CMV Emissions by Fuel Consumption and Power Demand Methods

Poster 1 - Identification

Title: CMV emissions by fuel consumption and power demand methods
Author: Kwame Agyei, MS (ME), PE (Mech, Env Eng)
Affiliation: Puget Sound Clean Air Agency, Seattle, WA
(206) 689 4054; kwamea@pscleanair.org

Poster 2 - Abstract

Emissions inventories for the Seattle area consistently show that marine vessels emit about 15% of the NOx and 20% of the SOx emitted in the region. The Puget Sound Clean Air Agency used the fuel-based method to estimate the emissions. Recent studies by Starcrest Consultants suggest that a fuel-based method tends to over-estimate marine emissions. Starcrest recommends a power demand method. This paper compares the estimates predicted by the two methods. The paper limits the study to vessels for which we have data to estimate emissions by the fuel consumption method and by the power demand method.

Poster 3 - Description of Contents

Equations and Inputs for fuel consumption method
Assumptions for fuel consumption method
Emission factors for fuel consumption method (Ref: GVRD, Vancouver, BC)
Equation and inputs for power demand method
Assumptions for power demand method
Emission factors for power demand method (Ref: Starcrest, Houston, TX)
Activity levels obtained by either method
Comparison of NOx emissions obtained by either method
Comparison of SOx emissions obtained by either method
Discussion of results and conclusions

Poster 4 - Fuel Consumption Methodology to Estimate Vessel Emissions

Tonne Fuel = (Hours Vessel Spent in Area) * (Gal fuel/hr) * (Conversion Factor)
Emissions = (Tonne Fuel) * (kg pollutant/tonne fuel consumed)

Poster 5 - Assumptions for Fuel Consumption Rates (Gal/hr)

WA State Ferries	-	260 gal/hr (WA Ferries provided actual gal/yr)
Victoria Clipper	-	600 gal/hr (Ref: Victoria Clipper Ferry)
Small Tugs	-	100 gal/hr (Puget Sound Tug Operators)
Big Tugs	-	300 gal/hr (Puget Sound Tug Operators)
Moving Cruise Vessel	-	2800 gal/hr (Chief Engineer, Star Princess)
Hoteling Cruise Vessel	-	700 gal/hr and stays for 10 hrs (S. Princess)

Poster 6 - Emission Factors (Ref: GVRD, Vancouver, BC)

Cruise Vessel	-	93.0 kg NOx/tonne fuel, 49 kg SOx/tonne fuel (2.5% S)
Aux Engines	-	53.4 kg NOx/tonne fuel, 49 kg SOx/tonne fuel (2.5% S)
Tugs	-	60.6 kg NOx/tonne fuel, 2.6 kg SOx/tonne fuel (0.13% S)
Ferries	-	60.6 kg NOx/tonne fuel, 1.0 kg SO2/tonne fuel (0.05% S)

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Poster 7 - **Power Demand Methodology**

Power Output	=	(Load Factor)*(# of Engines Used)*(Rated HP/eng)
Energy Output	=	(Power Output) * (Hours/yr spent in area)
Emissions	=	(Energy Output, kW-hr) * (units pollutant/kW-hr)

Poster 8 - **Assumptions for Power Demand Method**

WA State Ferries	-	Load Factor 0.59, 16 knots, ~ 2700 kW/eng, n eng
Victoria Clipper	-	Load Factor 0.59, 40 knots, 3300 kW/eng, 2 eng
Small Tugs	-	Load Factor 0.31, 12 knots, 3000 kW/eng, 2 eng
Big Tugs	-	Load Factor 0.31, 12 knots, 6700 kW/eng, 2 eng
Move Cruise Vessel	-	Load Factor, 0.31, 12 knots, ~ 50 MW (as given by USCG)
Hotel Cruise Vessel	-	Load Factor, 0.65, ~ 60 MW aux eng, 10-hr stay (USCG)

Poster 9 - **Emission Factors (Ref: Starcrest, Houston, TX)**

Cruise Vessel	-	13.4 kg NOx/MW-hr,	12.9 kg SOx/MW-hr
Aux Engines	-	13.0 kg NOx/MW-hr,	12.0 kg SOx/MW-hr
Tugs	-	13.3 kg NOx/MW-hr,	3.9 kg SOx/MW-hr
Ferries	-	13.3 kg NOx/MW-hr,	0.2 kg SOx/MW-hr

Poster 10 -	**1000 Gal**	**Tonne Fuel**	**MW-hr/yr**
Underway Cruise Vessels	296	1057	12604
Hoteling Cruise Vessels	384	1371	21686
Tugs	13694	43785	215328
WA Ferries, Vic Clipper	13872	44353	320661

Note: 1000 Gal Residual Fuel = 41 MW-hr; 1000 Gal Diesel Fuel = 40 MW-hr

Poster 11 - **Tonnes NOx Emitted in 2002**

Estimation Method	*Fuel Consumption*	*Power Demand*
Moving Cruise Vessels	98	35
Hoteling Cruise Vessels	73	282
Tugs	2653	2864
WA Ferries, Clipper	2688	3600

Poster 12 - **Ton SOx Emitted in 2002**

Estimation Method	*Fuel Consumption*	*Power Demand*
Underway Cruise Vessels	52	34
Hoteling Cruise Vessels	67	260
Tugs	114	840
WA Ferries, Clipper	44	54

Poster 13 - **Conclusions**

The results do not show that fuel consumption methods overestimate emissions. The ferry operators provided the actual ferry fuel consumption. The NOx emissions for both methods agree fairly well for tugs and ferries. Data for tugs and ferries were reliable. The discrepancy in the SOx emissions might be due to incorrect emissions factors

(because of varying fuel quality) and assumed cruise vessel fuel consumption rates not applicable to most of the cruise vessel fleet.