LUBRICANT SOLUTIONS UNDER CHANGING SCENARIO

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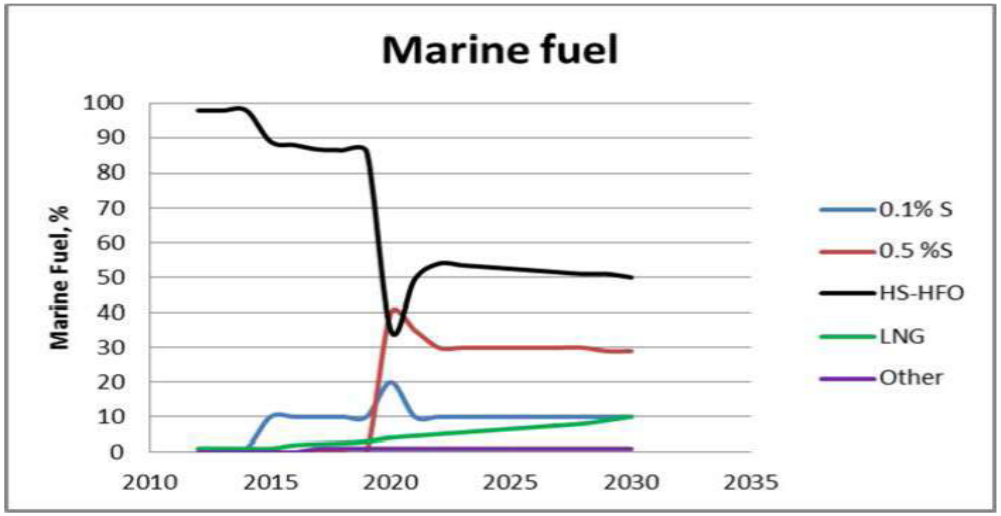
- Marine Lubricants – Market drivers
- Fuels & their impacts on Lubricants
- Present & future marine oils market – an overview
- Summary

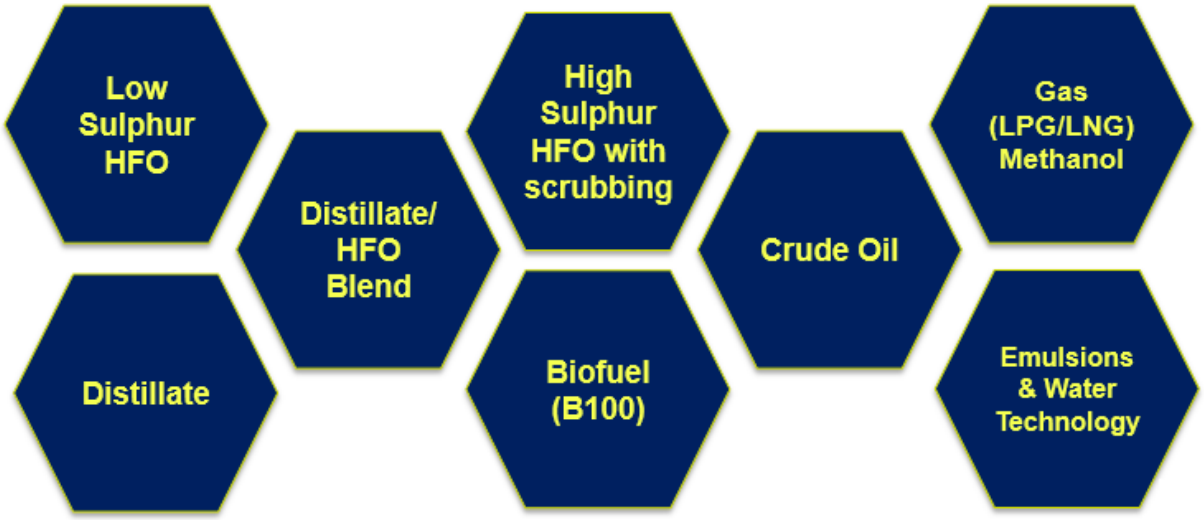
Various Options of Fuels & trends expected as per OEM

Type of Fuel	Typical Sulphur Content (% m/m)
Ultra Low Sulphur Fuel Oil	<0.1
Distillates	<0.5
Low Sulphur Fuel Oil	0.5 - 1.5
Heavy Fuel Oil	1.5 - 3.5



Expectations to future marine fuels (if IMO enforces the global max. 0.5% S in 2020).

Source MAN



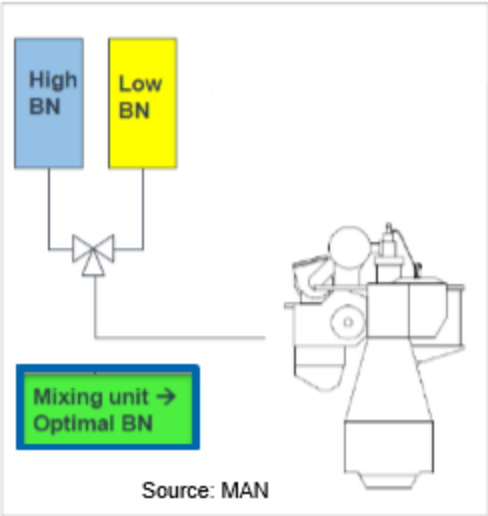
Fuel Operation Scenario

Fuel Combo	Challenges	2-Stroke	4-Stroke
High Sulfur HFO (2.5% - 3.5% S) with Low Sulfur distillate (<0.1%S)	Mis-match of fuel sulur content with BN & ash content of oil in lubricant Length of time >100hrs for ships transitioning in/out of ECAs 40BN was widely available for ships in ECAs A single cylinder oil containing: Ash Free Additives High and low alkalinity reserves	Due to immediate transition of fuel and switch of lubricant: High S Fuel with low BN lube: Corrosion of piston rings & liners Low S Fuel with high BN lube: Ash deposits on piston crowns and top lands High cost of distillate fuel lead to reduce engine load Results in correction of lube oil feed rate (an increase) - Over lubrication leads to deposit build up	Long Operations : 20BN/30BN Short Operations: 40BN/50BN Lube oil cannot be changed even when the fuel is switched, hence lube selection is based from "the worst" fuel quality Good asphaltenes detergency when monitoring fuel contamination from HFO
Low Sulfur HFO (0.5% S) with Low Sulfur Distillate (<0.1% S)	0.5% HFO in place post 2020/2025.	Might still need a neutralization capacity of 40BN	Typically 16-30BN A 20BN lube with sufficient asphaltenes detergency is best choice.

Dual Fuel Scenario

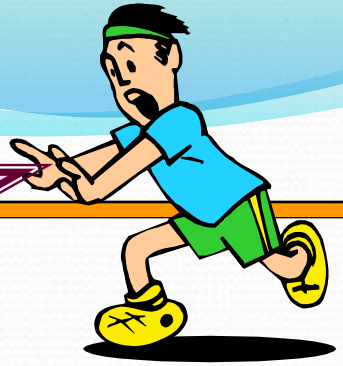
Fuel Combo	Challenges	2-Stroke	4-Stroke
Dual Fuel 100% HFO 95-99% Gas (1-5% HFO/MDO)	Less Calcium Carbonate in the formulation could lead to poorer wear profiles for low BN MDCLs Abnormal combustion of LNG-air mixure linked to ignition of volatile fractions of lubricant itself	2 lubes combined based on LNG/HFO Ratio **HFO**: Sufficient alkalinity reserve **Gas**: Low ash product to minimize deposition	**HFO:** requires high base number and good asphaltenes detergency **Gas**: A high BN will contribute to ash deposits in the combustion chamber, leads to misfiring or engine knocking.

Automated Lube Mixing (ALM) system'



Source: MAN

TYPES OF MARINE OILS



MCL (2 Stroke engine)

LOW SPEED/CROSS HEAD engines

HIGH TBN -70

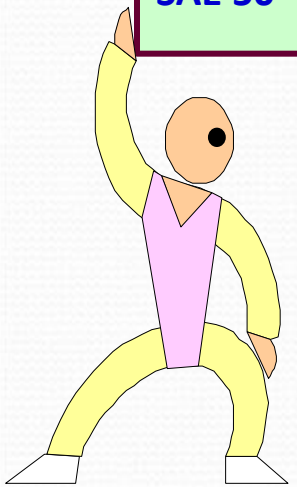
SAE 50

TPEO (4 Stroke)

M.SPEED/T.P. ENGINES

TBN 10-50 (AS PER FUEL'S')

SAE 30 OR 40

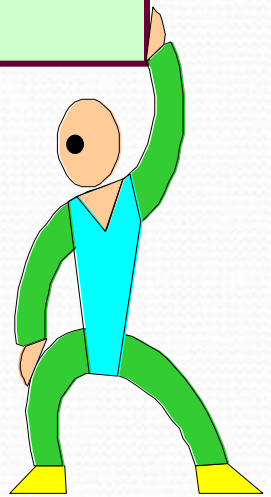


SYSTEM Oil (2 Stroke engine)

CIRCULATING (AUXILLARY UNITS)

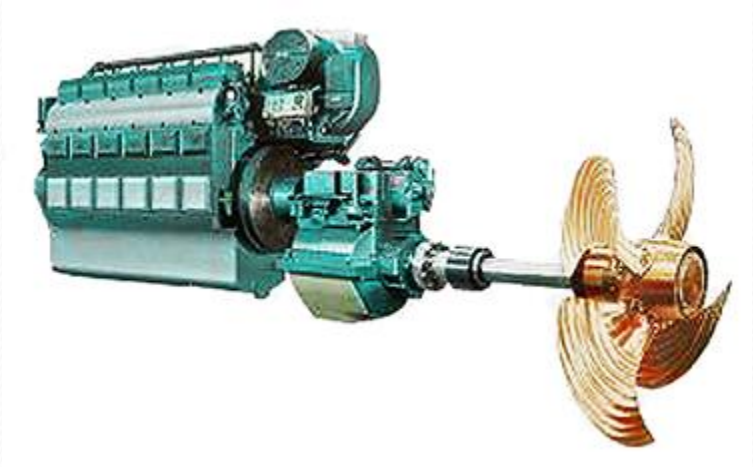
TBN 5-7

SAE 30



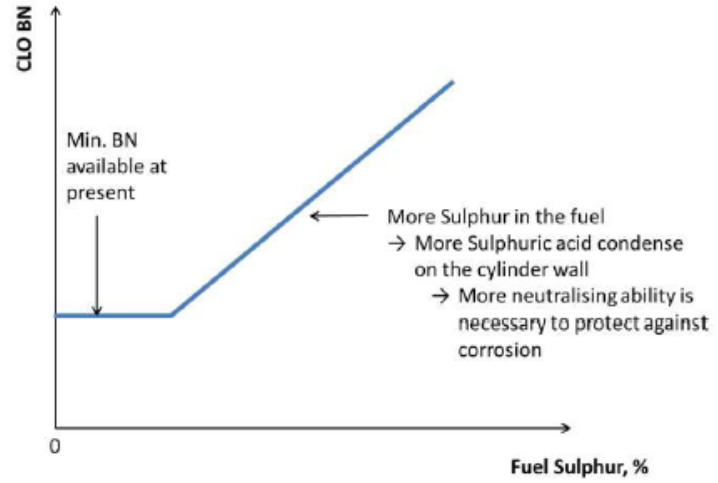
Marine lubricant's functions

- Keeps the engine parts clean
- Good film forming properties
- Good spreadability
- Good detergency, thermal stability
- Sulfuric acid neutralisation
- Asphaltene/sludge solvency
- Good antiwear and film retention properties

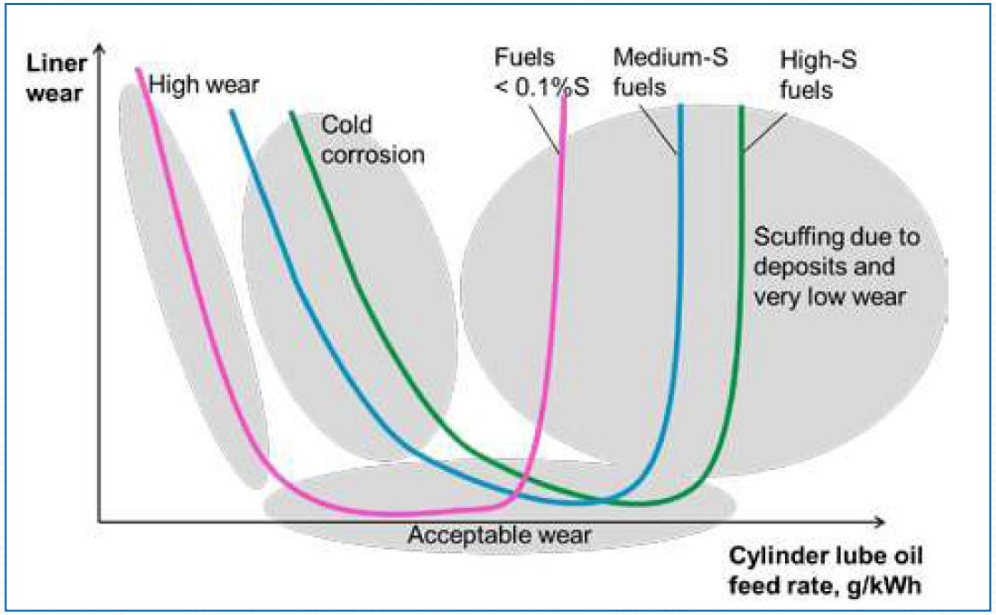


Liner wear Vs Oil feed rate

- Variation in cylinder lube oil feed rate and/or variation in BN will move the curves along the x-axis. Furthermore, engine configuration, operating conditions and ambient conditions (e.g. scavenge air humidity) also influence the situation.
- New and re-conditioned cylinder liners have special machining pattern (wave-cut) [6]. The wave-cut ensures that a sufficient amount of cylinder lube oil is retained on the liner surface.



Relationship between sulphur in the fuel and BN in the cylinder lube oil.



Slow Steaming

Slow steaming refers to the practice of operating cargo ships, especially container ships, at significantly less than their maximum speed.
When a ship 'slow steams' it reduces the engine load --and thereby the speed of the vessel.

Possible Impact

Positives	Negatives
Lower fuel costs	Fouling of the exhaust gas boiler
Lower emissions	Low temperature in the exhaust gas boiler affecting heat recovery efficiency
Flexibility on load planning	Premature wear and tear of vital parts
	Soot deposits on moving parts
	Internal temperatures can be below the dew point of S-acid. Results in sulphuric acid condensing on the liners leading to higher rates or corrosive wear

Uniqueness of Marine Lubricants

- No industry specifications
- Accepted performance level API CD/CF
- Major marine OEMs don't give blanket approvals for Marine oil additives
- Field test required separately for each OEM
  - Ship board trial
  - Land based DG set trial

Prior to run field trial, product with complete physico-chemical data along with engine test data has to be submitted to OEM to get field trial clearance i.e. no objection certificate for field trial.

Field trial duration is of min. 4000 hrs

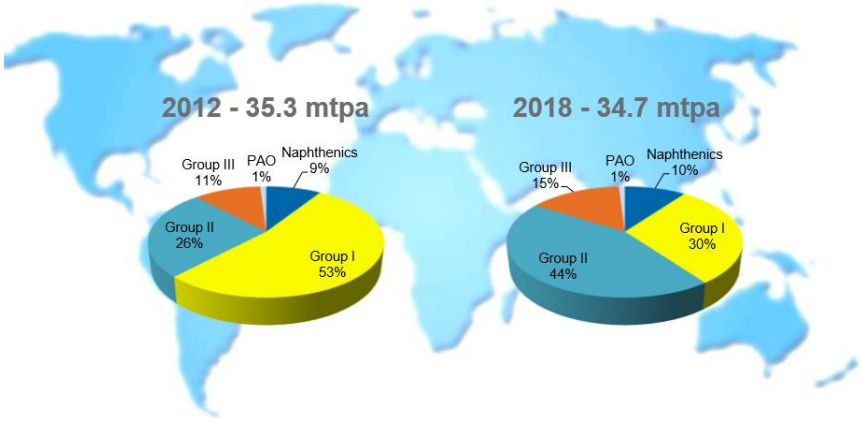
Marine lubricant Formulation methodology

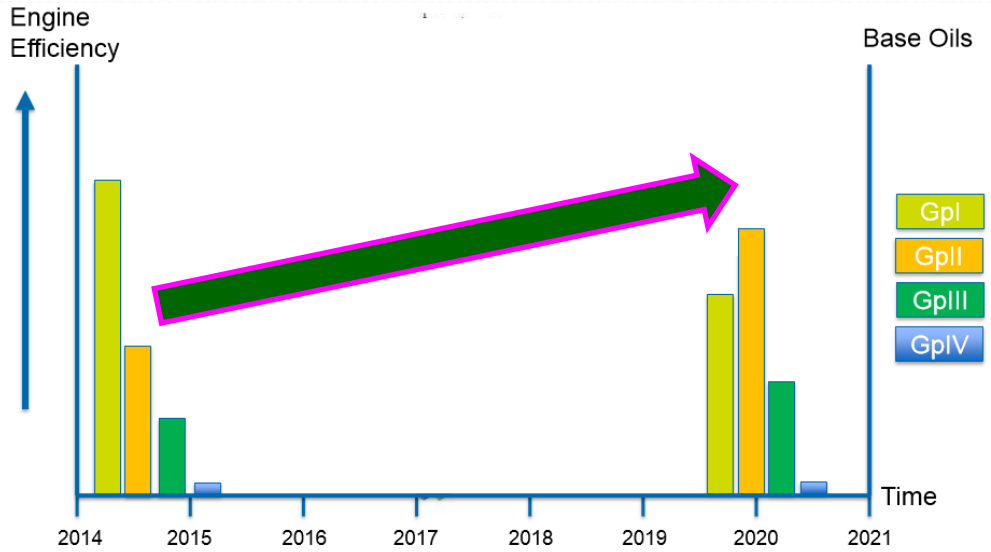
- Characterised by high level of detergency & alkalinity reserve – even upto 100 BN
- Fuel sulfur determines the lube oil detergency level
  - MCLs – Very high detergency due to use of sulfur rich fuel
  - TPEOs – A range of BN from 10-55 determined by fuel S level

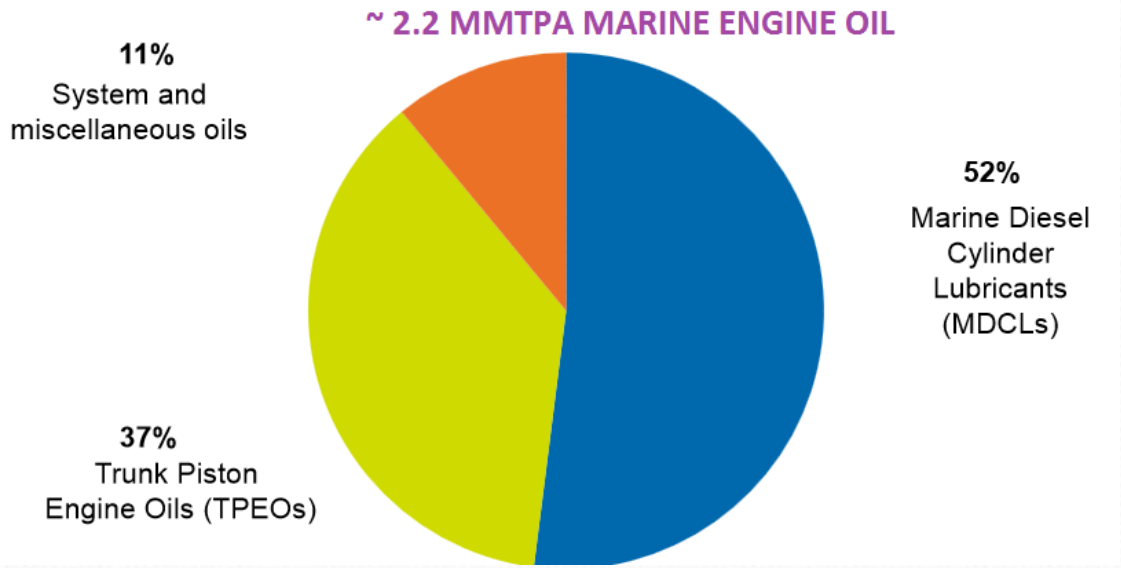
Commonly used additives in Marine Lubricants

Detergents – Sulfonates, phenates, salicylates
Dispersant – PIBSI type
Anti oxidants – Phenolic or Amininc type
Anti wear – ZDDP

Marine Engine Oil Market

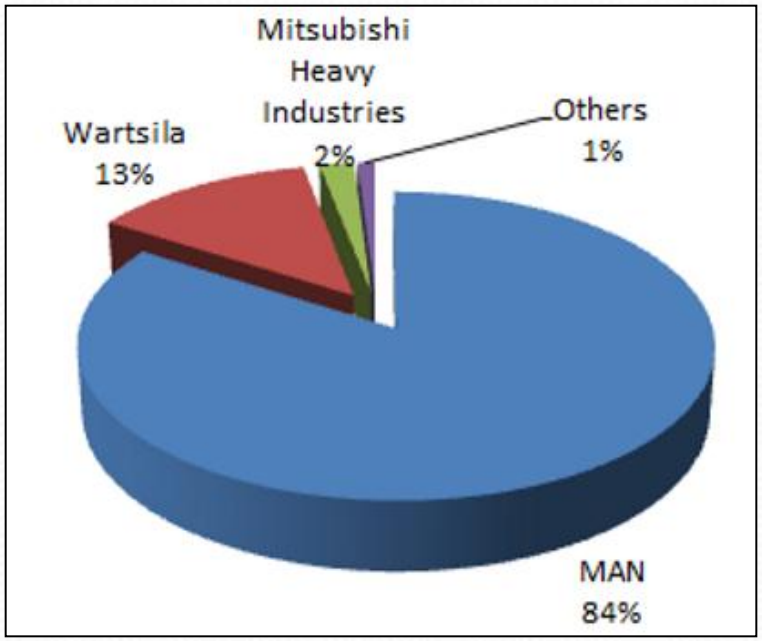




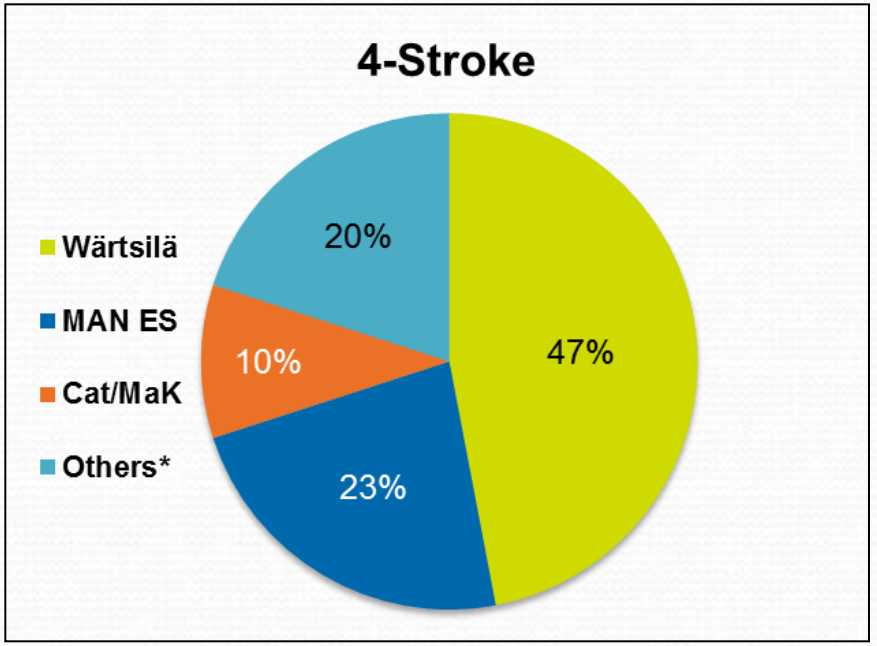


Major Original Equipment Manufacturers (OEM)

Marine 2 stroke engine OEMs



Marine 4 Stroke engine OEMs



Others : Mitsubishi, Caterpillar, Nigata, Himsen

Major OEMs are Europe based

Source : Lubrizol

Fuel sulfur level Vs Lubricant BN

MDCL

0.1 % S	0.5 % S	1.0 % S	1.5 % S	2.0 % S	3.5 % S
15-25 TBN					
	40 TBN				
		70 TBN			
				70-140 TBN	

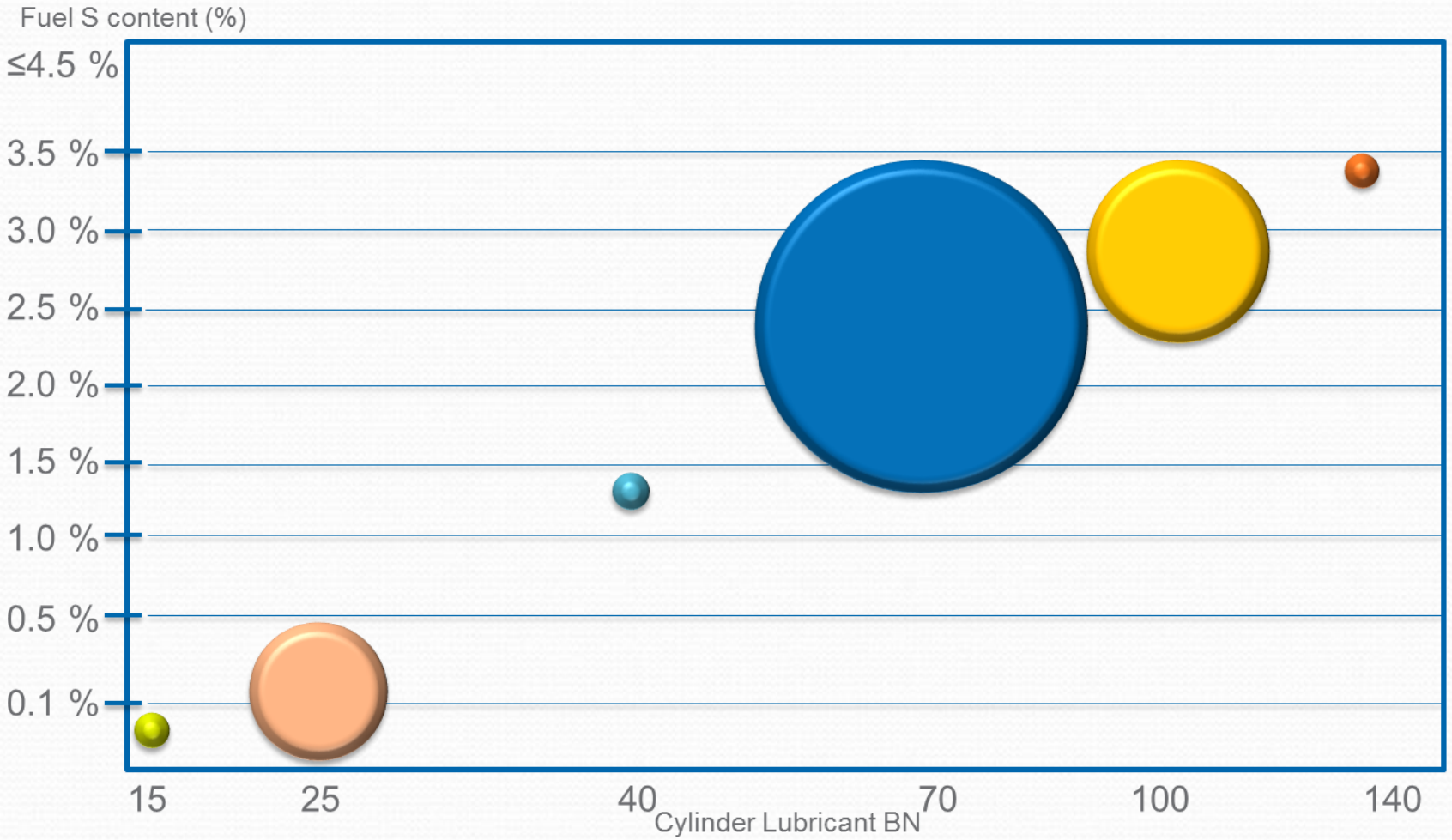
Automated Cylinder Oil Mixing system (ACOM) - only for MAN ES Engines
ACOM system can be used to mix high and low BN Cylinder oils

100 + TBN required to tackle cold corrosion and also for slow steaming operations

TPEO

0.1 % S	0.5 % S	1.0 % S	1.5 % S	2.0 % S	3.5 % S
12-15 TBN					
	20-30 TBN				
		30-55 TBN low to high S HFO (Asphaltenes)			

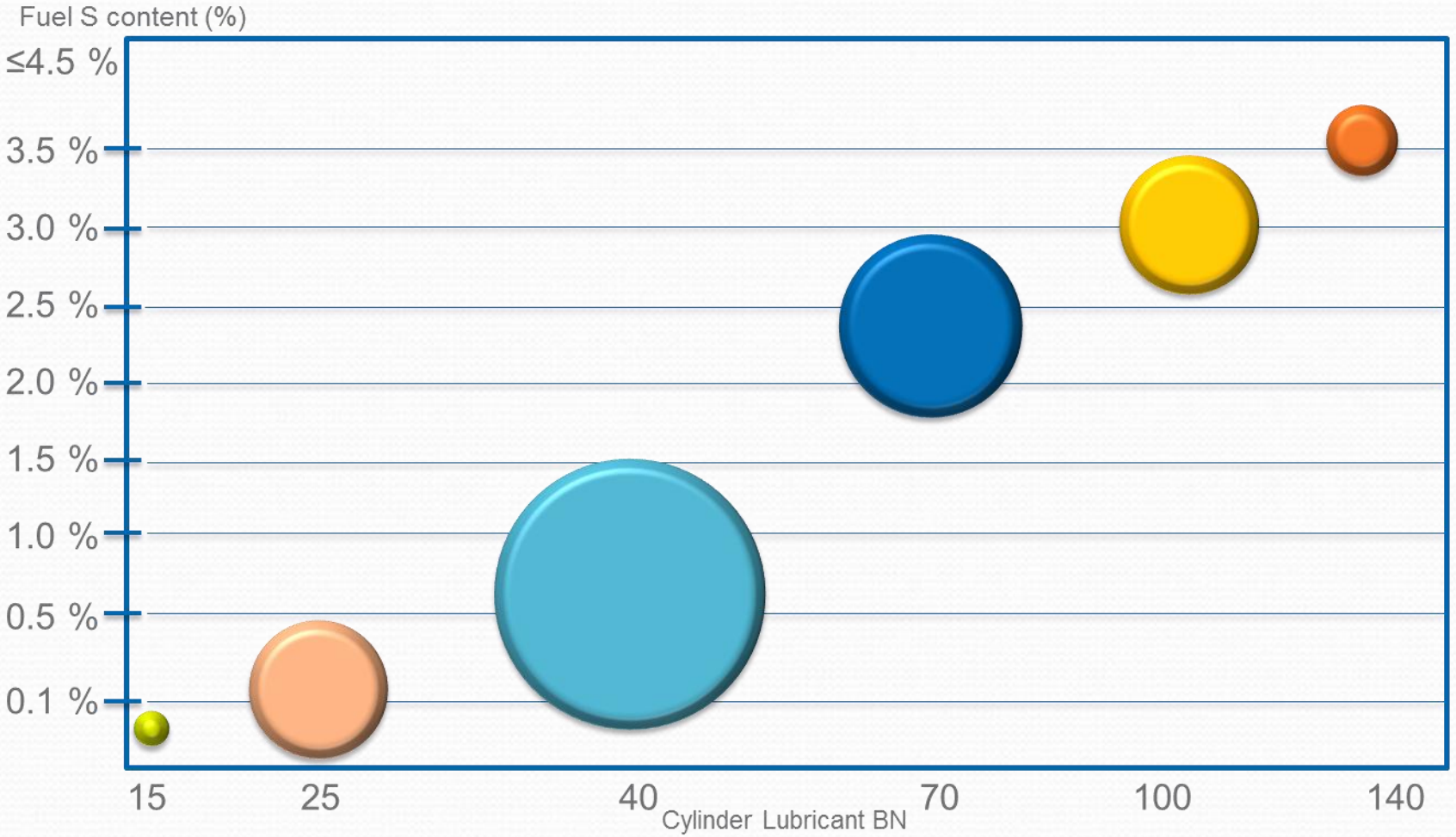
Current cylinder oil coverage – 70 & 100BN dominant



- 70BN & 100BN cylinder oils dominate the market

Courtesy : Lubrizol

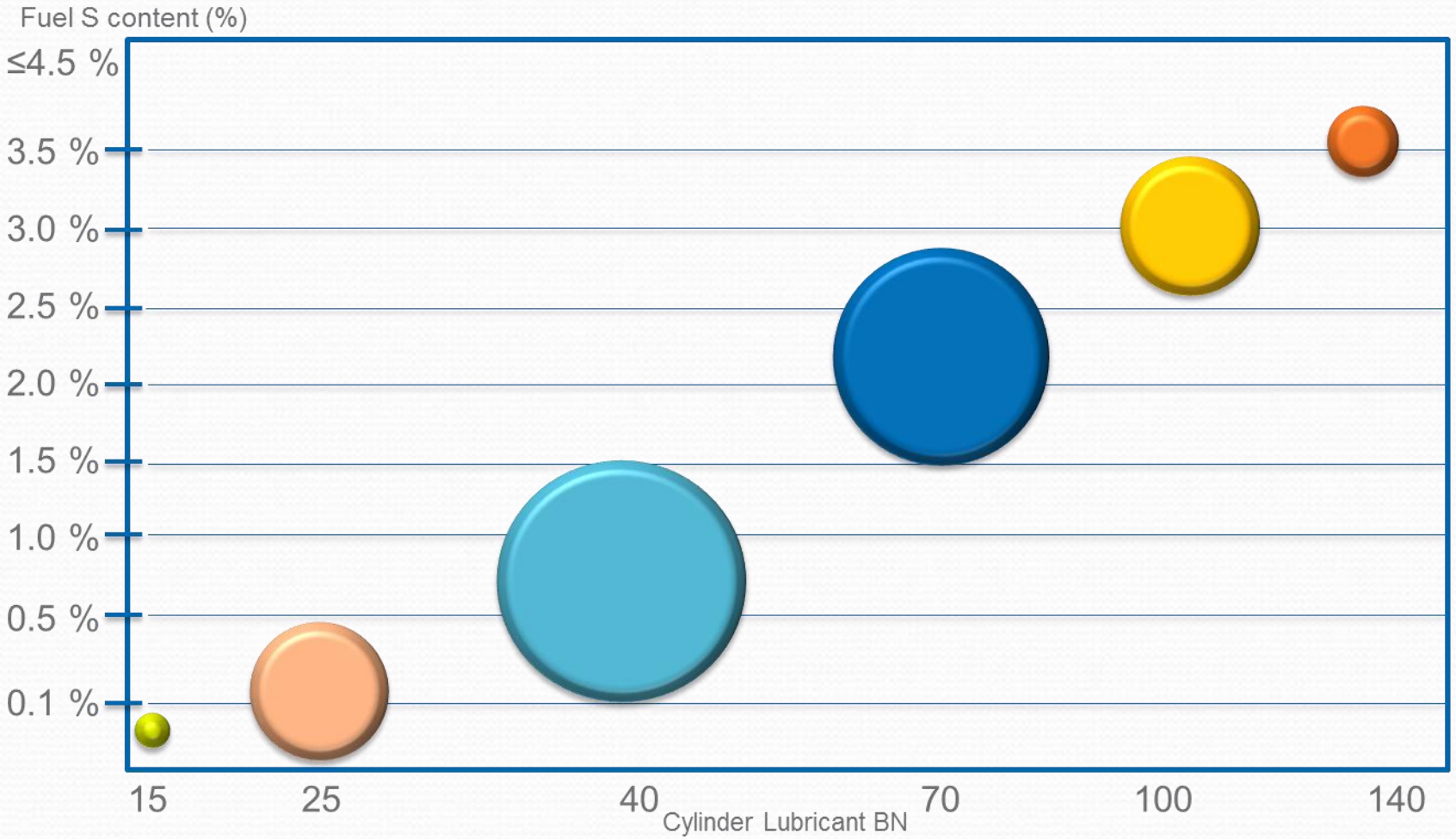
Cylinder oil coverage 2020 – 40BN dominant



- Lubrizol view of 2020 MDCL product evolution

Courtesy : Lubrizol

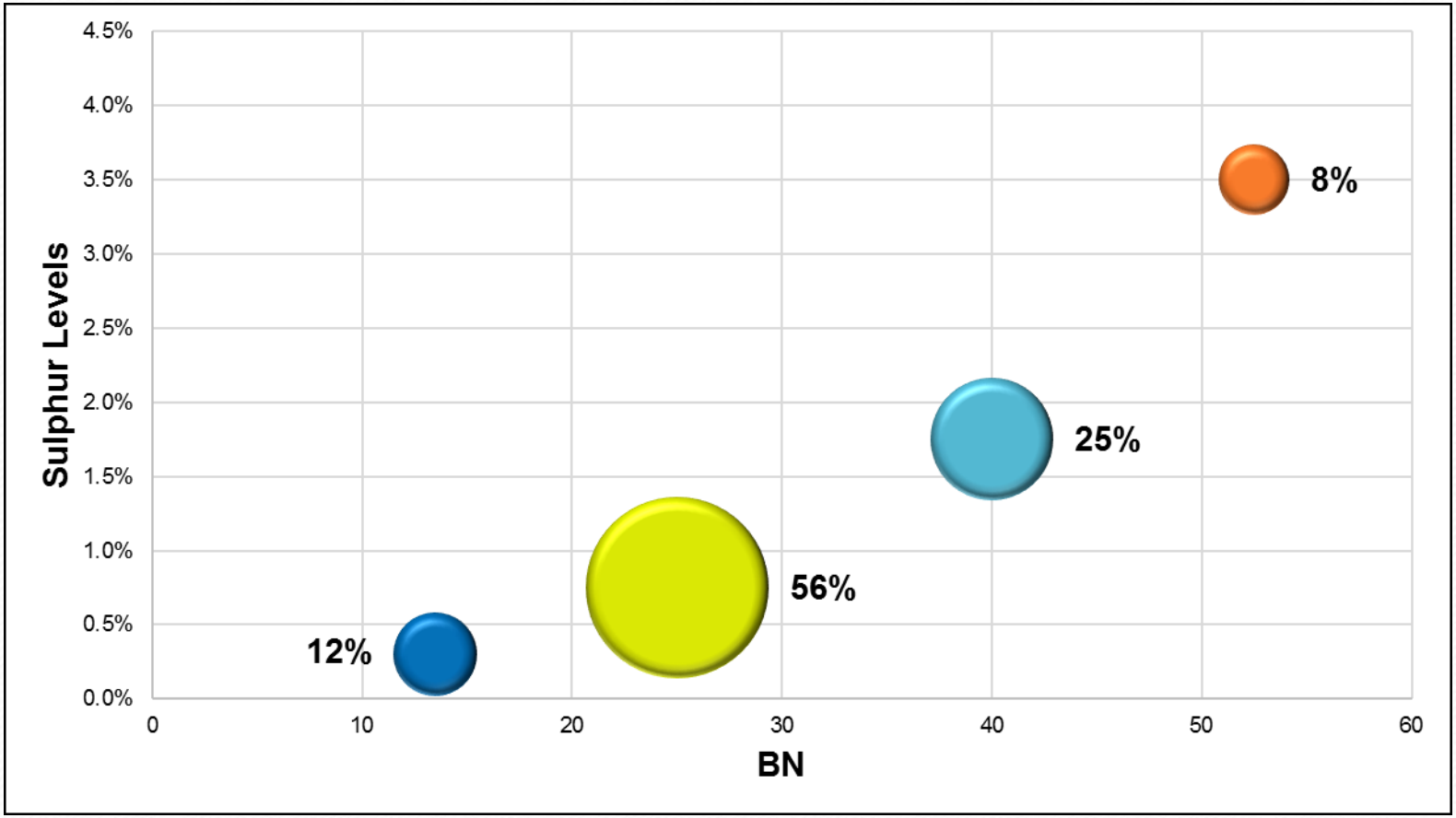
Cylinder oil coverage Beyond 2023



- Scrubber uptake changes cylinder lubricant landscape beyond 2023

Courtesy : Lubrizol

TPEO Coverage in Deep Sea Marine market 2020 : 20-30BN dominant (Industry view)



- Assuming that current 4-stroke vessels do not adopt scrubbers in 2020

Courtesy : Lubrizol

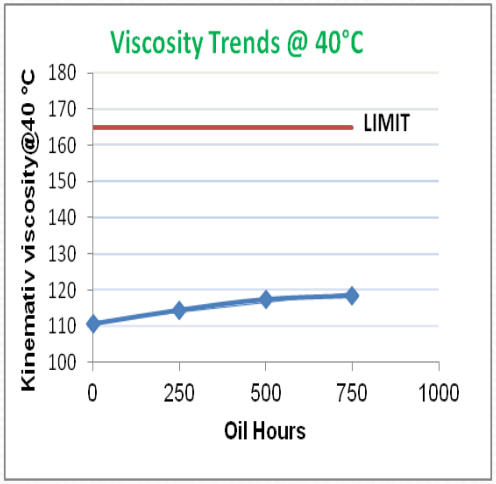
Important Attributes of Gas Engine Oil

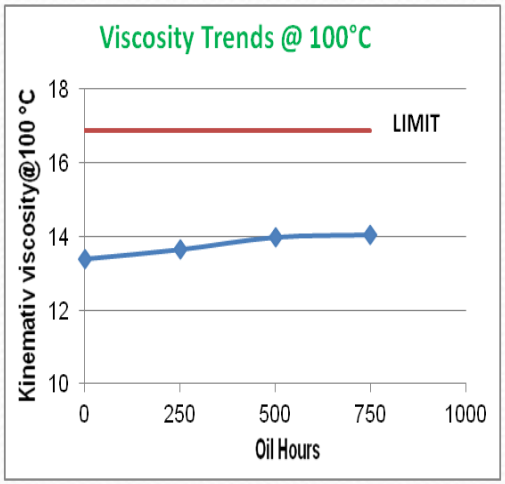
- ✓ Oxidation Stability
- ✓ Thermal Stability/Deposit Control
- ✓ Resistance to Nitration
- ✓ Dispersancy
- ✓ Corrosion
- ✓ Resistance to Friction & Wear

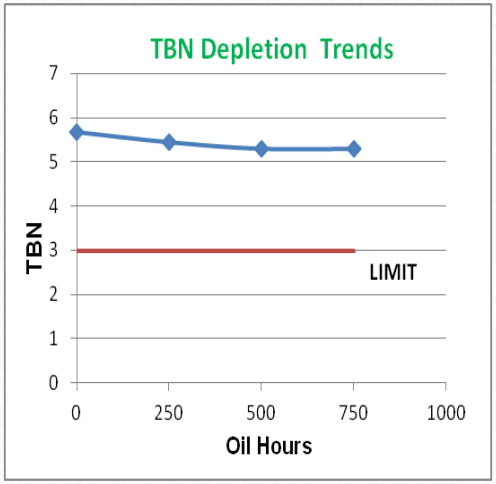
- ❑ No Standard Engine Tests as in the case of on-road High speed engines
- ❑ OEMs rely on actual field performance
- ❑ Performance assessment during formulation development – A challenge

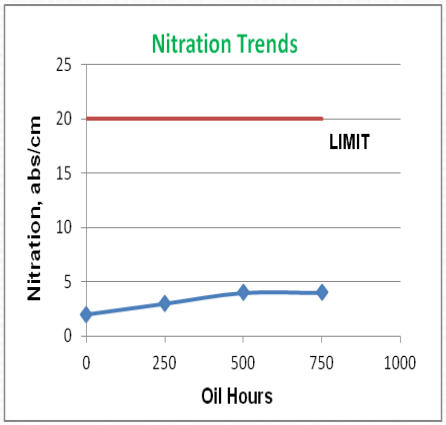
Field Validation of Gas Engine Oil

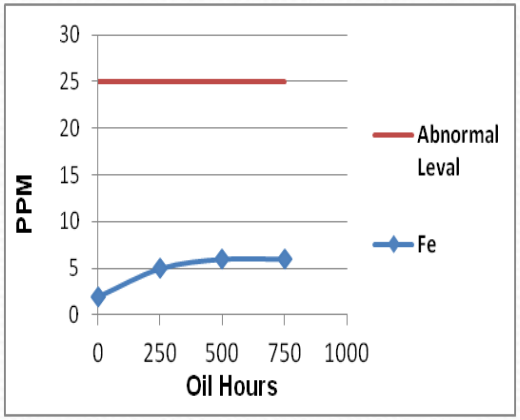
In a 9.73 MW Wartsila 20V34SG Engine

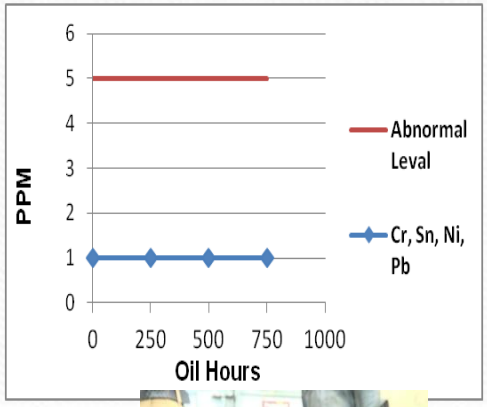












Indian oil's readiness for IMO 2020 - complete slate of cylinder oils for various fuel options

Product	BN/SAE Grade	Fuel Sulfur	Area of use
Servo Marine LB 1750	17 BN / SAE 50	<0.1 % S	ECA
Servo Marine ME 4050	40 BN / SAE 50	0.5 % max S	Non ECA
Servo Marine ME 7050 & Servo Marine 7050	70 BN / SAE 50	0.5-1.5 % S	Non ECA
Servo Marine ME 10050	100 BN / SAE 50	1.5-4.0 % S & slow steaming	Non ECA
Servo Marine ME 14050	140 BN / SAE 50	1.5-4.0 % S & slow steaming	Non ECA

Servo Green Edge – Stationary Gas Engine Oil SAE 40 Low TBN oil

Summary

- IMO 2020 will bring a drastic change in the marine lube oil product portfolio
- Ship owners can have various lube oil options depending upon the type of fuel used (low sulfur fuel or high sulfur fuel with scrubbers)
- Till 2023, 40 BN MCL market is expected to gain major market share
- After 2023, higher BN MCL versions (>100 BN) are expected to capture the market due to the technical advancement expected in scrubber technology
- Marine 2 stroke engines finely tuned for better fuel efficiency (long stoke engines from OEM such as MAN ES) require higher BN MCL (140 BN)


THANK YOU