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DEVELOPMENT OF NH_3 EMISSIONS ESTIMATION CAPABILITY IN A COMPREHENSIVE MODAL EMISSIONS MODEL

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Abstract

To provide accurate estimates of Ammonia (NH_3) emissions for inventory purposes, it is important to incorporate the effects of different driving modes on NH_3 emissions levels. Unlike the bag-based emission inventory models such as EMFAC and MOBILE, the newer generation of modal models such as CE-CERT's Comprehensive Modal Emissions Model (CMEM) are based on modal events, with the data collected at second-by-second time resolution. CMEM uses a parameterized physical approach where the emission process is broken down into different components that correspond to physical phenomena associated with vehicle operation and emission production. In this project, we describe the development of NH_3 modules for CMEM. This represents one of the first attempts to incorporate vehicle NH_3 emissions into a more comprehensive emissions model. This new emission component will enhance the emission capabilities of CMEM to meet the demand for greater levels of spatial and temporal resolution necessary for evaluating the effects of vehicle fleet and traffic changes on NH_3 emissions.

Methodology

- 8 Late model vehicles were tested on the FTP, US06, and MEC01v7 driving cycles.
- Vehicles were selected from the LEV, ULEV, and SULEV technology groups.

Table 1. Description of Test Vehicles

Vehicle			Emission group
2000	Honda	Accord	SULEV
2001	Nissan	Sentra CA	SULEV
2001	Chrysler	Sebring	ULEV
2001	Acura	CL	ULEV
2000	Jeep	Grand Cherokee	LEV
2001	Ford	Taurus	LEV
2001	Chevrolet	Cavalier	LEV
2001	Chevrolet	Silverado	LEV

- NH_3 was measured with both Fourier Transform Infrared (FTIR) system and Tunable Diode Laser (TDL).
- TDL NH_3 data was taken at the 1 second level of resolution, allowing for analysis of modal behavior.

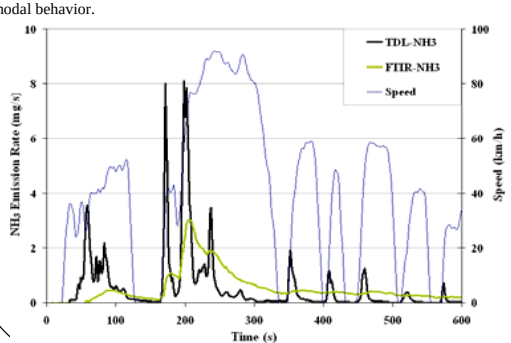

Figure 1. TDL vs. FTIR NH_3 Comparison

Emissions Results

- NH_3 emissions were found to follow a two-slope pattern, with a slow increase in NH_3 with increasing vehicle specific power (VSP) up to a break point, followed by a faster increase in emissions with power after the breakpoint.
- NH_3 emissions were fit using a piecewise linear regression with two linear slopes, an intercept, and a break point estimated from the data.
- All regressions were fit using the bin averaged data because of the greater number of seconds of driving on the test cycles at low power.
- Averaging NH_3 emissions within VSP bins averaged out differences in variability between the two parts of the regression.
- Composite vehicles were derived by averaging the intercept, slopes, and break points for all vehicles within technology groups.

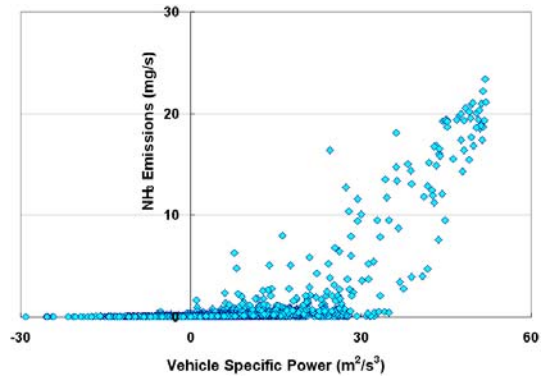

Fig 2. Ford Taurus second-by-second data

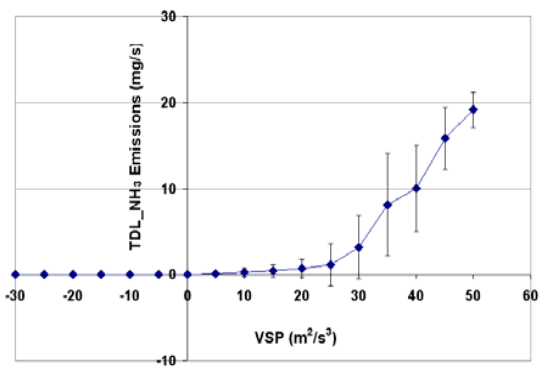

Fig 3. Ford Taurus Bins

Modeling Results

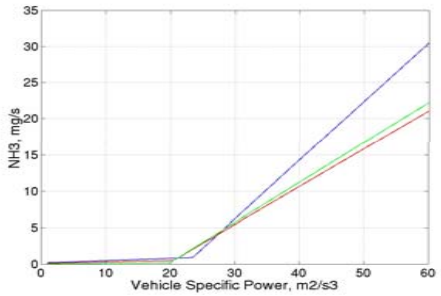

Fig 4. Composite Vehicle NH3 Regressions for LEV (blue), ULEV (red), and SULEV (green).

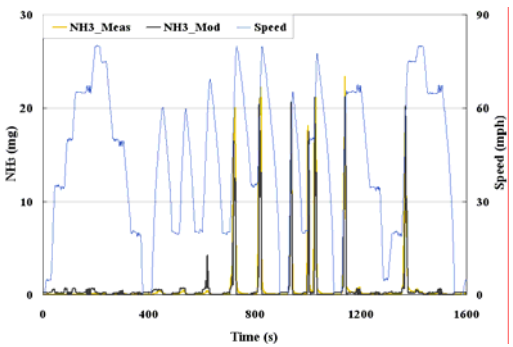

Fig 5. CMEM Validation over MEC01v7 cycle
observed cumulative NH_3 = 55.7mg/mi, modeled NH_3= 52.2mg/mi, difference = 6.2%

Summary and Conclusions

- A TDL can be used to collect NH_3 data with sufficient time resolution to enable modal modeling.
- Vehicle emissions of NH_3 can be modeled with a piecewise linear regression on Vehicle Specific Power.
- Composite vehicles were created using the average of the slopes and breakpoints of the individual regressions.
- NH_3 emissions for the composite vehicles were modeled for the test cycles.
- Future work will include development of NH_3 modules for older vehicle/technology classes for CMEM.