Retrofit Control Technology Discussion

Slide-type fuel valves
Alpha lubricator system
Water-in-fuel emulsion
EGR & SAM systems
SCR

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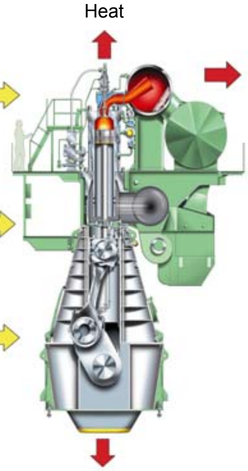

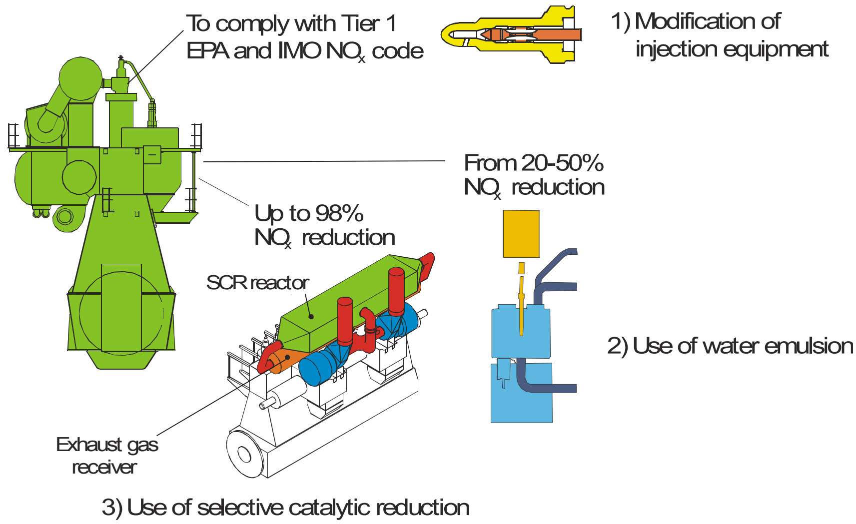

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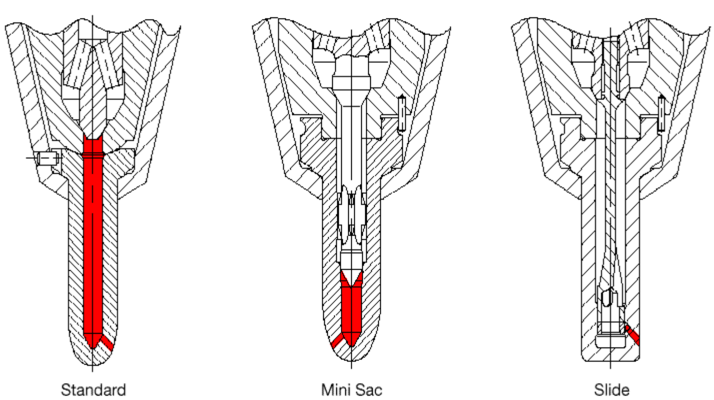
Slide Valve Design

Cross sections of fuel-valve nozzle tips



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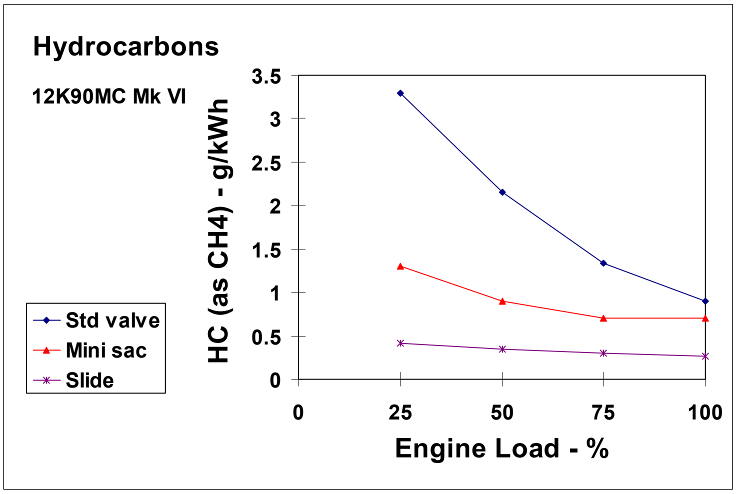

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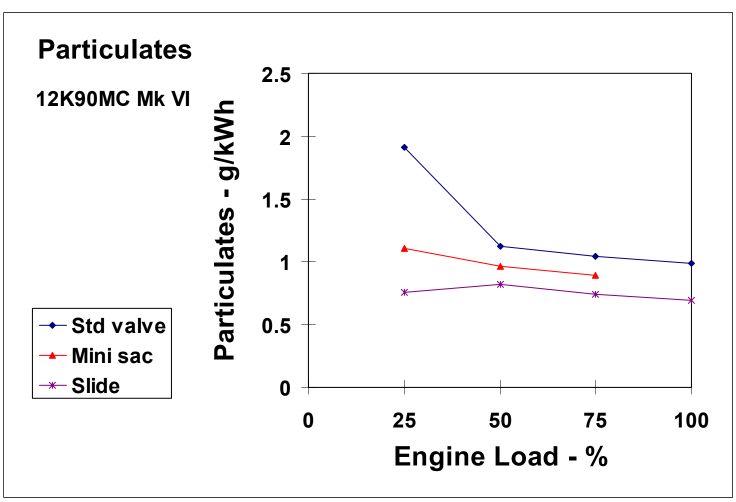


Slide Valve Characteristics

Minimal sac volume – no ’dripping’

- **Less HC and particulate emissions**
- **Less smoke formation**
- **Reduce fouling of gas ways and exhaust gas boiler**
- **Reduce fouling of piston topland and cylinder liner**

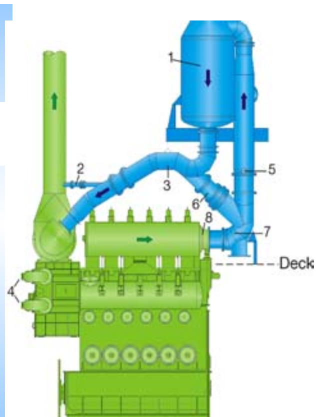
Usually combined with low-NOx behavior

Easy to retrofit

6S35MC, DeNOx

6S35MC, deNOx

1. SCR reactor
2. Turbocharger bypass
3. Temperature sensor after SCR
4. Large motors for auxiliary blowers
5. Urea injector
6. SCR bypass
7. Temperature sensor before SCR
8. Additional flange in exhaust gas receiver



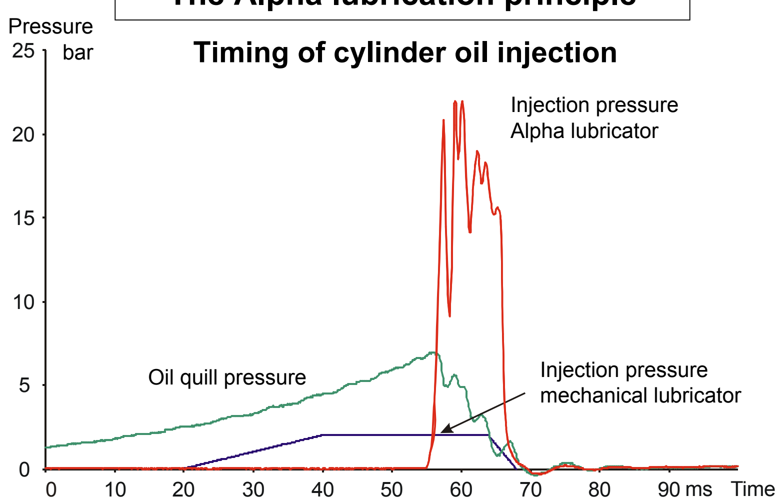
Engine performance data

	Prior to installation of SCR	*deNO$_x$ mode with injection of urea*
Engine load	**75.8%**	**77%**
Turbocharger rpm	**15,600**	**15,700**
T/C inlet temperature	**440° C**	**440° C**
Scavenge air pressure	**2.02 barg**	**2.10 barg**
NO$_x$ emission	**1100 ppm***	**132 ppm* (<2 g/kWh)**
Urea consumption	**-**	**62 l/h**

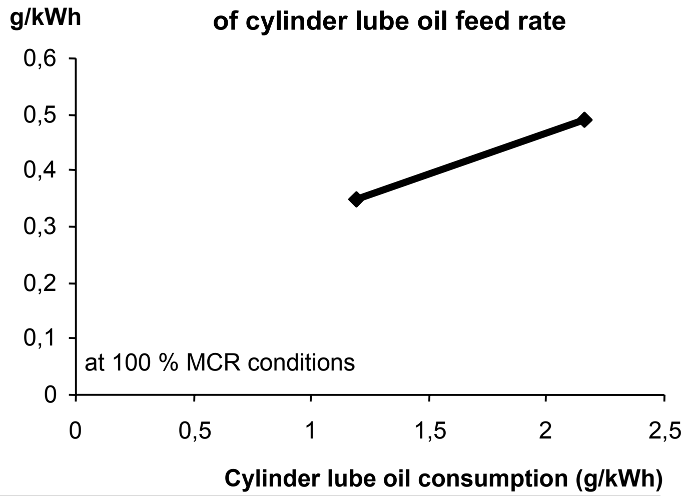
* Measured during SCR test trial

The Alpha lubrication principle

Timing of cylinder oil injection



Particulate emission on function of cylinder lube oil feed rate



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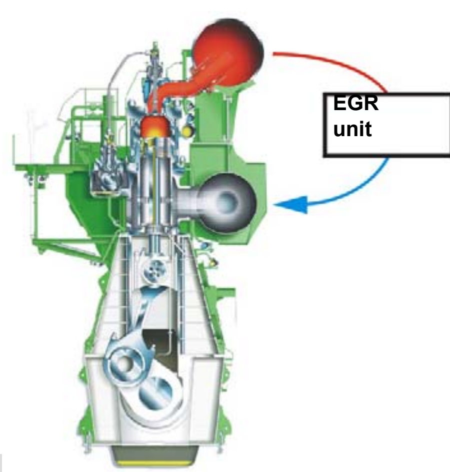
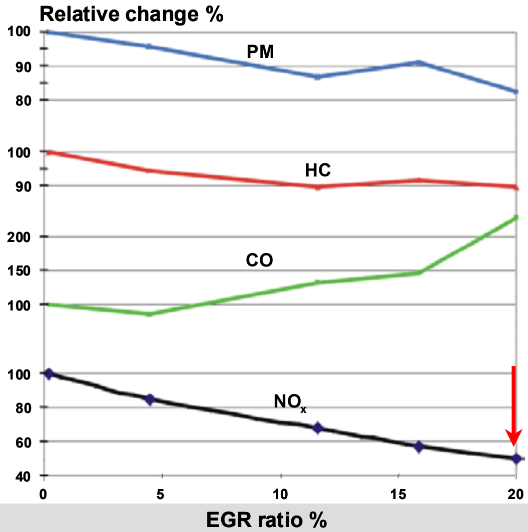
EGR influence on NO_x formation



- Re-circulation of exhaust gas lowers O_2 in scavenge air
- Low O_2 in scavenge air gives low combustion temperatures
- Low combustion temperatures give low NO_x
- Influence on reliability and safety: Field test



NOx Emission Control
EGR Emission Parameters

Emission Parameters at 75% Load at Various EGR Ratios

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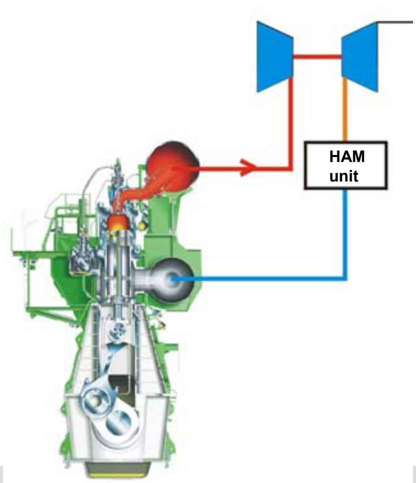
HAM influence on NO_x formation



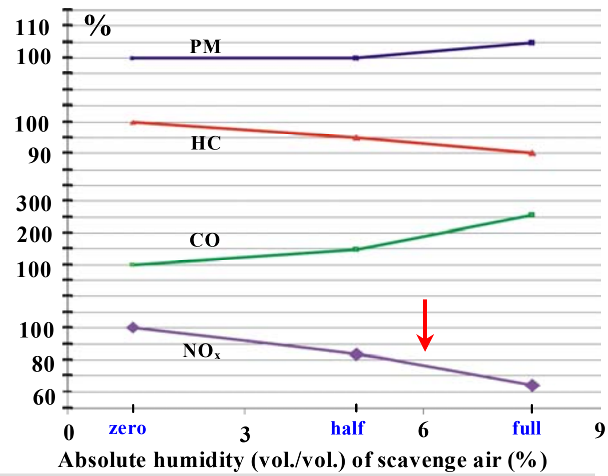
Humidification of scavenge air increases heat capacity and lower the O_2 content

High heat capacity and low O_2 in scavenge air give low combustion temperatures

Low combustion temperatures give low NO_x

Influence on reliability and safety: Field test

NOx Emission Control SAM Emission Parameters



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Example – Application, Cost

Evaluation of NO_x reduction methods and costs for a new 12K80MC engine

Assumptions:

Engine type:	12K80MC
Shaft power:	40.680 kW at 104 r/min
Initial NO_x level:	1.500 ppm at 15% O_2

Means:	Reduction level:	Investment:	Consumption:
Primary means Emission optimised fuel nozzles and valves	0-25%	25.000 USD	Fuel increase up to 2%
Emulsification Incl. homogenizator, larger fuel pumps and NOx optimised nozzles and valves	0-50%	400.000 USD	Fuel increase up to 5% fresh water
Selective catalytic reduction Incl. control equipment, mixer NH_3 handling equipment but excl. piping between SCR catalyst, engine, Ammonia tank and mixer	0-98%	1.500.000 USD	NH_3 6-7g/kWh at 95% NO_x reduction

Summary

- SCR still only solution for 95-98% NO_x reduction
- EGR and SAM have potentials, but further tests are needed
- Water emulsification possible for Tier 2 NO_x requirements
- ME engine possibility for further emission reduction is investigated
- Strong impact from fuel injection valves on NO_x, soot and smoke (case story Wallenius line)

QUESTIONS