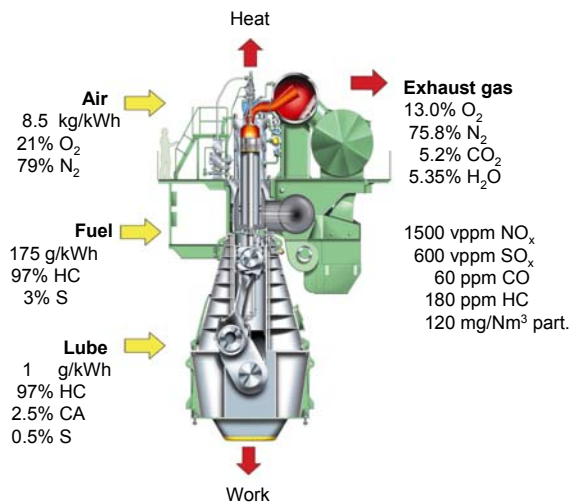
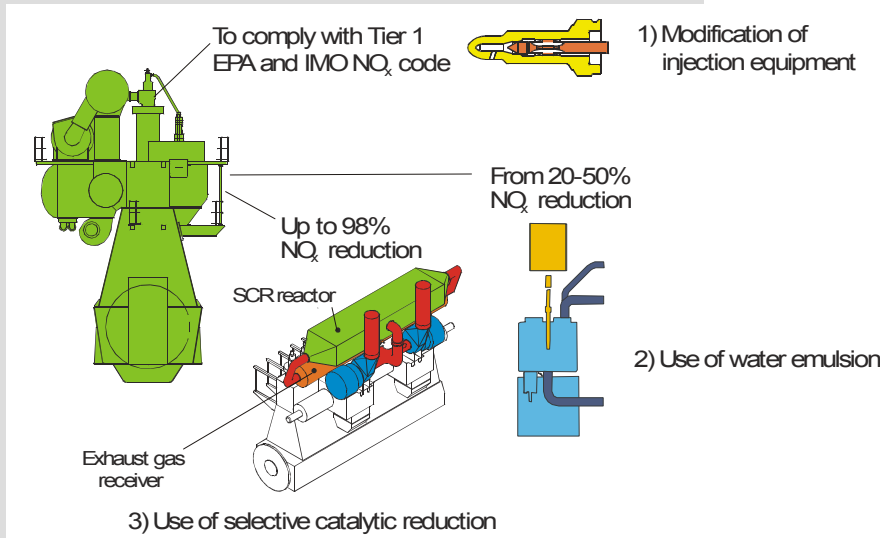




Retrofit Control Technology Discussion

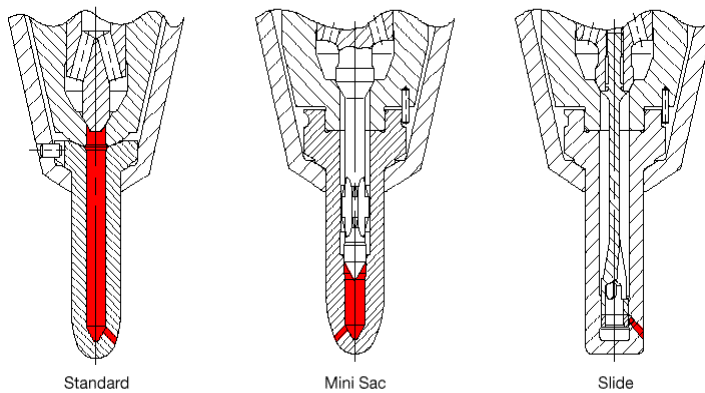
- Slide-type fuel valves
- Alpha lubricator system
- Water-in-fuel emulsion
- EGR & SAM systems
- SCR





## Slide Valve Design

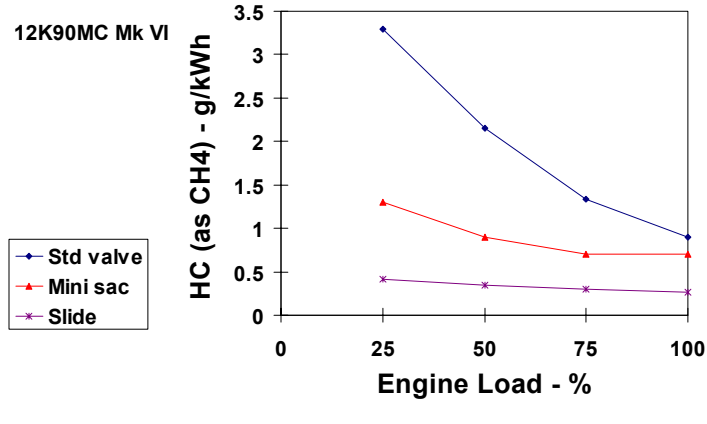
### Cross sections of fuel-valve nozzle tips





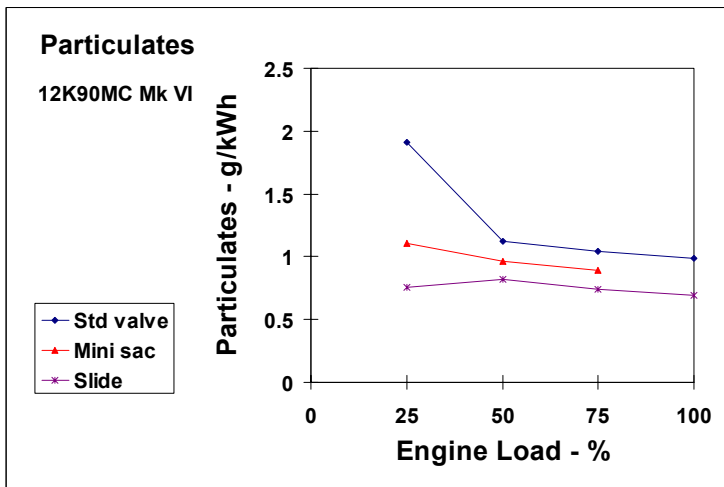
### Hydrocarbons

12K90MC Mk VI



### Particulates

12K90MC Mk VI



## 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**

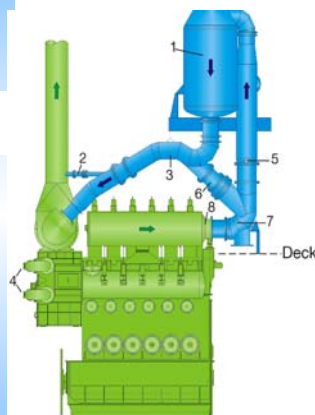
**Usually combined with low-NOx behavior**

**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**

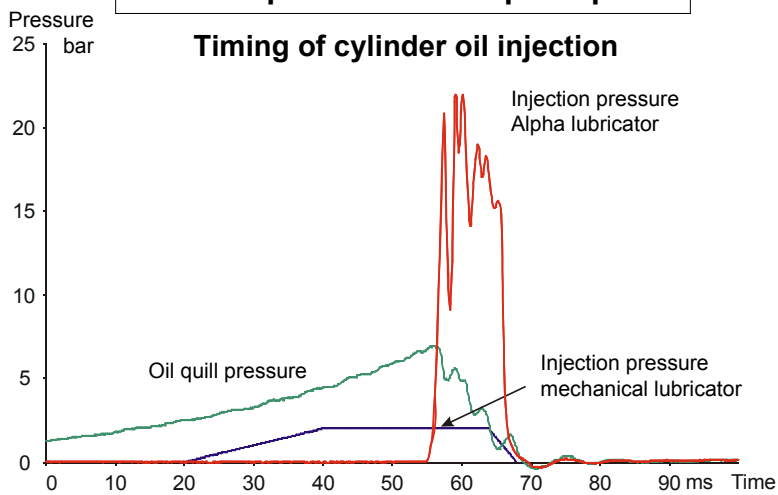
	<i>Prior to installation of SCR</i>	<i>deNO<sub>x</sub> mode with injection of urea</i>
Engine load	75.8%	77%
Turbocharger rpm	15,600	15,700
T/C inlet temperature	440 ° C	440 ° C
Scavenge air pressure	2.02 barg	2.10 barg
NO <sub>x</sub> emission	1100 ppm*	132 ppm* (<2 g/kWh)
Urea consumption	-	62 l/h

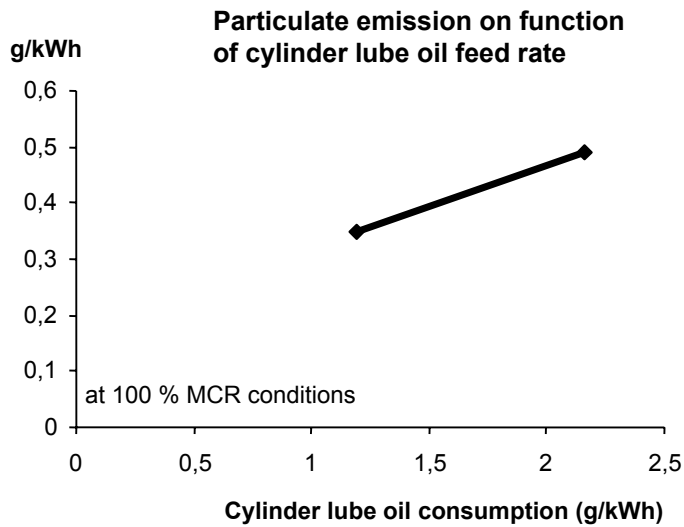
\* Measured during SCR test trial



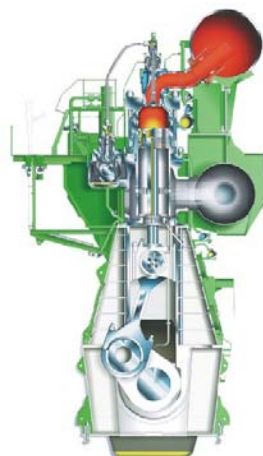
**The Alpha lubrication principle**

**Timing of cylinder oil injection**





### EGR influence on NO<sub>x</sub> formation



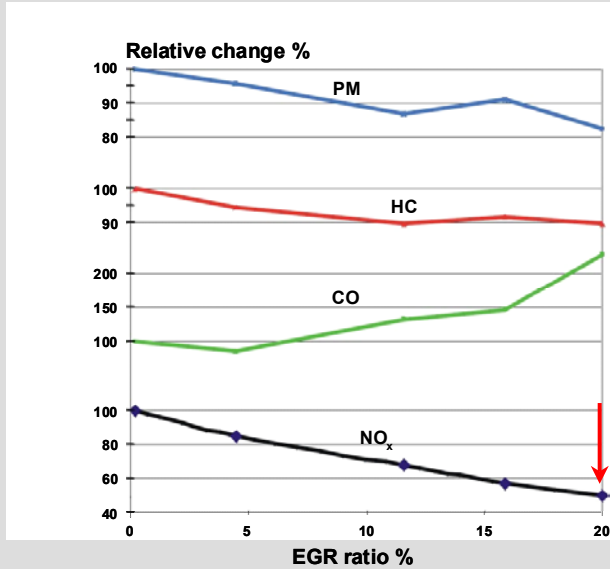
EGR unit

Re-circulation of exhaust gas lowers O<sub>2</sub> in scavenge air

Low O<sub>2</sub> in scavenge air gives low combustion temperatures

Low combustion temperatures give low NO<sub>x</sub>

Influence on reliability and safety: Field test

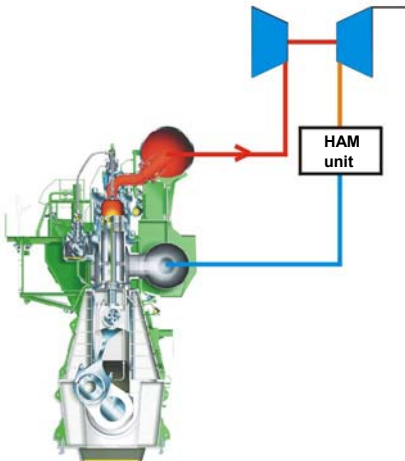


**NO<sub>x</sub> Emission Control  
EGR Emission Parameters**

**Emission Parameters at 75% Load at Various EGR Ratios**



**HAM influence on NO<sub>x</sub> formation**



Humidification of scavenge air increases heat capacity and lower the O<sub>2</sub> content

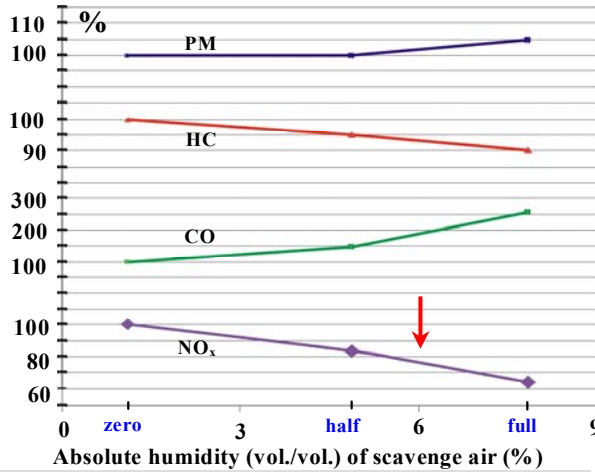
High heat capacity and low O<sub>2</sub> in scavenge air give low combustion temperatures

Low combustion temperatures give low NO<sub>x</sub>

Influence on reliability and safety: Field test



**NOx Emission Control SAM Emission Parameters**



**Example – Application, Cost**

**Evaluation of NO<sub>x</sub> reduction methods and costs for a new 12K80MC engine**

**Assumptions:**

Engine type: 12K80MC  
 Shaft power: 40.680 kW at 104 r/min  
 Initial NO<sub>x</sub> level: 1.500 ppm at 15% O<sub>2</sub>

Means:	Reduction level:	Investment:	Consumption:
<b>Primary means</b> Emission optimised fuel nozzles and valves	0-25%	25.000 USD	Fuel increase up to 2%
<b>Emulsification</b> Incl. homogenizator, larger fuel pumps and NOx optimised nozzles and valves	0-50%	400.000 USD	Fuel increase up to 5% fresh water
<b>Selective catalytic reduction</b> Incl. control equipment, mixer NH <sub>3</sub> handling equipment but excl. piping between SCR catalyst, engine, Ammonia tank and mixer	0-98%	1.500.000 USD	NH <sub>3</sub> 6-7g/kWh at 95% NO <sub>x</sub> reduction



## Summary

- SCR still only solution for 95-98% NO<sub>x</sub> reduction
- EGR and SAM have potentials, but further tests are needed
- Water emulsification possible for Tier 2 NO<sub>x</sub> requirements
- ME engine possibility for further emission reduction is investigated
- Strong impact from fuel injection valves on NO<sub>x</sub>, soot and smoke (case story Wallenius line)



# QUESTIONS

