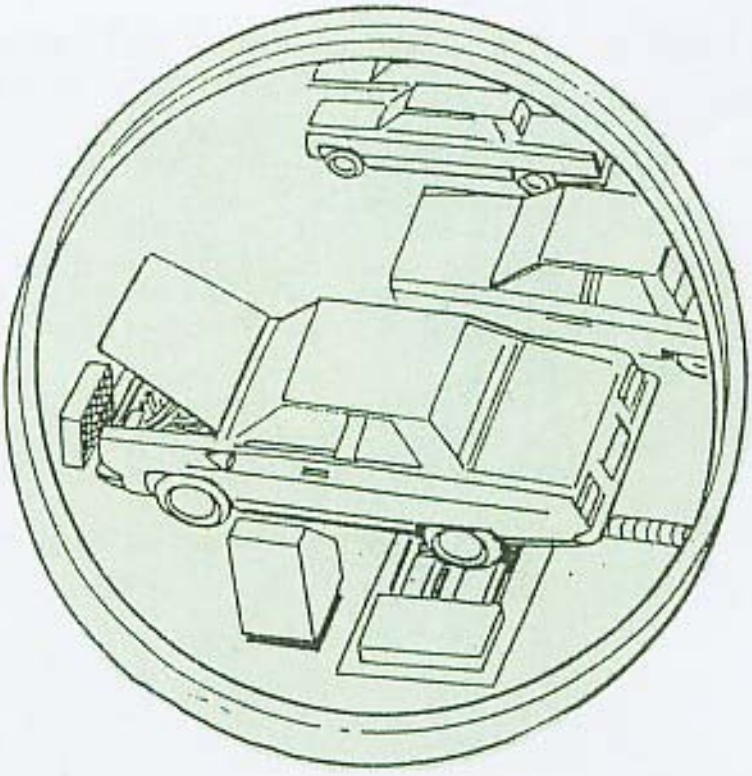
EFFECTS OF 'FUELSTAR' FUEL CATALYST ON LIGHT HEAVY-DUTY DIESEL VEHICLES

January, 2003

RESEARCH PROJECT CEE-02-8

ACCOMPLISHED FOR:

FUELSTAR INTERNATIONAL LTD.
14 D PARITY PLACE, GLENFIELD
AUCKLAND, NEW ZEALAND



Accomplished by:

California Environmental Engineering
3231 South Standard Avenue
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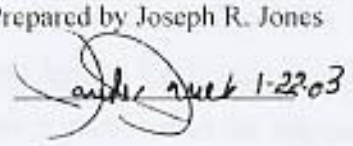
Prepared by Joseph R. Jones



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Joseph Jones, Program Management

California Environmental Engineering
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Introduction

Over the past several years, there has been increased national and international interest in alternative methods to control emissions and improve fuel economy of Diesel fueled vehicles. This is particularly true in the United States where Diesel Particulates have been declared as carcinogenic. In the following study an 'in-line' fuel catalyst (Fuelstar PSC100) was used to examine the effects it would have on both 'tailpipe emissions' and fuel economy. Chassis dynamometer tests were performed on a representative light-heavy duty diesel truck using California controlled diesel test fuel (CFR40, Part 86, 1313-94) which had an aromatic average level of thirteen percent (13 %) and a sulfur content of 400 PPM. A series of five dyno tests were run **with** and **without** the Fuelstar device.

The Federal EPA Urban Dynamometer Driving Schedule (UDDS) was used as the test of choice for the research. The 'UDDS' driving schedule consisted of a distinct non repetitive series of idle, acceleration, cruise, and deceleration modes of various time sequences and rates. The 1371-second test varies in speed ranging from 8 to 56.5 Miles Per Hour (MPH) and offers the fuel catalyst an optimum opportunity to display maximum effectiveness. The tests were conducted in August 2002 at the California Environmental Engineering (CEE) test facility in Santa Ana, California. The test facility is an independent laboratory certified by the California Air Resources Board (CARB) and recognized by the Federal Environmental Protection Agency (EPA). Located in Southern California, the test facility has tested thousands of light-and-medium-duty vehicles for most major vehicle manufacturers. Additionally, CEE has an engine test facility for both light and heavy-duty engines and a customized motorcycle dyno. The CEE facility is routinely subjected to Quality Audit (QA) inspections by the California Air Resources Board. A copy of the most recent QA inspection report is provided in the appendix.

The test vehicle selected and procured for use in the research was a 1987 model year Nissan "UD" truck with a manual-5-speed transmission. The truck, model CLA, had an engine displacement of 423 cubic inches and an accumulated mileage of 105,442. An eighteen foot (18') insulated box was removed to facilitate test cell space and chassis dyno weight constraints.

Testing Parameters & Protocol.

A series of five (5) 'UDDS' test cycles were run to establish tailpipe emission levels and fuel economy coefficients. Emission levels were calculated in Grams Per Mile (GPM) and fuel economy in Miles-Per-Gallon (MPG). Exhaust measurements were made for HydroCarbons (HC), Carbon Monoxide (CO), Nitrogen Oxides (Nox) and Particulate Matter (PM). The individual Particulate filters, after drying, were analyzed by Truesdail Laboratories. Truesdail is a leading Southern California Analytical Lab approved by CARB and EPA. They are located in close proximity to the CEE test facility.

Vehicle Preconditioning.

The selected test vehicle was fitted with a model PSC100 Fuelstar catalyst. Restorative maintenance was performed to include changing the oil, and the oil, air and fuel filters. Installation of the fuel catalyst was accomplished under supervision of a Fuelstar engineering specialist from the United Kingdom. The unit was installed vertically on the engine side of all filters. The fuel line between the Fuelstar unit and the engine was appropriately replaced with a new comparable line. Fifty plus (50+) miles was accumulated on the test vehicle using a transient driving cycle as recommended by CARB procedures. The route is a simulation of the American Motoring Association (AMA) driving schedule recognized by both CARB and EPA. It is a compilation of variable accelerations and decelerations using public roads and streets.

Emission Test Results

A series of five UDDS tests were performed with and without the Fuelstar catalyst. The initial data set was used as the "baseline" for comparison. The fifth data set was compared to the baseline for determining statistical significance. The data for the various gases measured indicate the percentage of difference from the first baseline test to the last test and are shown in the graph and table provided as **figure 1**.

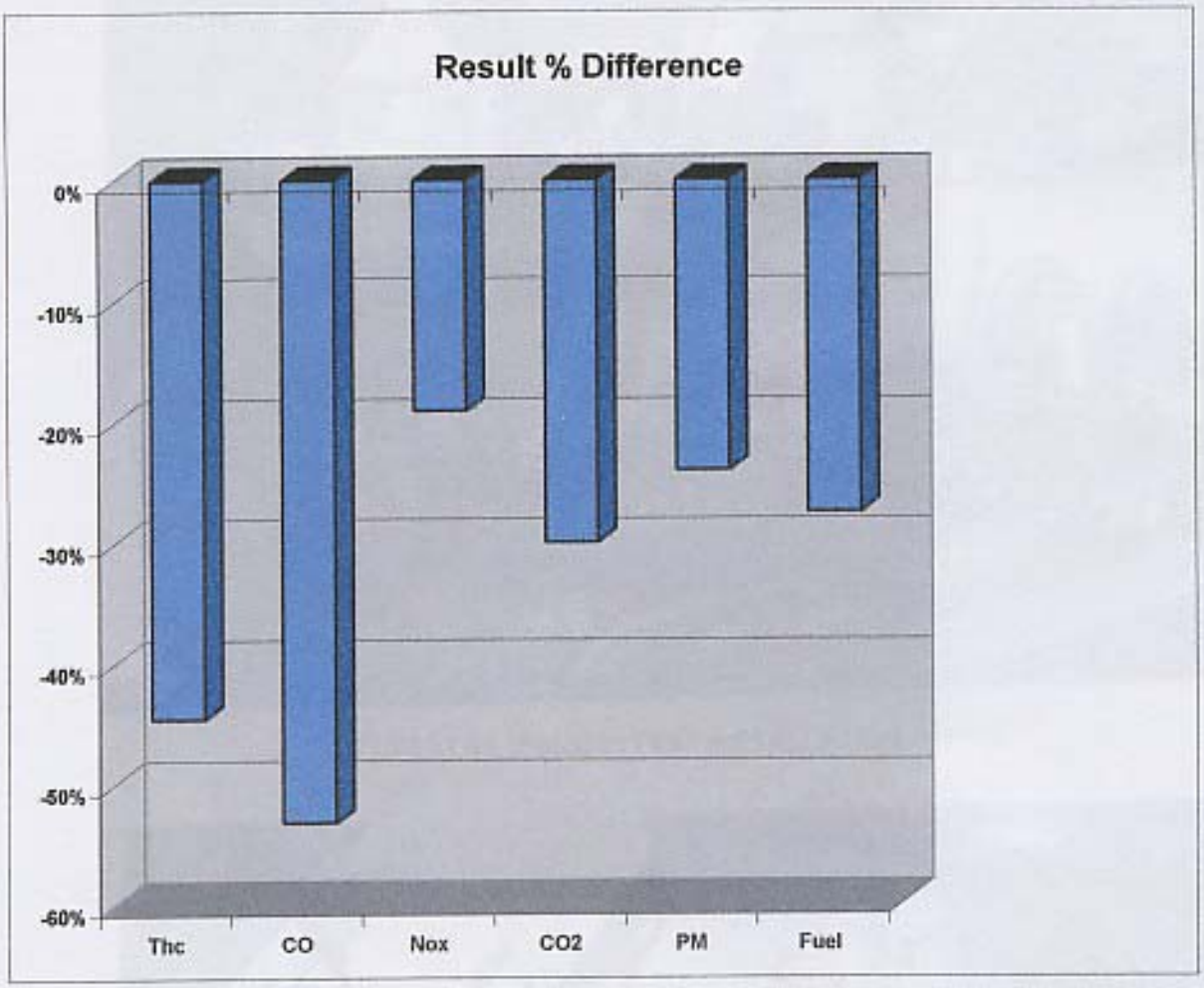
The results are based on the percentage of difference of weighted gaseous and PM mass emission rates between the baseline and the final test. While the data considered is based on a single vehicle the detailed testing with time provides an expected statistical pattern. Based on the trend of emission reduction with time, the emission and particulate results achieved could be expected to further lower with continued vehicle/engine use. It supports previous proven principle of operation that the Fuelstar catalyst improves combustion efficiency and is further enhanced with time (use). The catalyst had a more limited 'movement potential' (mp) in the laboratory and dyno-test environment. However, the 'mp' factor with time is considered meaningful to the final test data. It can be anticipated that more movement (vibration) representative of actual on-road use would further enhance operation of the in-line fuel catalyst and improve overall combustion efficiency.

The reduction of gaseous tailpipe emissions and particulate and the improvement in fuel economy is notable and considered meaningful. The largest emission effect was observed for the THC and CO emissions. Significant emission reductions were obtained for both Nox and Particulate when calculating the overall database using a factor of 2-times the standard error. The overall test time sequence, first to last, included vehicle preconditioning and a large amount of static (in-place) vehicle running. The total time duration including the actual test(s) encompassed an operational profile simulating several hundred engine hours. Based on the trend of emission reduction with time, the emissions and particulate results achieved using the Fuelstar catalyst could be expected to further decrease substantially with an improvement in fuel economy with continued vehicle/engine use.

Back Pressure and Noise Tests were accomplished concurrent with the Laboratory Testing. A BEHA-Model 93-20 sound level meter was used for the noise tests conducted in compliance with the US-SAE procedures. Back Pressure Readings were obtained using a calibrated pressure gauge strategically located in the exhaust line. **No notable change in decibel sound level or Back Pressure level was registered when using the Fuel Star Fuel Catalyst.**

Acknowledgments

We wish to acknowledge the significant support of Kim Popejoy, Vehicle Procurement Director of California Environmental Engineering (CEE), for assisting in identifying and procuring the test vehicle. We thank James Dietrich and Mike Barnett for their statistical analysis of the database and Arturo Herrera, CEE Lab manager, for his 'all night' testing vigil.



Percentage (%) Difference from First to Last Test

	Thc	CO	Nox	CO2	PM	Fuel
First test	0.833	3.434	8.564		0.4315	-13.815
Last test	0.462	1.606	6.931		0.3276	-17.618
Result % diff'nce	**-44.54%**	**-53.23%**	**-19.07%**	**-30.00%**	**-24.08%**	**-27.53%**

FUELSTAR (PC100) TEST INSTALLATION

FUELSTAR TEST VEHICLE (NISSAN UD)