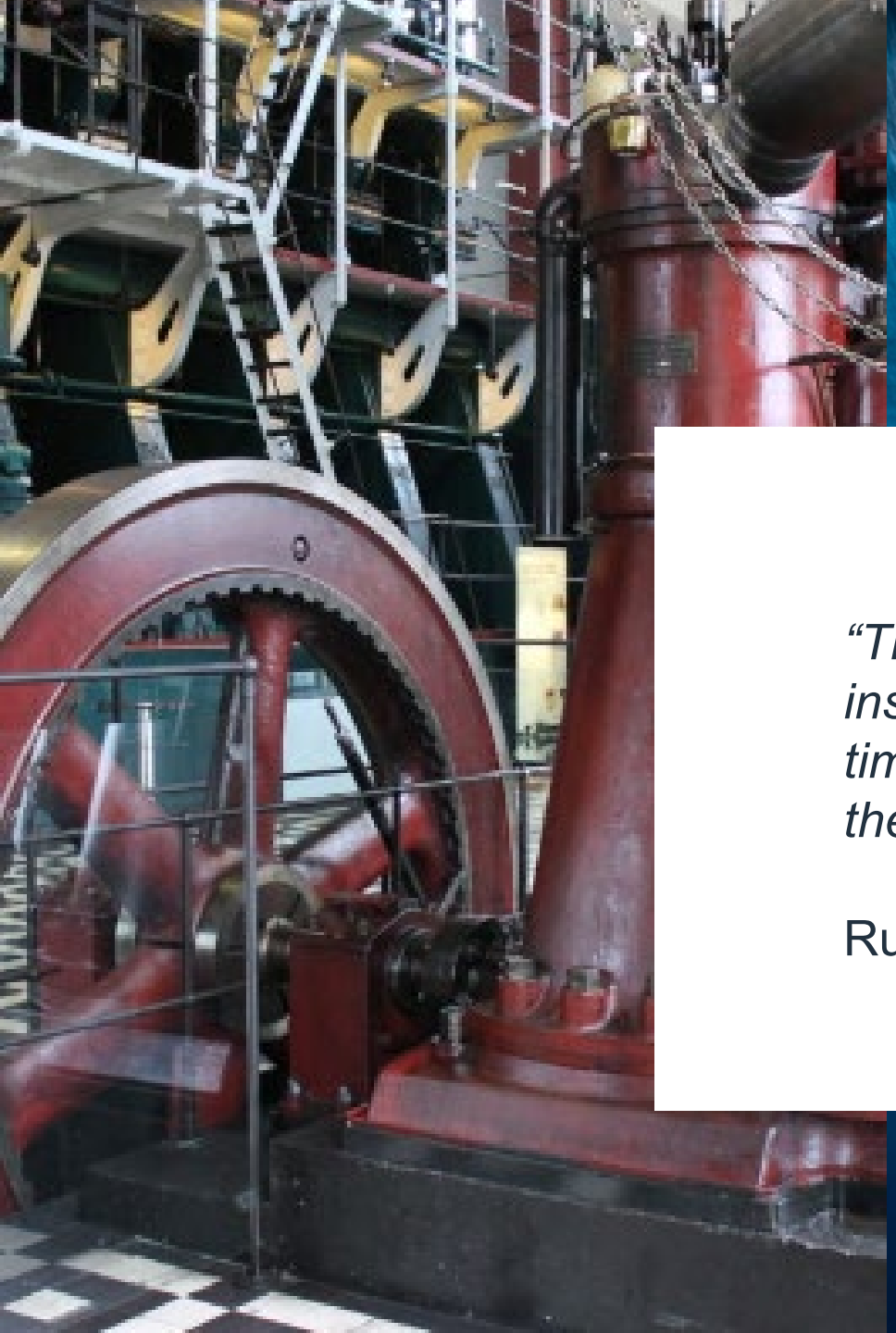
THE ROLE OF BIOFUELS IN THE NEW REGULATIONS LANDSCAPE

BILL STAMATOPOULOS - VERIFUEL

30/11/2022



“The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become, in course of time, as important as petroleum and the coal tar products of the present time.”

Rudolf Diesel, 1912

PILOT PROJECTS

- CMA CGM field testing in collaboration with Bureau Veritas (2019)
- Blend of FAME from used cooking oils and aromatic fuels:
  Perfectly stable over 3 months storage
- Commingling of this blend and DMA, Paraffinic ULSFO and Aromatic fuel:
  No problems reported
- Combustion & engine condition: **Business as usual**

Source: CIMAC Congress, Vancouver, 2019

B100 OFFERED TODAY IN ROTTERDAM

Characteristics	Unit	Method	Specification Min	Max	Typical value
Kinematic viscosity @ 40 ºC	mm2/s	ISO 3104	3.5	7.0	**5.0**
Density @ 15 ºC	kg/m3	ISO 12185	860	910	**880.0**
Sulphur	mg/kg	ISO 20884		1000	**15**
Flash Point	ºC	ISO 2719	60.0		**140.0**
Acid Number	mg KOH/g	ASTM D664		1.0	**0.5**
Water	% (v/v)	ISO 3733		0.50	**0.05**
FAME	% (m/m)	ISO 16931	90	100	**96.5**
Net Calorific Value	MJ/kg	DIN 51900-2	35		**37**
Cetane Number	-	ISO 4264	35		**55**
Oxidation Stability @ 110 ºC	hours	EN 14112	8		**>8**
Total Sediment	% (m/m)	ISO 10307		0.10	**<0.01**

Renewable fuel fraction: 100%
Fossil fuel fraction: 0%
Feedstock renewable fraction: 100% certified waste / residues

B50 ROTTERDAM

Stable

Parameter	Method	Unit	Result
Viscosity @ 50°C	ASTM D7042	cSt	10.47
Density @ 15°C	ASTM D7042	kg/m³	908.9
Sulphur	ISO 8754	% (m/m)	**0.22**
Flash Point	ISO 2719 B	°C	>67
Acid Number	ASTM D664	mg KOH/g	0.11
Total Sediment Acc.	ISO 10307-2	% (m/m)	0.01
TSP	ISO 10307-2	% (m/m)	<0.01
P-Value (SMS 1600)	SMS1600	-	1.3
Micro Carbon Residue	ISO 10370	% (m/m)	4.01
WAT	IP 389	°C	21.4
Pour Point	ISO 3016	°C	-3
Water Content	ASTM D6304	% (V/V)	0.09
Ash	INT 1002	% (m/m)	0.01
Vanadium	IP 501 (mod)	mg/kg	4
Sodium	IP 501 (mod)	mg/kg	5
Calcium	IP 501 (mod)	mg/kg	3
Zinc	IP 501 (mod)	mg/kg	1
Phosphorus	IP 501 (mod)	mg/kg	<1

Parameter	Method	Unit	Result
Aluminium + Silicon	IP 501 (mod)	mg/kg	5
Silicon	IP 501 (mod)	mg/kg	3
Aluminium	IP 501 (mod)	mg/kg	2
Iron	IP 501 (mod)	mg/kg	11
Nickel	IP 501 (mod)	mg/kg	6
Magnesium	IP 501 (mod)	mg/kg	<1
Potassium	IP 501 (mod)	mg/kg	1
CCAI	CCAI	-	825
Net Specific Energy	NSE Calculated	MJ/kg	42.19
Net Calorific Value	ASTM D240	MJ/kg	**39.467**
Carbon	**ASTM D5291**	**% (m/m)**	**84.2**
Hydrogen	**ASTM D5291**	**% (m/m)**	**11.4**
Nitrogen	**ASTM D5291**	**% (m/m)**	**0.31**
Oxygen (calculated)	**ASTM D5291**	**% (m/m)**	**3.87**

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MEPC 78, JUNE 2020

- A blend of not more than 30% by volume of biofuel meets the requirements of regulation 18.3.1 of MARPOL Annex VI. Verification of the NOx impacts is not required
- A blend of more than 30% by volume of biofuel should meet the requirements of regulation 18.3.2 of MARPOL Annex VI. If engine is certified to Reg 13 on a DM or RM grade fuel no need for NOx verification provided that NOx critical components/settings/operating values must be as in NOx TF (MEPC.1/Circ.795)
- Unified interpretation should not be applied to the engine family, without clear evidence that the different number of cylinders has no negative impact on the NOx emissions. (Rev 1 MEPC.1/Circ.895).

Well-to-Tank – sustainability ?

- Lack of globally accepted standard or certification to verify the green production from end to end
- Emissions reduction potential depends on feedstock, production method and supply chain
- Block chain technology to verify source / carbon and to ensure transparency in the entire value chain
- Ongoing international research
- ISCC

ISCC
International Sustainability & Carbon Certification

Ethics:
No competition with food & no effect on wild life. Fields, forests and crops, may be needed to meet other, more basic human needs.

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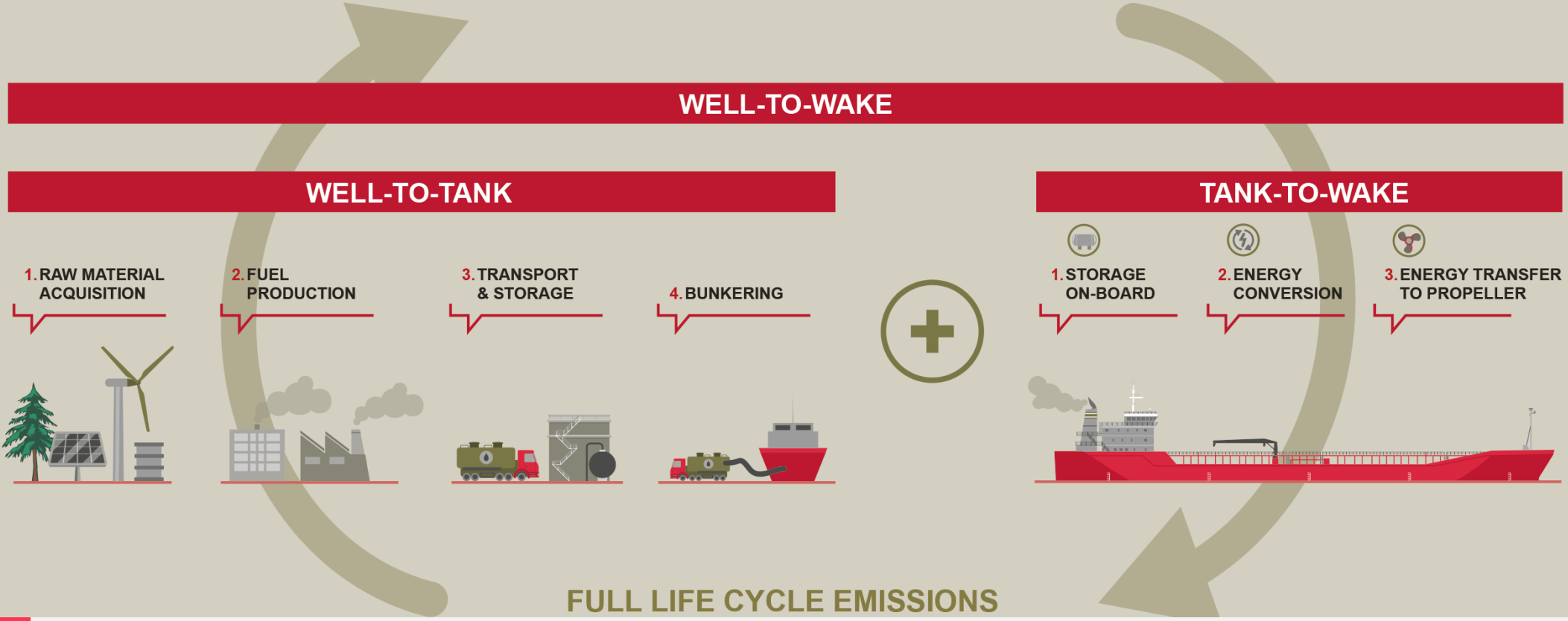
WELL-TO-WAKE EMISSIONS

"Well-to-wake" refers to the entire process from fuel production, and delivery to use onboard ships, and all emissions produced therein.



TtW emission factor for B25 biofuel blend
Interim report MEPC 79/7/12

UCOME B25 biofuel: 25% biodiesel blended with 75% HFO.

TtW emission factor as per interim report of MEPC 79/7/12 :

$$GHGTtW = SF * CF + GWPM * MEF + GWPN * NEF$$

SF carbon source factor of blended fuel.
B25 blend:
(75% HFO and 25% Biomass)
0.75 as SF of Biomass is 0

Carbon factor
$Cf_{CO_2} = 2,834$

Global Warming Potential for CH_4

Carbon factor
$Cf_{CH_4} = 0,00005$

Global Warming Potential for N_2O

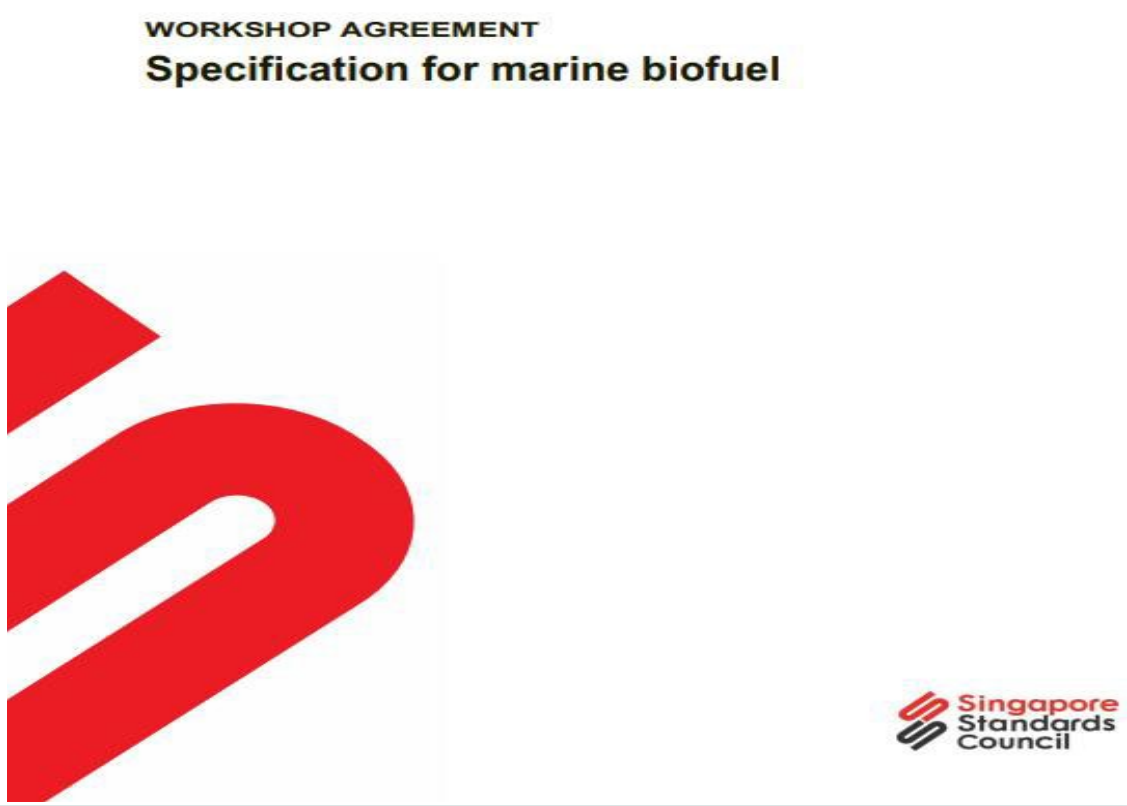
Carbon factor
$Cf_{N_2O} = 0,00018$

Result of above:

GHGTtW = 2,176 tCO2eq/t-fuel

BIOFUEL SPECS

New ISO 8217 including biofuels, is expected by early 2024



WHAT TO CHOOSE TODAY ?

BIOFUEL

Successful trials since 2019

No CAPEX required

Improved CO_2 emission factor

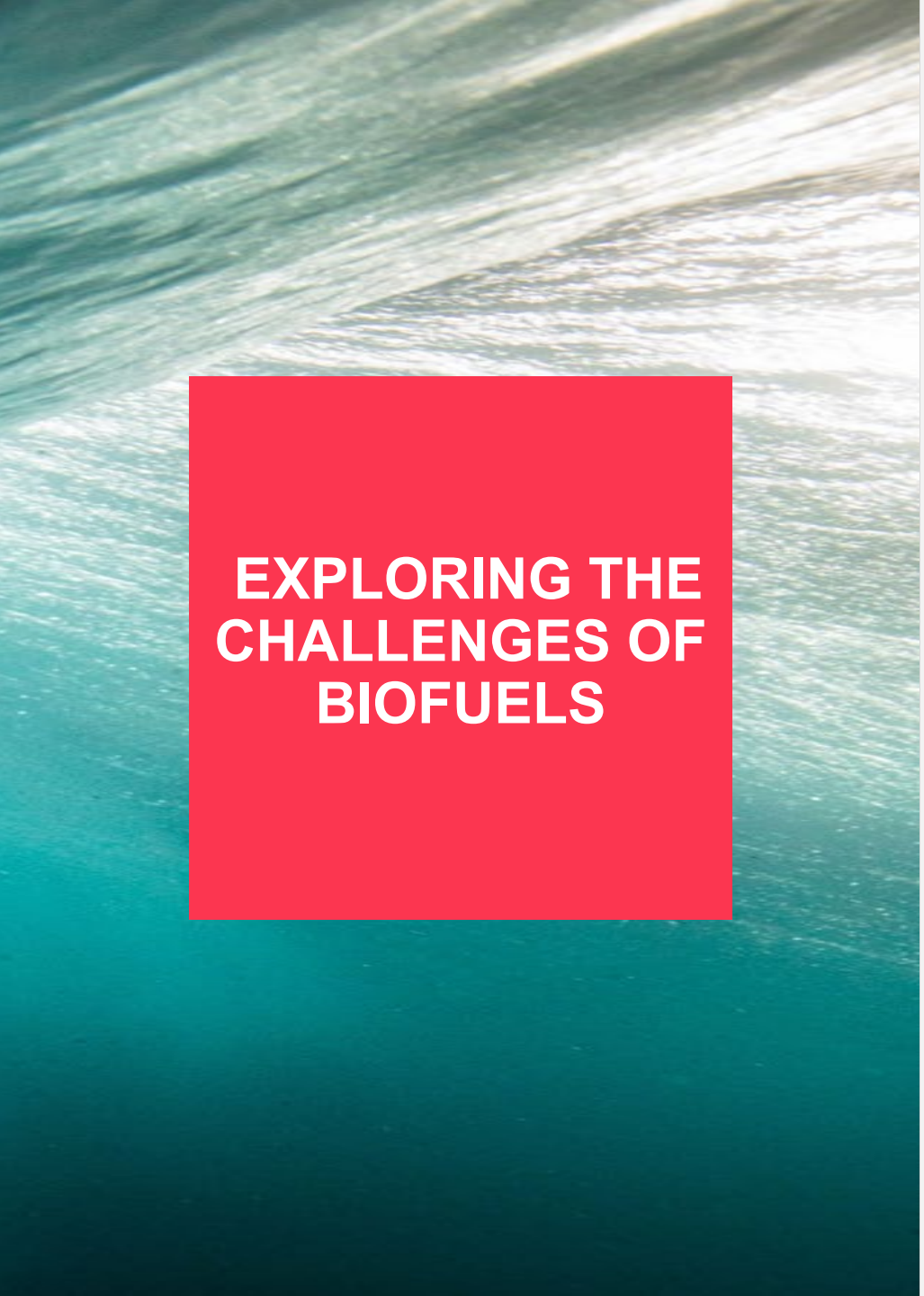
Mix with fossil fuels (“drop-in”)

Convenient alternative fuel source

Will benefit from low emissions supply chain

Limited safety risk vs zero carbon fuels

Can use existing bunkering infrastructure



EXPLORING THE CHALLENGES OF BIOFUELS

Cost
In Spore B10 to B24 at a 20-40% premium
In ARA at 20% premium

Insurance
Compliant with ISO 8217 or expensive extra insurances

Energy content
Lower calorific value

Microbial growth
Excessive formation of sludge, clogged filters and piping, frequent draining of tanks, application of biocide

Corrosion (B80 – B100)
Hoses/gaskets/rubber sealings: loss of integrity / interaction with copper, brass, zinc. Verify components are endurable

Availability

Crew
Training on handling, temperatures, housekeeping, management of change

Cold Flow Properties
Keep storage/transfer temperatures above the cloud point

Storage
Bioproducts may degrade over time due to oxidation (deposits in piping/engines). Shelf life and/or use of antioxidants

Lubricating oil

Compatibility of ODME and OWS/OCM
Equipment already type approved as per MEPC.107(49) - (15ppm bilge separators/alarm).

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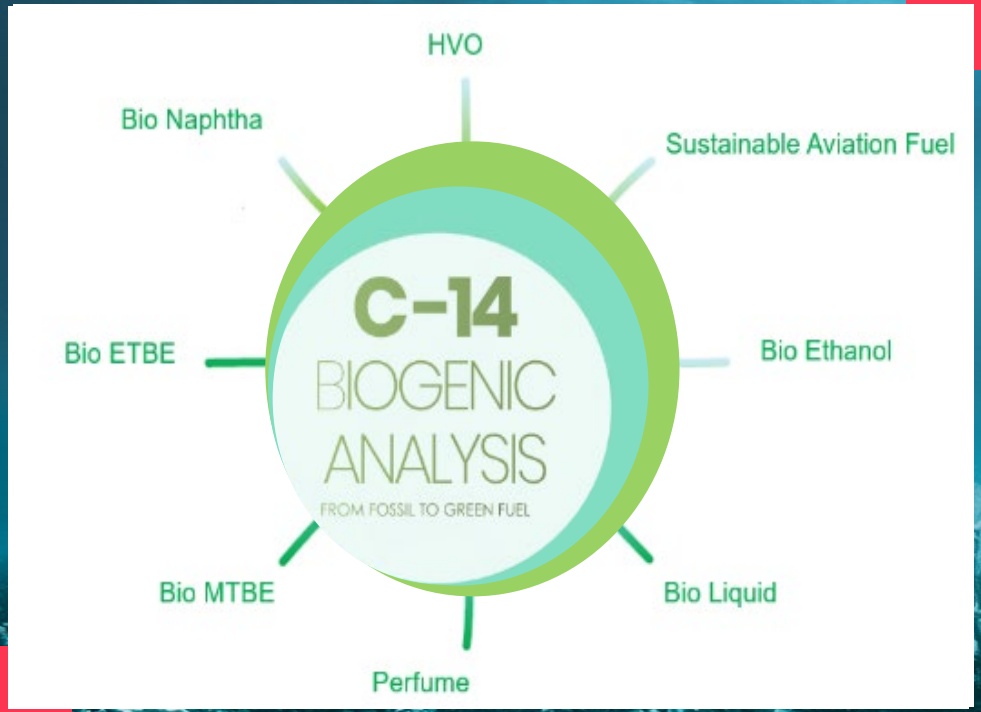
IS BIO-FUEL ONLY FOR MARITIME APPLICATIONS?



Demand for FAME is typically influenced by its use by the on-road transportation sector. The higher the national bio-based diesel mandate, the lesser capacity can be utilized by the marine sector.

Competition with aviation industry that committed to reducing carbon emissions by 50% from their 2005 level by 2050

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Hydro processed esters and fatty acids synthetic paraffinic kerosene (HEFA-SPK) fuel is anticipated to be the principal aviation biofuel used over the short to medium term

WHEN WILL BIOFUELS MOVE BEYOND THE TRIAL PHASE AND SCALE?

Suppliers need commitment of volume to secure feedstocks

Support from governments

Rdam: 329K Mts in H1:2022

Spore: 70K Mts till Sep 2022

Though it may never be the dominant fuel, biofuels are an indispensable stepping-stone on the path to decarbonization

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