IS CLEAN DIESEL AN OXYMORON?

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The subject of this paper is diesel fuel and clean air. The Engine Manufacturers Association (EMA) is an international trade association that represents worldwide manufacturers of internal combustion engines, including Navistar, for all applications except passenger cars and airplanes. Last year the EMA celebrated its 25th anniversary. The North American diesel engine production quantities by manufacturer in 1993 are:

Manufacturer	Engine Production
Navistar	186,000
Cummins	176,000
General Motors	135,000
Caterpillar	79,000
Deere	72,000
Detroit Diesel	71,000

To expand in the diesel business, one must continue to work hand-in-hand with the regulators, and most importantly, the fuel manufacturers.

The inspiration for the title, "Is Clean Diesel an Oxymoron?" comes from an individual, who when asked to comment on clean diesel, responded that "Clean diesel is an oxymoron." When one sees trucks produce a black cloud of smoke, it is easy to understand why someone might say something like that.

The progress made from the unregulated days in oxides of nitrogen (N0x) (Figure 1) and particulate matter (PM) (Figure 2) emissions are quite impressive. The 1992 heavy duty engine certifications as compared to emission standards are shown in Figure 3 where HC is the Hydrocarbon compounds and CO is the Carbon monoxide.

The three major groups of technologies that reduce exhaust emissions are engine modification, aftertreatment systems and fuel modifications. The engine hardware technologies known to reduce emissions are listed below:

- Optimized Turbochargers.
- Charged Air Cooling.
- Intake Manifold & Port Design.
- Combustion Chamber Design.

- Oil Control.
- Retarded Injection Timing.
- Higher Injection Pressure.
- Electronic Controls.
- Injection Nozzle Configuration.
- Rate Shaping.
- EGR Cooled EGR.
- Variable Geometry/Waste-gated Turbochargers.

Exhaust emissions can be further reduced by aftertreatment devices shown below:

- Oxidation Catalyst.
- Particulate Traps.
- NO_x Catalyst.

Oxidation Catalyst reduces SOF and global warming Particulate Traps, burn carbonaceous PM (soot), of and NO_x Catalyst reduce NO_x (and must be developed). When new technologies are developed to reduce emissions, other factors should be considered. Some of these new technology issues are:

- Durability.
- Reliability.
- Fuel Efficiency.
- Customer Acceptance.
- Customer Satisfaction.
- Costs
 - Developmental;
 - Initial Purchase; and
 - Life Cycle.

The third method to reduce diesel exhaust emissions is through cleaner diesel fuels. In 1994, diesel fuel has:

- 0.05% by Weight Maximum Sulfur Content.
- Cap on Aromatics at 35% by Volume.
- PM Emissions of 0.065 g/bhp-hr.

California will require a 10% aromatic fuel in 1994 that goes much further in the concept of clean diesel fuel.

From the engine manufacturers perspective, the following changes in diesel fuel properties will improve emissions:



FIGURE 1 EPA Heavy-Duty Truck engine NOx emission standards.



Model Year FIGURE 2 EPA Heavy-Duty Truck engine PM emission standards.



FIGURE 3 EPA 1992 Heavy-Duty engine certification compared to emission standards.

- Sulfur Reduction.
- Aromatic Reductions or C/H Ratio Control.
- Cetane Enhancement.
- Distillation Curve Control.
- API Gravity Control.
- Use of Oxygenates.
- Other Improvements.

Sulfur reduction includes PM reduction, more aggressive oxidation catalyst, and a more feasible NOx catalyst. Aromatics reductions are both PM and NOx reduction with no tradeoff. The EMA believes the Cetane enhancement will be the most cost-effective improvement. They have proposed to API to raise minimum Cetane from 40 to 55. Higher cetane will also help with customer satisfaction in the areas of noise, cold starting and white smoke. The use of Oxygenates will provide large reductions in PM with a small NOx penalty according to a Coordinating Research Council (CRC) study.

Improvements in diesel fuel quality will result in: reduced emissions from all diesel engines, not just future engines; emissions reductions beyond those obtainable with engine hardware changes; emission improvements that will not deteriorate with time; and allowing engine manufacturers the opportunity to make additional engine changes to provide emissions reductions which would not otherwise be practical. Such improvements only serve to add to the environmental advantages of diesel fueled diesel engines. To help overcome the negative connotations of diesel, a former Navistar VP suggested clean diesel fuel should be called "Envirolene."

Clean diesel is not an oxymoron. Diesel engines have played a significant role in helping the United States to become a great industrial nation. Some diesel advantages are:

- Fuel Economy;
- Safety;
- Customer Acceptance;
- Global Warming;
- Low HC & CO Emissions;
- Improved PM & N0x Control;
- · Potential of Clean Diesel Fuel; and
- Fuel Infrastructure in Place.

The net result of these efforts is that in the near future one will not be able to tell if a diesel truck is standing still or accelerating by looking at the exhaust stack.