

Summary of Sine Maersk Testing



Maritime Air Quality Technical Working Group
Long Beach, California
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California Environmental Protection Agency
Air Resources Board

Purpose of Testing

- ◆ Observe the impact of Vessel Speed Reduction (VSR) program
- ◆ Obtain additional information on the baseline emissions from ships and particulate matter (PM) speciation data

Vessel Summary

- ◆ Sine Maersk is a typical large container ship built in 1998
- ◆ Main engine is a 55 MW MAN B&W model 12K90MC with slide valves
- ◆ Auxiliary engines are 3 MW Holeby model 7L32/40
- ◆ Main and auxiliary engines operate on heavy fuel oil

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Emissions Testing Summary

- ◆ Measurements performed at sea between LA & Tacoma, February 2004
- ◆ MAN B&W performed testing with UC Riverside testing staff observing
- ◆ Measured PM, NO_x, HC, CO, CO₂ & O₂
- ◆ Speciated PM by sulfate, carbon, ash, and organic compounds (SOF)
- ◆ Engines used 2.4% sulfur heavy fuel oil

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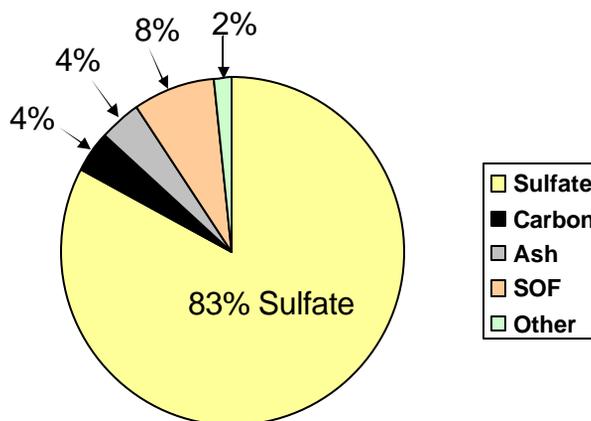
Main Engine Emissions (g/kW-hr)

Pollutant	Engine Load				
	86%	78%	53%	25%	12%
NO _x	20.7	20.3	20.4	23.1	24.2
PM	1.97	1.80	1.55	1.36	1.51
HC	0.08	0.09	0.12	0.14	0.21
CO	0.17	0.17	0.20	0.29	0.36

* 12% load corresponds to 12 knots in VSR zone

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Main Engine PM Speciation*



* Speciation at 50% load.

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Auxiliary Emissions (g/kW-hr)

Pollutant	Engine Load			
	73%	53%	30%	22%
NOx	12.5	12.4	11.4	14.2
PM*	1.83	1.68	1.64	1.74

* PM estimated from measured gaseous components and Bosch number.

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Sine Maersk Main Engine NOx Emissions with & w/o VSR over 20 nm*

Mode	Speed (knots)	Time (hrs.)	Load (%)	Rated Power (kW)	Emission Factor (g/kW-hr)	Emissions (lbs)
VSR	12	1.67	12	55,000	24	582
w/o VSR	24**	0.833	78	55,000	20	1,574

* Simplified comparison for illustration only. Does not account for auxiliary engines/boilers.

** Estimated value.

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What about the increase in auxiliary engine and boiler emissions?*

Mode	Time (hrs.)	Total Auxiliary Engine Power (kW)**	Auxiliary Engine Emission Factor (g/kW-hr)**	Auxiliary Boiler Emission Factor (lb/hr)**	Auxiliary Engine & Boiler Emissions (lbs)**
VSR (12 knots)	1.67	1,500	12.4	2.7	72
w/o VSR (24 knots)	0.833	1,500	12.4	2.7	36

* Simplified comparison over hypothetical 20 nm distance.

** Estimated value.

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Emissions Summary with and without VSR Program*

Mode	Main Engine Emissions (lbs)	Auxiliary Engine/ Boiler Emissions (lbs)	Total Emissions over Route (lbs)
VSR	582	72	654 (60% decrease)
W/O VSR	1,574	36	1,610

* Simplified comparison over hypothetical 20 nm distance. Results will vary with other vessels.

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Observations

- ◆ The VSR program will result in large NOx emission reductions from this vessel
- ◆ Based on similar calculations, the VSR program will result in large PM emission reductions from this vessel, and there will be minor changes in HC & CO emissions
- ◆ The testing adds valuable data to the existing limited pool of emissions data for ships in use
- ◆ Additional vessel testing planned

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