Task Force on Techno-Economic Issues

Emission reduction techniques in maritime shipping

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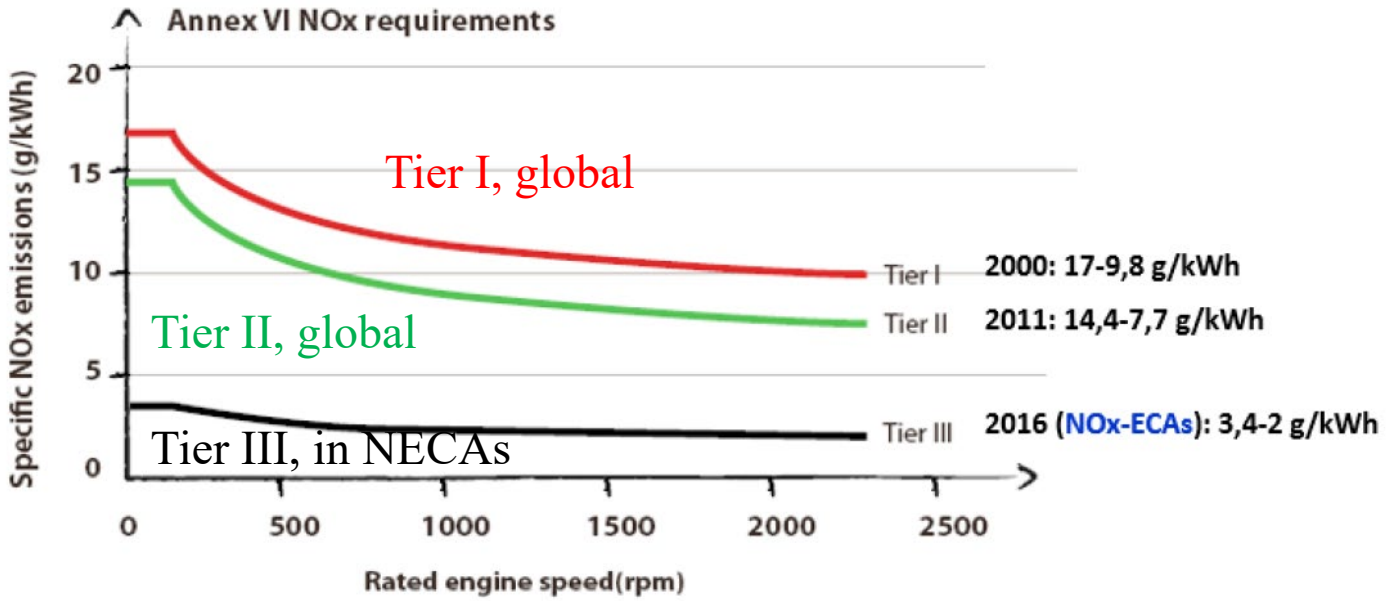
Summary of the presentation

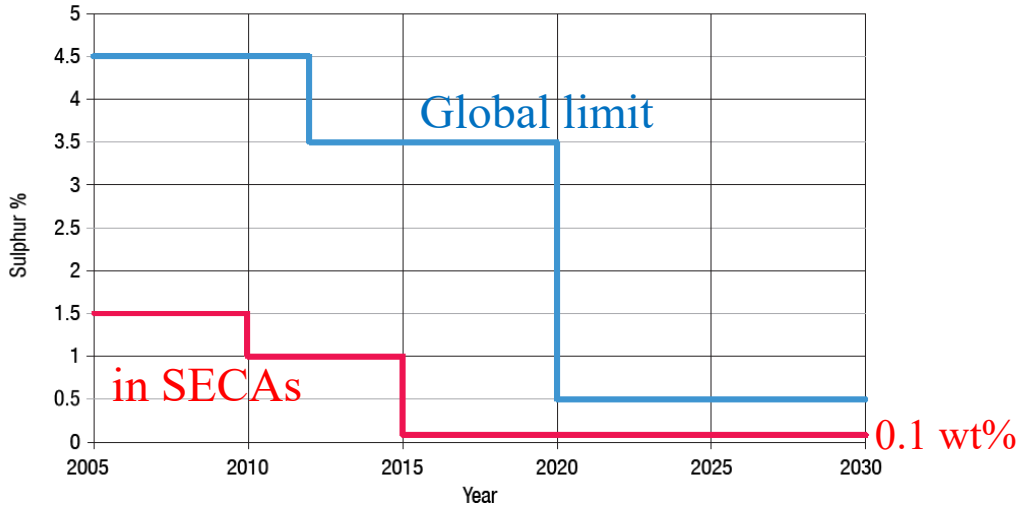
- International legislation for abating SO_2 and NO_x
- Primary reduction measures : fuel switches, slow steaming, etc.
- Secondary reduction measures :
  SO_2 scrubbers, NO_x EGR and SCR and PM filters
- Summary table of reduction efficiencies and costs

Regulation: Marpol Convention Annex VI

NO_x :



SO_2 :



Primary reduction measures

Switch to low-sulphur content fuel oils:

- Significant reductions of SO_2 and PM emissions, depending on sulphur content and fuel quality

Switch to liquefied natural gas (LNG):

- Suppression of SO_2, high reduction of NO_x (~ 90%), PM (~ 98%), BC (~ 75-90%)
- Increase of CH_4 emissions if leakage

Switch to water-in-fuel emulsions:

- NO_x emissions reduction (up to 50-60%), and also PM and BC emissions

Switch to alternative fuels: biofuels, methanol:

- Biofuels: CO_2 reduction, but also PM and BC emissions
- Methanol: CO_2 reduction (if bio), no SO_2, and NO_x, PM and BC reductions

→ But, limited availability and higher consumption (lower energy content)

Slow steaming: reducing the sailing speed to save fuel

- Reduction of all emissions except CO, but limits about delivery efficiency

Secondary reduction measures

Exhaust Gas Recirculation (EGR):

- Recirculating gases → reduction of temperature/O_2 content
- Significant reductions of NO_x emissions (~25-80%), as well as PM and BC as the gases are cleaned before recirculating

Selective Catalytic Reduction (SCR):

- Injection of ammonia (NH_3) solution to neutralize NO_x into N_2 and H_2O
- Great reduction of NO_x (~ 70-95%), and slightly BC too but risk of NH_3 leakage
- Reductions of PM, VOC and CO if oxidation catalyst installed (with "clean" fuels)

Diesel particulate filters (DPF):

- Porous ceramic substrate to trap particles: PM (~45-92%) and BC (~70-90%)

Scrubbers: dry or wet (open-loop, closed-loop or hybrid)

- Chemical reaction with alkaline products to neutralize SO_2
- Important reduction of SO_2 (~ 90-98%), PM (~70-90%) and BC (~25-70%)
- Limits: potential impact of seawater release for open-loop system + storage space for both

→ Drawbacks for secondary measures: extra energy required + installation costs

Summary table of reductions and costs

Reduction techniques :	SO_2	NO_x	PM	BC	fuel penalty	Investments costs (€/kW)	Operation & maintenance costs
Primary measures:							
- Switch to low sulphur fuels	up to 97%[1]	-	60-90%	30-80%	-	-	88-223 €/t fuel
- Switch to LNG	90-100%	90%	98%	75-90%	- 5-10%	219-1603	- 43 €/t fuel (+ fuel savings)
- Switch to water-in-fuel emulsions	-	1-60%	20-90%	up to 85%	+ 0-2%	11-44	33-271 k€/year[5]
- Switch to biodiesel and biofuels	-	-	12-37%	38-75%	+ 8-11%	-	-
- Switch to methanol	100%[3]	55%	99%	97%[2]	+ 9%	-	10-15 €/MWh
- Slow steaming	13-50[4]%	21-64%	18-69%	0-30%	- 15-50%	71	- 42-77% (fuel savings)[6]
Secondary measures:							
- Exhaust Gas Recirculation (EGR)	-	25-80%	-	0-20%	+ 1-2%	36-60	17-25€/kW
- Selective Catalytic Reduction (SCR)	-	70-95%	20-40%	-	-	19-100	3-10 €/MWh
- PM filters	-	-	45-92%	70-90%	+ 1-2%	16-130	+1-4% fuel penalties
- Scrubbers	90-98%	-	70-90%	25-70%	+ 0.5-3%	100-433	0,7[7]-12 €/MWh (~2% of capital investments)

Thank you very much for your attention! Questions?

TFTEI Technical Secretariat

https://unece.org/fileadmin/DAM/env/documents/2020/AIR/WGSR/TFTEI_informal_doc_on_shipping_emissions-final-december2020.pdf

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