



CIMAC

THE INTERNATIONAL COUNCIL ON COMBUSTION ENGINES

Challenges and opportunities for better environment

CIMAC Circle @ Marintec Shanghai 2015

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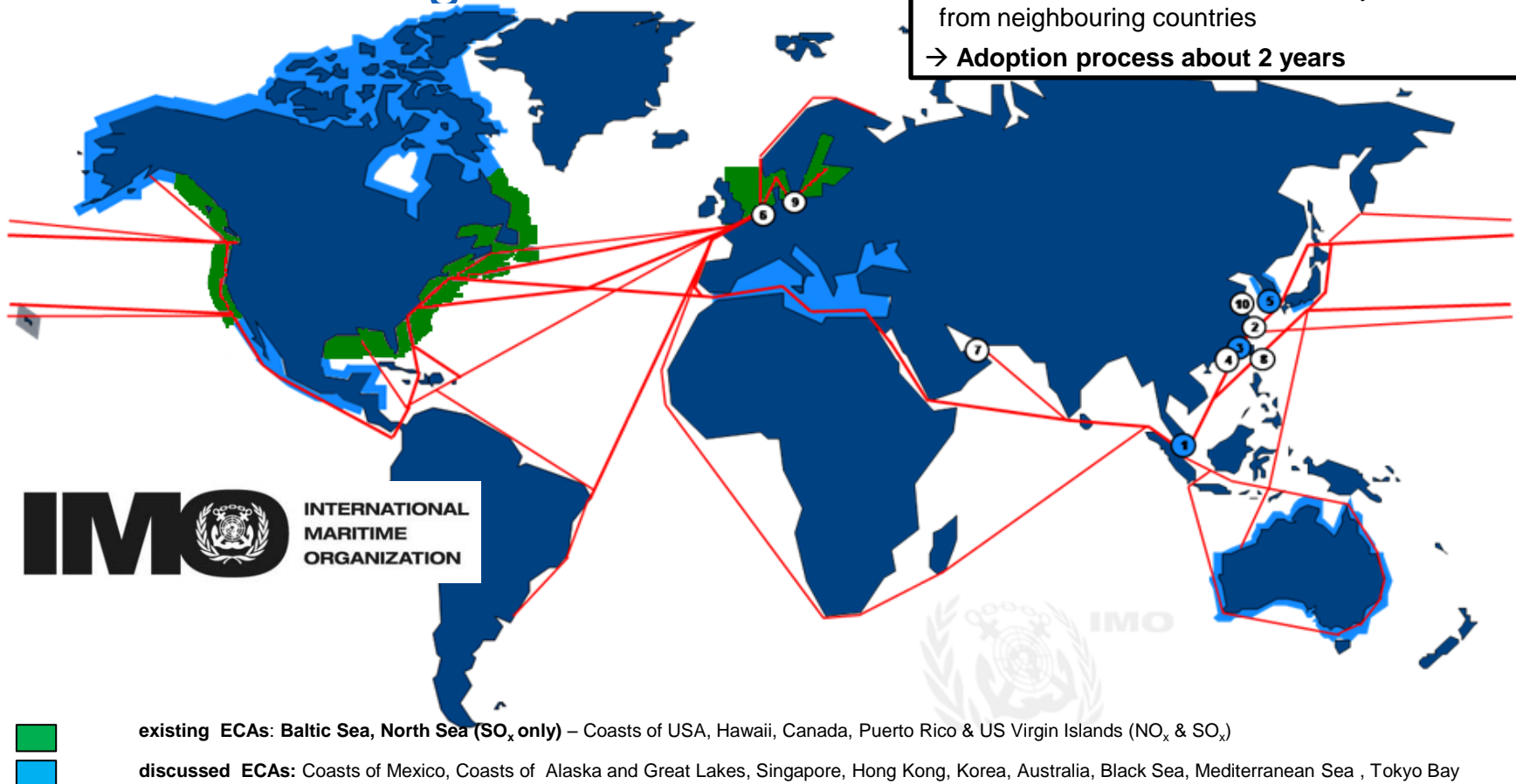




Outcome of MEPC 66 IMO Tier III regulation

Tier III decision - MEPC 66 on 04.04.2014

- from 01.01.2016 for ships operating in North American and U.S. Caribbean Sea ECA
- further NECAs are to be introduced by submission from neighbouring countries
- Adoption process about 2 years

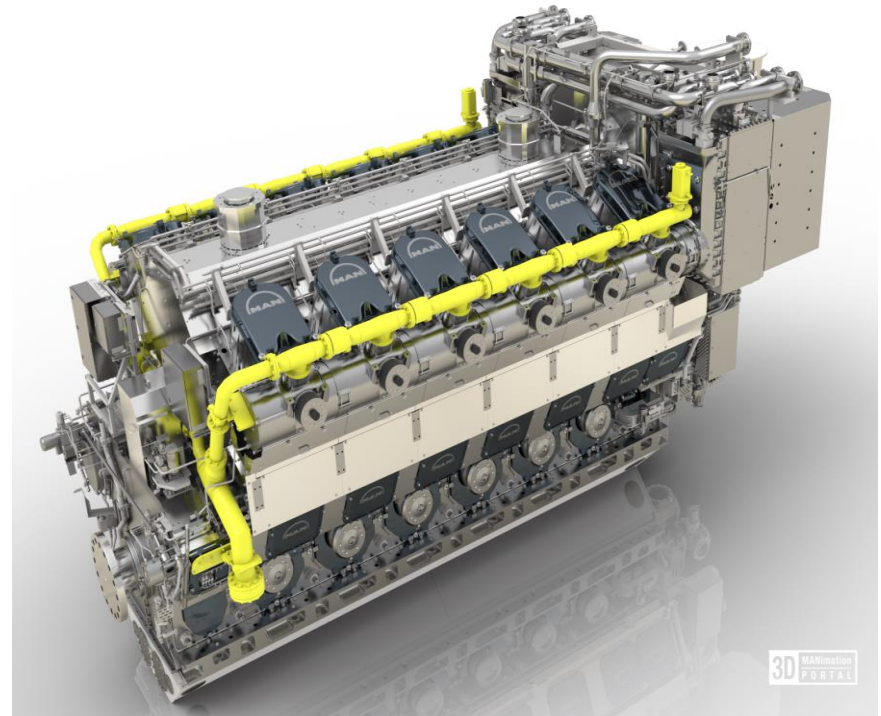




4-Stroke DF engines

Benefits

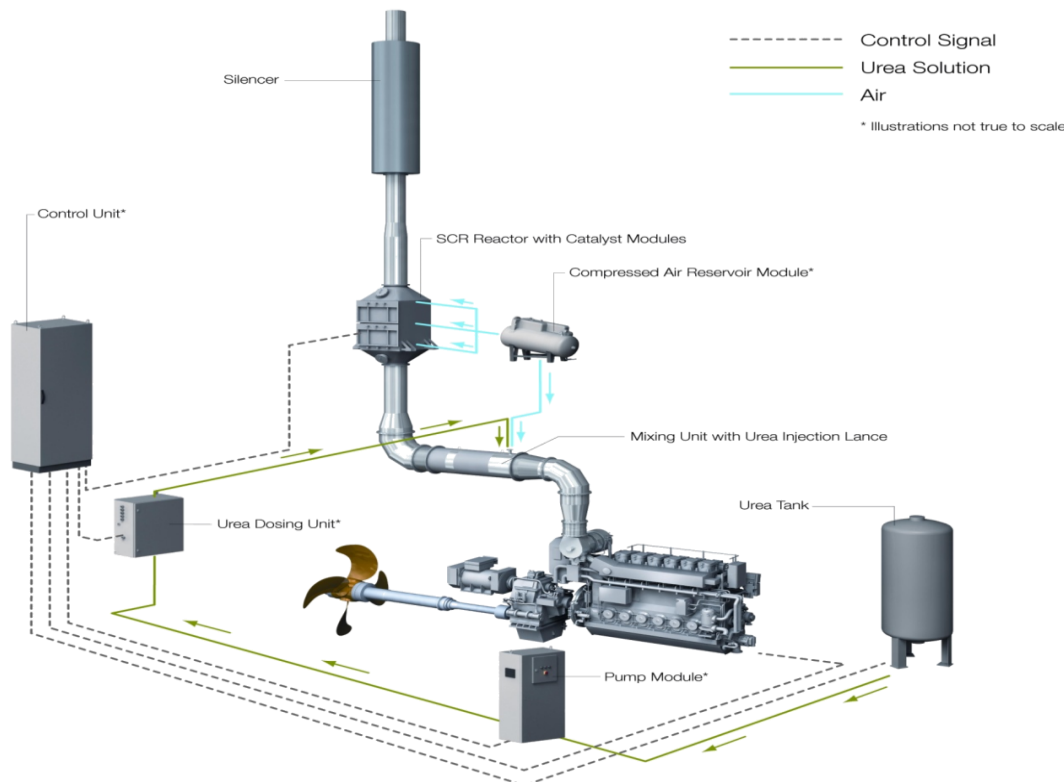
- Meet IMO Tier III regulations in gas mode
- Multiple applications, low fuel consumption
- Flexibility to burn gas as well as HFO
- Reduced CO₂ emission in gas mode





MDT-SCR System

Modular design of SCR components to cover entire medium speed engines



The MAN Diesel & Turbo SCR system standard is available in fourteen different sizes. In this way, it fully covers the entire portfolio of MAN medium speed diesel engines. Furthermore, customized SCR systems can be offered on demand.

Main components of the SCR system:

- SCR reactor
- Catalyst elements
- Soot blowing system
- Dosing unit
- Mixing device
- Urea injection lance
- Control unit
- Compressed air reservoir module



MAN B&W 2-Stroke Engine Tier III technologies – EGR and SCR(HP and LP)

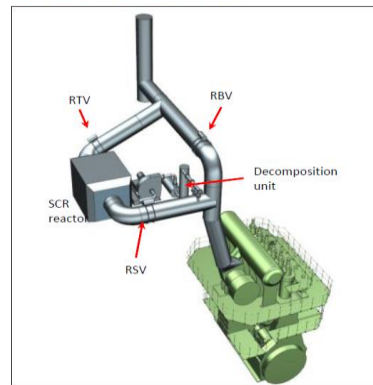
EGR and HP SCR can both be applied with all current 2-stroke engines, with various fuels, for Tier III compliance.
LP SCR also for all engines, but not for HFO.

EGR (Exhaust Gas Recirculation)

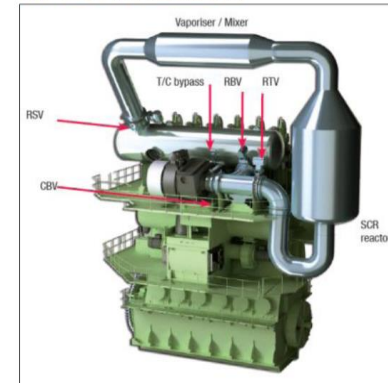


SCR Layouts – High Pressure and Low Pressure SCR

■ LP SCR (After-Turbine SCR)



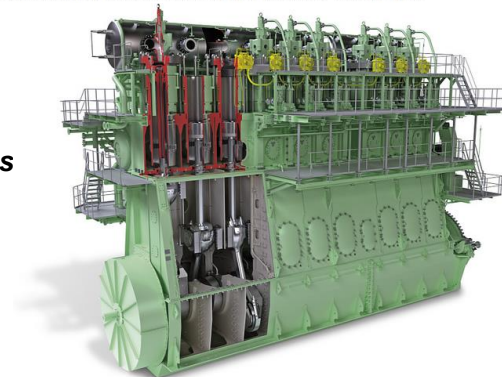
■ HP SCR (Pre-Turbine SCR)



* RSV : Reactor Sealing Valve, RTV : Reactor Throttle Valve, RBV : Reactor Bypass Valve, CBV : Cylinder Bypass Valve, TBV : T/C Bypass Valve

MAN B&W 2-Stroke ME-GI ,and ME-LGI engines

- **Diesel cycle** high fuel efficiency ~50% .
- High fuel flexibility – burn **all** gas grades **without derating**. Burns **all** fuel **types**
- **No derating** because of **knocking** danger.
- **Negligible methane slip**.
- **In compliance with IMO Tier III with EGR , HP SCR or LP SCR.**





Total propulsion efficiency

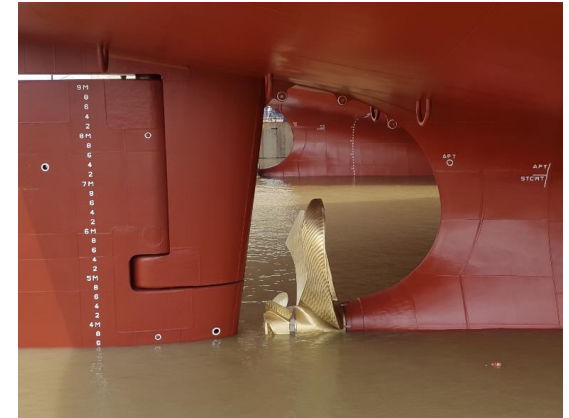
MAN Alpha Kappel Propeller

- The Kappel principle for ship propellers has been refined over 20 years via **extensive R&D**
- Kappel is today the most efficient propeller design, **increasing propulsive efficiency by 2-5%**, compared to conventional propellers (by reducing tip losses)
- Can be applied on **both FPP and CPP**

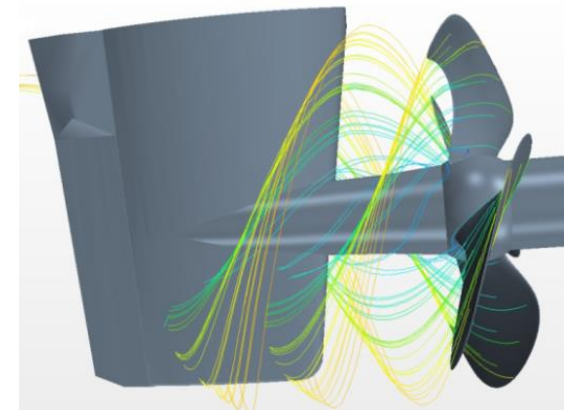
MAN Alpha aft ship optimization

- MAN **Alpha** have developed a CFD optimization routine. Efficiency improvement of **2-4%**
- The rudder bulb solution is customized to each individual project

Kappel Propeller design



CFD calculation with bulb





Future emission regulations in China

Limits and measurement methods for exhaust pollutants from marine compression ignition engines (CHINA I , II) (2nd draft seeking feedback)

- Applicable to inland water vessel, coastal vessel, river-sea ship and channel vessel
- The 1st stage to be effective 2017
- The 2nd stage will start 2020, with the HC + NO_x limit lowered by over 20% in general, PM limit lowered by 40-60% compared to 1st stage.

The coming Emission Control Areas in China

- Target: By 2020, in Perl River Delta, Yangtze River Delta, and Bohai Rim area (Beijing, Tianjin, Hebei province), to reduce the emission of SO_x, NO_x, and PM by 65%, 20%, and 30% respectively, based on the level of 2015
- By end of 2015, to issue “ Ship emission control area implementation plan for Pearl River Delta, Yangtze River Delta, and Bohai Rim area(Beijing, Tianjin, Hebei province) waters”



Challenges and opportunities for better environment - proposals

Challenges:

- Specific Fuel Oil Consumption vs. NO_x emission level
- First investment cost vs. Technical solutions
- Technical solutions vs operational and lifecycle costs
- Operational cost vs. engine efficiency and emission level
- More various emission limits vs. Cost to develop the different solutions

Opportunities as proposed general approach :

- Low Sulphur distillate fuel, or equivalent solutions, to be adopted, in inland water & coastal area, and the coming ECA areas.
- LNG and other alternative fuels, such as LPG, Methanol , etc., are further developed.
- Fuel efficiency and emission control are both considered
- Retrofit solution should also be developed, while emission limits for new building are implemented



Challenges and opportunities for better environment - proposals

The 2nd stage limit of MEP requires reduced HC+NO_x emission level by further over 20%, a challenge. To meet the 2nd stage Emission Limit for Inland and Coastal vessels, following are proposals for consideration:

- Further engine tuning for lower NO_x emission, while at SFOC penalty, should be evaluated.
- 4-Stroke DF engines, or 4-Stroke diesel engines with SCR, as M/E and Genset engines.
- Apply EGR, SCR, engine tuning or WiF, etc. on two stroke engines where applicable.
- Whether to apply EGR, SCR, engine tuning, WiF, or DF, the technology and market development in the coming years, will find the way. While it would streamline the solutions, when the emission regulations are harmonized internationally.



Environmental friendly transportation and clean air

