



Development of an Exposure Model for Diesel Locomotive Emissions near the Alameda Corridor

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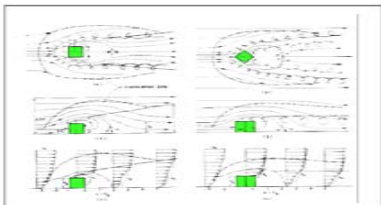
Objectives and Significance

- The objective of the investigation is to measure gaseous pollutants and particulate matter (PM) at different distances from the Alameda Corridor railroad from passage of the diesel trains.
- The study will provide the exposure concentrations of these pollutants at different distances from the Alameda Corridor railroad and can be used for exposure control options such as installation of appropriate filtration systems, avoidance of construction of buildings within a specified distance from the corridor, emission control strategy and dislocating schools to further distances away from the corridor.

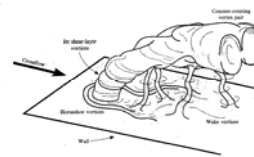
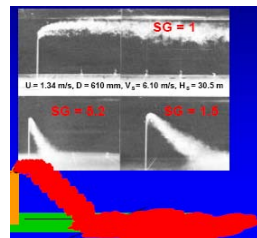
Background

- There are increasing recognitions that particulate air pollution can have an acute effect on human health.
- Previous studies on vehicle emissions near major roads indicate that dispersion and concentration of these pollutants are strongly dependant on local wind speed and direction.
- Weak degrees of correlation between particle numbers and the gaseous concentrations.
- The concentrations of these pollutants are reduced at distances from the major roads.
- All these studies were performed in open areas.

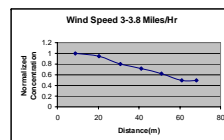
In Urban Areas, Characteristics of Wind Around Buildings Affect the Trajectory of Pollutants.



Characteristics of a Jet in Cross Flow and The Effect of Specific Gravity on Jet's Trajectory



Measurement Site & Preliminary Results



Reducing Pollutants From Mobile Sources

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Objective

An exploratory research for development of a new add-on technology for reducing particulates and NOx emissions of diesel engines.

Background

Three-way Catalytic Converter
For the catalyst to work properly, the combustion process should be nearly stoichiometric. If the exhaust is too lean, NOx are not destroyed and if it is too rich HC and CO are not removed. For a diesel engine, reduction of NOx is very limited due to the fact that diesel engines run lean. Thus, reduction of NOx emissions is performed with design of combustion process and/or the choice of operating conditions.

Exhaust Gas Recirculation (EGR)

In EGR approach, the exhaust gas acts as diluents in the air-fuel mixture to lower the combustion rate and temperature, thus increase its efficiency and reduce NOx emissions. The maximum EGR fraction is 15-20% of the fuel-air flow rate which limits its capability for a high rate of reduction in emissions.

Selective Catalytic Reduction (SCR)

In SCR approach, a hydrocarbon is injected in the diesel exhaust to react with exhaust gases and convert nitrogen oxides to mostly nitrogen dioxide. Urea which is a combination of ammonia and carbon dioxide has been used extensively in agricultural machineries to reduce NOx emissions. Other hydrocarbons are being tested.

Phase I Investigations

Phase I investigation was focused on development of the optimized design parameters for a coil-shaped injector-mixer for injecting a hydrocarbon into the diesel exhaust for reducing NOx emission.

Tasks:

- Experimental investigations of the effect of various coil lengths with optimized pitch and wire diameter on mixing enhancement of a turbulent jet and on pressure drop inside a tube,
- Mixing effectiveness of a heated optimized coil,
- The effect of an optimized coil-shaped oxidizer injector on the NOx emission of a diesel engine.

Results of Phase I Investigations:

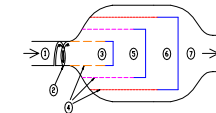
- Results indicate that increased mixing could be obtained with a coil with small L/D ratio and reducing coil length would delay the mixing enhancement to a further downstream location.
- Reducing the coil length decreases the pressure drop across the coil and at very low Reynolds numbers, the increase in the pressure drop is not significant and at very high Reynolds numbers, it is nearly a constant value.

- Emission measurements using the coil-shaped injector with diesel as the post treatment agent showed more than 60% reduction in NOx emission for the limited measurements performed. Further reduction in NOx emission is possible with timing control of engine combustion and the injection process.

Phase II RESEARCH (Development of an Add-on Injector-Filter Unit)

The new add on injector unit has the following components:

- Pretreated exhaust emissions enter the injector-filter unit.
- Hydrocarbon is sprayed into the exhaust and the tubular turbulator induces a mean swirl on the exhaust flow to enhance mixing between the two fluids.
- Screen with different solidities with solid caps.
- 3,5,6. The hydrocarbon reacts with the exhaust to convert it to nitrogen dioxide. The nitrogen dioxide reacts with PM at different stages, as the exhaust gases are passed through different layers of screens with different solidity to "burns off", producing "ash".
- Filtered exhaust exit the unit.



Laboratory and Field Tests

Laboratory tests will be performed with a 2.2 liter diesel engine in a newly established MAE/CEERS Engine Test Cell.

Field Testing will be performed on a Long Beach Transit (LBT) diesel bus with on board emission monitoring equipment. Emissions will be measured during idling with and without injected hydrocarbons.

System Developments

Results of the investigations will be used to develop new high efficiency SCR systems that can reduce more than 85% NOx and significant amount of PM emissions from diesel engines during idling. The SCR filter can be scaled for different size engines, thus it can be used for diesel trucks, diesel buses and stationary diesel engines.