Integration of Vehicle Activity into Emissions Estimation based on On-Board Measurements for Diesel Light-Duty Vehicles

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ABSTRACT

Diesel vehicles market is expanding globally, since these vehicles are attractive in terms of improved fuel economy.

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Portable Emission Monitoring Systems (PEMS) indicate that emissions are not directly proportional to vehicle miles traveled, but are episodic in nature, with high emissions events coinciding with periods of high acceleration and speed.

But… can current methodologies that correlate vehicle activities with emission estimation for light-duty gasoline vehicles (LDGVs) be extended to diesel vehicles (LDDVs)?

Focus: Assess whether current methodologies (namely, Vehicle Specific Power – VSP – approach) that integrate vehicle activities with emission estimation for LDGVs can be extended to LDDVs.

Secondary objective : Compare fuel use and emissions between LDDVs and LDGVs.

METHODOLOGY

Portable Emissions Measurement System (PEMS) in LDDVs & LDGVs

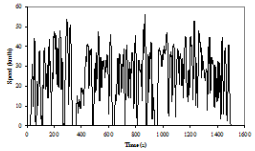
(Second-by-second data)

EURO IV gasoline passenger car, 1.4 L VW Polo 1.4 16V

EURO III family-size diesel vehicle, 1.9 L Skoda Octavia TDI 90 HP

EURO II light commercial diesel vehicle, 2.5 L Citroen Jumper 2.5D

Speed profiles & Emission rates (g/s)



Vehicle Specific Power (VSP) approach

$$VSP = v \cdot [1.1 \cdot a + 9.81 \cdot \sin(\arctan(grade)) + 0.132] + 0.000302 \cdot v^3$$

ANOVA

Average emissions rates by VSP mode (g/s)

Comparison of emissions between LDDV and LDGV

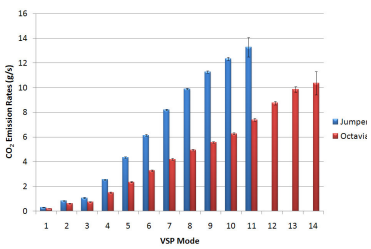
RESULTS

➢ **ANOVA ⇒ Evaluation of statistical significance of the explanatory variables on emission rates**

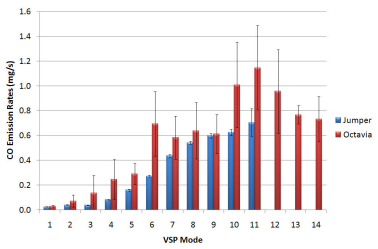
- Strong correlation between speed and facility type, independent of the vehicle.
- Generally speed and VSP are significant factors for emissions rates, and the significance is not as high for facility type.

➢ **Average emission rates for EURO II light commercial diesel vehicle Citroen Jumper 2.5D & EURO III family-size diesel car Skoda Octavia TDI 90 HP:**

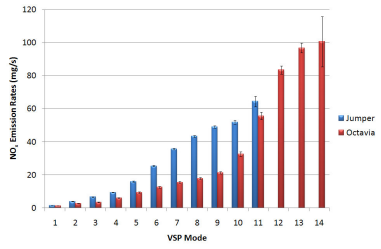
a) CO_2



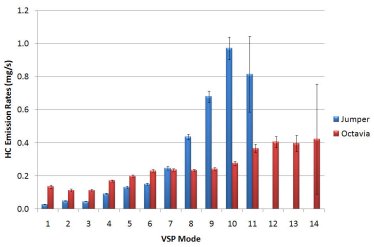
b) CO



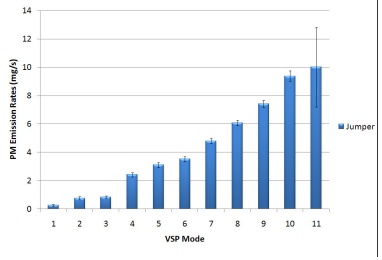
(c) NO_x



(d) HC



(e) PM



➢ **Comparison of emission rates per VSP mode: EURO III Skoda Octavia TDI 90 HP vs. EURO IV Gasoline VW Polo 1.4L**

	LDDV	LDGV
CO_2	👎	👍
CO	👎	👍
NO_x	👎	👍
HC	👍 (Depends from VSP mode)	
PM	👎	👍

CONCLUSIONS

1. VSP is highly correlated with variability in second-by-second emissions of pollutants from diesel vehicles.
2. The VSP method that was previously developed for LDGVs was found to be applicable to LDDVs as well.
3. Modal diesel CO_2, NO_x, HC, and PM mission rates increase for positive VSP for the tested diesel vehicles.
4. Modal CO emission rates for the tested diesel vehicles increase for the Jumper but the trend is less clear for the Octavia. CO emissions appear to be more affected by speed changes and high accelerations compared to other pollutants.
5. CO_2 emission rates are higher for the gasoline Polo compared to the diesel Octavia, even though the gasoline vehicle is newer and smaller ⇒ this is consistent with the expectation that LDDVs are generally more fuel efficient than LDGVs.
6. NO_x emission rates are higher for the diesel Octavia than for the gasoline Polo, but the Polo vehicles generate higher CO emission rates ⇒ this is consistent with the expectation that LDDVs produce higher NO_x and lower CO emissions than LDGVs.

MAIN CONCLUSION:

VSP approach can be used to aggregate micro-scale data from LDDVs to produce driving cycle-based emission estimates.

ACKNOWLEDGMENTS : The research of Dr. M.C. Coelho has the support of the Portuguese Science and Technology Foundation (SFRH/BPD/21317/2005) and Luso-American Foundation (Projects 600-03/2006 & 2-03/2008, within the "PORTUGAL–USA: Networks and Partnerships for Research" Program). The participation of Drs. Zhai, Frey and Rouphail is based partially upon research supported by the U.S. National Science Foundation under Grant No. CMS-0230506 and EPA STAR Grant R831835. Any opinions, findings, conclusions or recommendations expressed in this document are those of the author(s) and do not necessarily reflect the views of the U.S. NSF or EPA. The authors thank Dr. Patrick Lebal, Dr. Guido Lenaers and Dr. Leen Govaerts at VITO for providing PEMS data.