation stability by re-additising the fuel or blending with a fuel that has additional stability additive; however each case would have to be evaluated separately. Contact your fuel supplier or a reputable additive company for further information. Degraded fuel may contain insoluble material or other degradation products that can clog filters, increase maintenance, and lead to operational problems.

5.2.4 **All marine distillate oil tanks** should have an effective drainage arrangement and as best as possible be kept clean, remote from heat sources and other sources that will encourage water accumulation. Regular draining of the fuel tanks (at least twice daily as recommended for conventional marine distillate fuels) through designed drain cocks should be rigidly followed to limit the degree of water and sludge build up. This will reduce the risk of the fuel creating an environment for microbial activity.

5.2.5 **Monitor the fuel storage tanks** for water content and microbial contamination. This is also recommended for conventional marine distillate fuels. The low blends (B7 and lower) of biodiesel show similar water holding capabilities as traditional fuel, but monitoring of water bottoms and microbial contamination may be even more important with biodiesel blends due to the biodegradable nature of the B100 component.

5.2.6 **Modern high pressure common rail** (HPCR) fuel injection systems may exacerbate the issue of water in the fuel due to heating and cooling effects on the fuel releasing the water from the recycled fuel. Engine manufacturer's guidelines on using biodiesel should be specifically adhered.

5.2.7 **Monitor fuel filter condition** for any increased rate of clogging by checking for increased back pressure or any increase in the automated back-flushing cycles. Due to its greater solvency, biodiesel can dislodge fuel debris and other contaminants that have accumulated over time, in the storage tanks and through to the engine's fuel injection system. Despite the effects of these contaminants being less evident at blends below B7, solvency effects within the fuel system can still happen. It is therefore good practice to be aware of the nature of biodiesel in having a cleaning effect on the fuel system, at least in the initial stages of a system first taking in biodiesel and this may become apparent through a rise in filter clogging or sludge deposition at the separators.

5.2.8 **B100 biodiesel** generally has a higher wax forming temperature than conventional diesel. In blends of B7 or less this should not be a problem as the cold weather parameters of the diesel fuel controlled in the specification should dominate, but it is a good idea to take appropriate measures if B100 and/or biodiesel blends are exposed to outside conditions before entering storage on the ship. Measures that could be considered include; keeping the fuel temperature at least 10 deg C above the pour point and locating the fuel in storage tanks away from potential cold ambient temperature interfaces. For ships intending to operate in cold zones, then ship specific cold flow requirements should be included in the bunker purchasing contract.

5.2.9 **Isolated individual unit fuel tanks**, such as those for lifeboats and emergency generators require particular attention. If possible avoid using marine diesel fuel containing biodiesel blends in these tanks. Keep the tanks topped up to the maximum to reduce rates of oxidation and condensation. Often these tanks are in a more exposed aggressive environment and are not so often refilled, so the fuel may be stored for longer periods. As a matter of good practice periodic checks (4 times annually) should be carried out on the fuel condition in these fuel tanks to ensure there is no general degradation of the fuel and on a more regular basis (every 1 to 2 weeks) that there is no water collection, which might accelerate degradation.

5.2.10 **Some ships, particularly in the US military**, ballast their fuel tanks with salt water as the marine diesel fuel is used. Additional testing may be needed to ensure water separation equipment for salt-water ballasted fuel storage on-board ship is not affected by biodiesel blends. Limited testing has indicated biodiesel may adversely affect this equipment, even in B7 or lower blends. Most of today's systems have eliminated water ballasting, but for military ships this may still be a concern.

6 Biodiesel Blends in Marine Residual Fuel Oils

- There is very little recorded experience of biodiesel blends in a residual fuel oil. It is unlikely for economic reasons that biodiesel would purposely be blended into a residual fuel. However, in certain situations fuel supply logistics may favour a fuel supplier using a marine distillate fuel containing biodiesel as a cutter stock to blend lower viscosity grades of marine residual fuel. The other possibility is a marine distillate fuel containing a biodiesel blend on board ship may mix with residual fuel on change over.

- There is some uncertainty regarding how well a biodiesel blend will mix or remain homogenous with residual fuel oils, although the viscosity specifications for B7 blends and lower are the same as conventional diesel. There is also uncertainty regarding the cleaning effect of B7 or lower blends with residual fuels, and whether the impacts will be greater than with marine distillate fuels, particularly with regard to the filter blocking tendency of the resulting fuel blend.

- As a precaution when carrying out a change over from a HFO to a MGO containing biodiesel, particular attention should be given to the filter and possible rise in filter blocking frequency as well as fuel pump functionality.

- The impact of residual fuel containing biodiesel on the engine fuel system components, in particular the fuel pump plungers and fuel injectors which are operating at considerably higher temperatures than when using a marine diesel fuel is also uncertain. In view of this as a routine practice ensure residual fuels are ordered to the latest ISO 8217:2012 standard, which limits the levels of biodiesel blends to de-minimis levels (< 0.1% v/v). If you suspect that there are more than de-minimis levels of biodiesel present, then monitor performance of fuel pumps and injectors, for possible sticking, which may come about through lacquering on the fuel pump plungers and or injector nozzle needle valves.

- CIMAC WG7 will continue to work on collating feedback from the industry on this issue as it is made available and will provide timely updates. (Details of how to pass on your experiences are explained at the end of this document).

7 A snap shot on advanced distillate fuels and bio fuels: Synthetic Paraffinic Middle Distillate Fuels

The worldwide distillate fuel market is beginning to introduce paraffinic middle distillate fuels made from various processes including Fischer-Tropsch, Gas to Liquid, Hydro processed Esters of Fatty Acids (also called Hydro processed Renewable Diesel or Hyprocessed vegetable oil). The feedstocks for these processes can vary from coal to natural gas to plant and algae oils to biomass.Although the feedstocks and processes to make these fuels may be different, the final product is chemically very similar to petroleum distillate fuels. As a result, blends of petroleum fuel and synthetic paraffinic middle distillate fuels meet all specifications and are considered by some users to be "drop in" replacements. Synthetic paraffinic middle distillate fuel processes may use similar feed stocks to biodiesel, but do NOT produce a Fatty Acid Ester. Rather, the end product is hydro-carbon based and thus similar in chemical make-up to conventional diesel. Large scale commercialization of these processes has recently shown potential for expansion.

8 Feeding back your experiences on the use of marine biodiesel to CIMAC

CIMAC is interested in gathering additional information from field experience on the use of all levels of biodiesel blends in marine operations and invites users to contribute to the pool of knowledge by providing feedback on their experiences.

If you plan to use a biodiesel blend and or have some information regarding your experiences into the use of biodiesel and you would be willing to share this information for the benefit of the wider marine industry, then please do pass the information you have back to CIMAC WG7, through the following contact:

Mr. Timothy Wilson Convener of the CIMAC WG7 Sub Group 6 for Bio diesel.
Contact email: timothy.wilson@lr.org. M: ++44 (0) 7717344389 T:+44 (0) 2380 249641

Information received will be collated and may be used to update this guidance document as well as assisting in guiding the further development of the ISO specifications for biodiesel blends in marine fuel applications.