TECHNICAL CIRCULAR

DOC No.: HHI-TEC-0442
Date : MAR 15, 2022

SUBJECT: CONSIDERATION FOR ALTERNATIVE FUELS

TYPE: ALL HYUNDAI-WINGD 2-STROKE ENGINES

DISTRIBUTION

☑ Ship yard	☑ Ship owner

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We have occationally received the questions about alternative fuels, especially drop-in fuels that can be used in the same pipe line as existing conventional fuel oil. In view of such interest in alternative fuels, we would like to inform you of the general considerations for WinGD engines to use biodiesel and biogas as a drop-in fuel.

WinGD mentioned in the attached document that WinGD engines can operate with alternative drop-in diesel/gas fuels, however there are many considerations and challengs that must be considered, also various properties of biofuels and etc and we do not consider the application of such altanative drop-in fuels during shop test in our factory at this moment in time.

The detailed information is explained in the attachment on the next page.

※ Attachment : Considerations on alternative drop-in fuels and their applicability on WinGD engines

Yours sincerely,

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Considerations on alternative drop-in fuels and their applicability on WinGD engines

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To Whom It May Concern,

Winterthur, 14. January 2022

In view of the increased interest in alternative drop-in fuels, WinGD has prepared general considerations for the use of these fuels on board vessels equipped with WinGD engines. Due to the variety in quality and origin of alternative fuels or biofuels throughout the world, many different products may be supplied under these terms. Therefore, a good understanding of the nature of the specific fuel available is essential to the proper preparation and handling of such fuel onboard a vessel.

Alternative drop-in gas fuels:

Any hydrocarbon mixture, which is similar to LNG in composition and fulfils WinGD specifications, is fit for use on WinGD dual-fuel (DF) engines. Examples of such fuels are liquified biogas (LBG) and liquified synthetic gas (designated as e-LNG or LSNG), which are obtained by biological or power-to-gas processes, respectively. Both LBG and e-LNG are typically very pure gases with partly even better properties than LNG, e.g. higher methane number. Those fuels can be sourced for the application on WinGD DF engines without any hesitation or need for specific adjustments or precaution.

Alternative drop-in diesel fuels:

Hydrocarbon fuels of non-petroleum origin can be used as a drop-in fuel in WinGD engines assuming they fulfil WinGD fuel specifications, fit into one of the grades of ISO 8217 and fulfil Marpol Annex VI – Regulation 18 requirement, which states that fuels must not:

- include any added substance or chemical waste, which either jeopardizes the safety of ships or adversely affects the performance of the machinery,
- be harmful to personnel
- or contribute overall to additional air pollution.

Examples of fuels which typically fulfil above mentioned requirements and can be used on WinGD engines are hydrotreated vegetable oil (HVO) or synthetic diesel obtained via Fischer-Tropsch synthesis.

FAME (fatty acid methyl esters):

ISO 8217 specifies a permissible content of FAME in certain marine distillate grades up to 7%. These grades are DFA/DFZ (MGO) and DFB (MDO). The use of FAME in residual marine fuels is restricted to *de minimis* (0.50 % m/m) in the current edition of ISO 8217:2017. FAME are usually produced via transesterification of fats with methanol. These components are mandatory in automotive and agricultural diesel in some countries. FAME specification can vary depending on the geographical location with the most widely accepted and used specification being the European EN 14214 and American ASTM D 6751 standards. WinGD engines can operate even on high FAME content in the fuel. However, certain considerations have to be taken into account before use of such fuels.

Regulatory considerations:

- ISO 8217 does not allow the use of non-hydrocarbon biofuels in residual fuels
- Marpol Annex VI (Regulation 18) allows the use of non-fossil fuels if such fuels do not "cause an engine to exceed NOx emissions limits". Note that this may be difficult to verify in view of the variations in biofuel properties and percentage of biofuel in the final blend.

FAME purity:

Please note that there is no standard for the purity of FAME for use in marine fuels. Often, the term FAME is used for biofuels, which do not fulfil the above mentioned EN or ASTM standards. Some not fully converted vegetable oils or fat fractions of unknown purity can potentially cause damages to onboard machinery. Therefore, it is crucial to understand the origin and purity of the FAME in biodiesel where added.

It is important to mention that once FAME is blended with residual fuel, it is difficult to verify its properties required to comply with the above mentioned EN or ASTM standards.

Basic steps are required to determine the operational feasibility of FAME biofuel blends. Before bunkering, please ask the fuel supplier for information about the biofuel fraction used for blending, with emphasis on the following:

- Standard of the FAME fraction used for blending
- FAME origin – if possible
- Quantity of: Free fatty acid (FFE), Fatty acid methyl esters, Mono- (MAG), di- (DAG) and triglycerides (TAG) or free Glycerine.

This information, in conjunction with one of the FAME standards, could be used for the verification of the purity of the FAME fraction in the biofuel blend, and therefore for the risk assessment for the use of such fuel.

FAME specifications:

FAME based biofuel or blends thereof with distillate or residual fuel must fulfil the following specifications:

- Fuel must fulfil the Table 2 specifications in ISO 8217:2017 as well as WinGD residual diesel fuel specifications.
- Acid number should not exceed 2.5 mg KOH/g. NOTE: the maximum acid number of FAME certified with EN 14214 is 0.50 mg KOH/g. If the blend exceeds this limit, it is recommended to perform additional analyses for the determination of free fatty acids or other corrosive compounds.
- No strong acids are allowed - Strong acid number 0.00 mg KOH/g
- The inorganic content of the fuel should be verified. FAME should not contain any elements normally not seen in marine fuels. Any unusual increase of inorganic constituents should be investigated.

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FAME containing fuels - possible challenges:

- Tendency towards oxidation which might decrease long-term storage capability
- Affinity to water, which might result in microbial growth and resultant fouling of the fuel and associated infrastructure or loss of combustion properties
- Poor low-temperature flow properties, which might cause filter clogging problems
- Tendency towards an increase of acid number if degradation occurs

Fuel supply system considerations

In case an operator wishes to use FAME containing fuels, he should ensure that the on-board storage, handling, treatment, service and machinery systems are compatible with the product. Before bunkering such fuels WinGD recommends:

- Contacting the supplier for guidance and experience obtained with the usage of such fuels,
- Verifying the suitability of the fuel supply system for usage with FAME containing fuels. Materials such as copper, lead, zinc, tin, bronze, brass might induce oxidation of FAME in storage and therefore make these fuels unusable.
- Biodiesel can have good solvency properties and it can remove deposits from the fuel supply system and bring it to the engine. Therefore, to avoid this, it is recommended to clean components of the fuel supply system, which might be in contact with biofuel before fuel changeover.
- Water contamination of the fuel shall be avoided as this might lead to corrosion or microbial growth.

Other alternative drop-in fuels:

There may be numerous industrial streams or experimental fuels, which might be proposed for use as marine fuel. In case of doubts or before conducting any tests of such fuels, please contact WinGD for assistance and opinion. Although some of the fuels might be suited in the future for continuous vessel operation, WinGD cannot take any liability whatsoever for fuels, which are not fulfilling ISO 8217, and/or fuels, which are not validated by WinGD.

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All information provided above shall serve for guidance only and must not be considered as binding WinGD specifications. The responsibility for using any fuels, which do not comply with WinGD's requirements and recommendations as set out in the WinGD Operation Manuals, Technical Bulletins and other guidelines issued by WinGD, remains with the ship operator and/or fuel supplier.