



YANMAR

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technical bulletin

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Recommendations for the Operation of Yanmar Engines with Biodiesel and Warranty Issues

Dear Equipment Manufacturer of Yanmar Engines:

This document outlines Yanmar's recommendations and warranty conditions in case certain engines manufactured by Yanmar (see below No. 2) are operated with biodiesel fuel. This document is an addendum to the Yanmar engine standard operation manual and the application manual. Certain warranty claims under Yanmar's material and workmanship warranty and/ or under its parts warranty are herewith excluded in case any damage or defect to the engines and/ or parts have occurred because Yanmar engines are not operated with the fuel as recommended hereunder, or not in the manner as recommended hereunder (see below No. 5).

This document is an addendum to your Yanmar engine standard operation manual and the application manual. The recommendations contained in this addendum are representing the latest research results with respect to operation of Yanmar engines with certain biodiesel fuels. We kindly ask all of our Equipment Manufacturers to carefully read this addendum, to follow its recommendations in order to assure the usual long-term satisfaction and reliability of Yanmar engines, and in order to make optimal use and to enjoy the advantages of Yanmar engines. In case you should approve your applications for operation with biodiesel fuel, we suggest taking the recommendations into account when preparing your own operation manuals for your customers. We further suggest keeping this document stored together with the Yanmar engine standard operation manual and the application manual.

1. General Description of Biodiesel

- a) Biodiesel is a renewable, oxygenated fuel made from agricultural and renewable resources such as soybeans or rapeseeds. Biodiesel is a fuel comprised of methyl or ethyl ester-based oxygenates of long chain fatty acids derived from the transesterification of vegetable oils, animal fats, and cooking oils. It contains no petroleum-based diesel fuel but can be blended at any level with petroleum-based diesel fuel. In case it is not blended with petroleum-based diesel fuel such biodiesel is referred to as "B 100", which means that it consists of 100% (pure) biodiesel. However, most common biodiesel is blended with

conventional (petroleum-based) diesel fuel. The percentage of the blend can be identified by its name. The most common blends are “B 5” (consisting of 5 % bio- diesel and 95 % conventional petroleum-based diesel fuel) and “B 20” (a blend of 20 % biodiesel and 80 % conventional diesel). Raw pressed vegetable oils are not considered to be biodiesel.

b) Advantages of Biodiesel:

- Biodiesel produces less visible smoke and a lower amount of particulate matter.
- Biodiesel is biodegradable and nontoxic.
- Biodiesel is safer than conventional diesel fuel because of its higher flash point.

Following the increased interest in the reduction of emissions and the reduction of the use of petroleum distillate based fuels; many governments and regulating bodies encourage the use of biodiesel.

c) Disadvantages of Biodiesel:

Concentrations that are higher than 5% of biodiesel (higher than B5) can have an adverse affect on the engine's performance, its integrity and/ or durability. The risk of problems occurring in the engine increases as the level of biodiesel blend increases. The following negative affects are exemplary and typical for the usage of high concentrated biodiesel blends:

- Biodiesel can accelerate the oxidation of Aluminum, Brass, Bronze, Copper and Zinc.
- Biodiesel damages, and finally seeps through certain seals, gaskets, hoses, glues and plastics.
- Certain natural rubbers, nitrile and butyl rubbers will become harder and more brittle as degradation proceeds when used with biodiesel.
- Biodiesel typically creates deposits in the engines.

- Due to its natural characteristic, biodiesel will decrease the engine output by approximately 2 percent (in case of B 20) comparing to conventional (petroleum-based) diesel fuel.
- The fuel consumption ratio will increase by approximately 3 percent (in case of B 20) comparing to conventional diesel fuel.

2. Approved Engines

All of the following engine series of Yanmar can be operated with biodiesel with concentrations up to B 20. In case of using biodiesel fuel up to B5 concentrations, no special preparations etc. have to be made and the original operating conditions and service intervals as stated in the operating manuals apply. In case of running below indicated engines with biodiesel concentrations above B 6 up to B 20, the required operating conditions (see below No. 4) have to be observed.

Other than the following listed engines cannot be run with biodiesel:

- 3TNM68, 3TNM72, 2TNV70, 3TNV70 and 3TNV76
Tier 2 and Tier 4
- 3TNV82A, 3TNV84, 3TNV84T, 3TNV88, 4TNV84, 4TNV84T, 4TNV88, 4TNV94L, 4TNV98 and 4TNV98T
Tier 2, Tier3 and/or interim Tier 4
- 4TNV106 and 4TNV106T
Tier 2
- 4TNE92, 4TNE94L and 4TNE98 for forklift application
Tier 2 and interim Tier 4

3. Approved Fuel

In case of using biodiesel (only concentrations up to B20) such fuel should comply with the below recommended standards. However, raw pressed vegetable oils are not considered to be biodiesel and are not acceptable for use as fuel in any concentration in Yanmar engines.

- a) EN14214 (European standard) and/or ASTM D-6751 (American standard).
- b) All applicable engines can be operated with biodiesel fuel up to B20 (20% bio-fuel blend) as a maximum concentration.
(For your information: In Japan, the legally allowed maximum concentration for on-road applications is B 5.)

4. Conditions for the Operation with Biodiesel (B 6 through B 20)

When operating your applicable Yanmar engine (No. 2) with biodiesel blends concentrated above B5, we seriously recommend observing the following operation, service and maintenance conditions:

- a) The original service interval of the below stated services as indicated in the respective Yanmar engine standard operation manual, the application manual and the service manual should be halved (please refer to your own manuals for the each service interval):
 - Replacement interval of engine oil filter, engine oil and the fuel filter.
 - Cleaning interval of the water separator
 - Drain interval of the fuel tank.
- b) It is required to inspect, clean and adjust the fuel injector every 1000 operating hours.
- c) Replacement of the following parts before using the recommended biodiesel:
 - (1) Fuel hose
 - (2) Fuel feed pump (Diaphragm type)
 - (3) If not already installed, a water separator needs to be built in
 - (4) O-ring of fuel filter
 - (5) O-ring of water separator

Please refer to the attached list of exchange parts for details.

- d) Please use only biodiesel fuel that is appropriate to the intended operation environment of the engines. This especially applies if the operating ambient temperature falls below 0 degree centigrade.
- e) Operation with biodiesel requires daily maintenance as follows:
 - (1) Please daily check the engine oil level. If the oil level rises above the oil level of the previous day, the engine oil needs to be immediately replaced.
 - (2) Please daily check the water level of the water separator. If the water level rises above the “max” indicator , an immediate drain of the water separator is required.

- f) Biodiesel blends up to B 20 can only be used for a limited time of up to 3 months of the date of biodiesel manufacture. Therefore biodiesel needs to be used at latest within 2 months from the time of filling the tank or within 3 months from the time of production by the fuel supplier, whichever comes first.

- g) Before a long-term storage without operating the engine, the biodiesel needs to be drained out completely and the engine has to be run for 5 hours with conventional diesel fuel as indicated in your operation manual.

5. Effects on Engine Warranty

Yanmar's engine warranty covers failures that are a result of defects in material or workmanship.

Damages, performance issues or service issues, determined by Yanmar to be caused by the use of biodiesel fuel not meeting the specifications as outlined here above (No. 3) are not considered to be defects in material or workmanship and are not covered under Yanmar's engine warranty. The same applies to damages or other issues that are caused by nonobservance of the recommended operating conditions of Yanmar engines with biodiesel here above (No. 4).

Yanmar would kindly ask its Equipment Manufacturers to understand that we are not in the position to guarantee for products from other companies that may have insufficient quality. Furthermore Yanmar cannot extend a warranty in cases where absolutely necessary service and maintenance procedures with respect to the operation with biodiesel (see above, No. 4) are not accomplished.

The above recommendations are based on the latest technical expertise in terms of biodiesel fuel. Yanmar fully supports the use of environmentally beneficial alternative fuels. Our approved industrial engines (see above No. 2) are compatible with B5 biodiesel to help encourage the greater use of renewable, domestically grown fuel.

Yanmar is continuing its evaluation of biodiesel concentrations that are higher than 5% for many more of our products. We are aware of the growing interest in higher concentrated biodiesel fuel blends and fully support this interest in renewable fuels.

Therefore we are permanently carrying out research in the field of new biodiesel developments and are further developing our engines in order to approve higher concentrated biodiesel use in our engines with full warranty in effect in the near future.

A handwritten signature in black ink, appearing to read 'T. Nishida', is written over a solid horizontal line.

T. Nishida
Manager of Quality Assurance Department
Power System Operations Division
Yanmar Co., Ltd.

Attachment: - List of exchange parts