A division of

Olson Engineering, Inc.

Effect of the Rentar In-line-Fuel Catalyst on Elemental and Organic Carbon Particulates

Cummins N-14 Diesel Engine Operating on California Specification No. 2 Diesel Fuel

Prepared for

Rentar Environmental Solutions, Inc.
11586 Pierson Road
West Palm Beach, FL 33414

January 2004

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Introduction

A project sponsored by Rentar Environmental Solutions, Inc. was conducted at the Ecologic Engine Testing Laboratory of ETS, a division of Olson Engineering, Inc. The objective was to measure the effect of the Rentar in-line-fuel catalyst for reducing elemental and organic carbon particulates in the exhaust when a Cummins N-14 Diesel engine was operated over two typical test cycles with conventional California specification No. 2 diesel fuel

Test Vehicle

The test vehicle is a 1994 model over-the-road Peterbuilt tractor powered by a Cummins N-14 Diesel engine (V.I.N. # RD355104). The six cylinder Diesel engine is rated at 350 HP in this application. The tractor registered 1,062,760 miles on the odometer at the project beginning.

Test Fuel

The test fuel was a California specification No. 2 Diesel fuel.

Test Protocol

The project included testing by the Urban Dynamometer Driving Sequence – Heavy Duty cycle (UDDS – HD and 55 MPH steady state operation at 20 road load horsepower. The UDDS-HD protocol is described in the Code of Federal Regulations (CFR 40, 86). Duplicate data sets were collected on the baseline fuel. After completion of baseline testing the Rentar in-line fuel catalyst was installed exactly as specified by the Rentar representative. The test vehicle was operated over a typical driving pattern on the chassis dynamometer for 100 hours. Filter samples from the UDDS cycle and steady state operation were also collected at 90 hours. Duplicate exhaust particulate filter samples were then captured at 100 hours. All filters and filter holders were prepared and provided by the independent outside laboratory (DATACHEM Laboratories, Salt Lake City, UT) that subsequently did the analyses.

Results

Element carbon (EC) and Organic carbon (OC) were captured during the two test cycles. The National Institute for Occupational Safety and Health (NIOSH) Method 5040, which is designed to determine the mass of EC and OC from a filter, was performed for the EC/OC analysis by the outside independent laboratory (DATACHEM Laboratories, Salt Lake City, UT). The EC/OC summary results are tabulated on the next two pages.

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TABLE 1

RESULTS SUMMARY

EFFECT OF THE RENTAR IN-LINE-FUEL CATALYST ON ELEMENTAL AND ORGANIC CARBON CAPTURED FROM THE TAILPIPLE DURING TYPICAL OPERATING CYCLES

CHASSIS DYNAMOMETER TESTING
PETERBUILT FREIGHTLINER TRACTOR
POWERED BY A CUMMINS N-14 DIESEL ENGINE
CALIFORNIA SPECIFICATION NO. 2 DIESEL FUEL

UDDS – HD Transient Cycle

Baseline Data

	Grams per Cubic Meter		
Test Number	OC	EC	Total Carbon
2	0.0046	0.001	0.0056
5	0.0046	0.001	0.0056
Average	**0.0046**	**0.001**	**0.0056**

90 Hours with Device

	Grams per Cubic Meter		
Test Number	OC	EC	Total Carbon
90 hrs	0.0045	0.0008	0.0053
5	0.00434	0.00081	0.0052
Average	**0.00442**	**0.0008**	**0.0053**

100 Hours with Device

	Grams per Cubic Meter		
Test Number	OC	EC	Total Carbon
1	0.0038	0.0007	0.0045
5	0.00377	0.00066	0.0044
Average	**0.0038**	**0.00068**	**0.0045**
Change % at 100 hours	**-17.4**	**-32**	**-19.6**

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TABLE 1
(Continued)

Steady-State 55 MPH

Baseline Data

	Grams per Cubic Meter		
Test Number	OC	EC	Total Carbon
1	0.0059	0.0013	0.0072
6	0.0059	0.0017	0.0076
Average	**0.0059**	**0.0015**	**0.0074**

90 Hours with Device

	Grams per Cubic Meter		
Test Number	OC	EC	Total Carbon
120803	0.0057	0.0012	0.0069

100 Hours with Device

	Grams per Cubic Meter		
Test Number	OC	EC	Total Carbon
2	0.00559	0.00135	0.0069
4	0.00647	0.00118	0.0077
Average	**0.006**	**0.0013**	**0.0073**
Change % at 100 hours	**+1.7**	**-13.3**	**-1.4**

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DATA CHEM LABORATORIES
A Sorenson Company

ANALYTICAL REPORT

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Part 1 of 1
0217040B222122RX

Date FEB 17 2004
Laboratory Group Name 03I-2985-03
Account No. 07350

Olson Engineering
Attention: Alfred Ng
1370 South Acacia Ave.
Fullerton, CA 92831

FAX
Telephone (714) 774-3569
E-mail ngxx0029@tc.umn.edu

Sampling Collection and Shipment

Sampling Site Ecologic Engine Lab Date of Collection

Date Samples Received at Laboratory November 20, 2003

Analysis

Method of Analysis NMAM 5040

Date(s) of Analysis November 23, 2003 - December 23, 2003

Analytical Results

Field Sample Number	Laboratory Number	Sample Type	Organic Carbon µg/sample	Elemental Carbon µg/sample	Total Carbon µg/sample	Organic Carbon mg/m³	Elemental Carbon mg/m³	Total Carbon mg/m³	Air Volume L		
2A	03I35706	FILTER	1100	240	1300	12.	2.8	15.	88.33		†
2B	03I35707	FILTER	59.	ND	59.	0.67	<0.015	0.67	88.33		†
5	03I35712	FILTER	1100	230	1300	13.	2.6	15.	88.33		†
5	03I38619	FILTER	2300	430	2700	4.3	0.81	5.1	530		†
90 HR A	03I38622	FILTER	2400	410	2800	4.5	0.78	5.3	530		†
90 HR B	03I38623	FILTER	76.	ND	76.	0.14	<0.0025	0.14	530		†
UDDS 1A	03I42190	FILTER	2000	360	2400	3.8	0.68	4.5	530		†
UDDS 1B	03I42191	FILTER	75.	1.8	76.	0.14	0.0034	0.14	530		†
UDDS 5	03I42196	FILTER	2000	350	2300	3.8	0.66	4.4	530		†
Reporting Limit			5.2	1.3	6.5						

† See comment on last page.
ND Parameter not detected above LOD.
NR Parameter not requested.
NA Parameter not applicable.

** See comment on last page.
( ) Parameter between LOD and LOQ.

Analyst: Mei Qi Huang

Reviewer: Penny A. Foote

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DATA CHEM LABORATORIES
A Sorenson Company

ANALYTICAL REPORT

021704082221 22RX

Date FEB 17 2004
Laboratory Group Name 03I-2985-03

General Set Comments

Method Reference: NIOSH Manual of Analytical Methods (NMAM) fourth ed., 9/30/99
Sample analysis was performed on a representative 1x1.5 cm^2 area of the sample filter. The reported µg/sample values correspond to the entire exposed area of the sample. The µg/sample values assume an even distribution of organic and elemental carbon on the exposed area of the sample filter. The value for the exposed area is either specified by the client or calculated by subtracting 2 mm (the width of the cassette rim) from the edge of the filter.

Blank correction was performed as instructed by client as follows:
Blank corrected sample 2A (03I35706) with sample 2B (03I35707).
Blank corrected sample 90 HR A (03I38622) with sample 90 HR B (03I38623).
Blank corrected sample UDDS 1A (03I42190) with sample UDDS 1B (03I42191).
Blank corrected 5 (03I35712) with the submitted media blank.

Sample Comments

Laboratory Number	Comment	
03I35706	See set comments.	
03I35707	See set comments.	Not blank corrected.
03I35712	See set comments.	
03I38619	See set comments.	Not blank corrected.
03I38622	See set comments.	
03I38623	See set comments.	Not blank corrected.
03I42190	See set comments.	
03I42191	See set comments.	Not blank corrected.
03I42196	See set comments.	Not blank corrected.

General Lab Comments

The results provided in this report relate only to the items tested.
This page is the concluding page of the report.

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RESULTS SUMMARY

EFFECT OF THE RENTAR IN-LINE-FUEL CATALYST ON ELEMENTAL AND ORGANIC CARBON CAPTURED FROM THE TAILPIPLE DURING TYPICAL OPERATING CYCLES

CHASSIS DYNAMOMETER TESTING
PETERBUILT FREIGHTLINER TRACTOR
POWERED BY A CUMMINS N-14 DIESEL ENGINE
CALIFORNIA SPECIFICATION NO. 2 DIESEL FUEL

Steady-State 55 MPH

Baseline Data

	Grams per Mile		
Test Number	EC	OC	Total Carbon
1	0.03	0.138	0.168
6	0.04	0.138	0.178
Average	**0.035**	**0.138**	**0.173**

90 Hours with Device

	Grams per Mile		
Test Number	EC	OC	Total Carbon
120803	0.028	0.133	0.161

100 Hours with Device

	Grams per Mile		
Test Number	EC	OC	Total Carbon
2	0.033	0.135	0.168
4	0.028	0.151	0.179
Average	**0.031**	**0.143**	**0.1735**
Change % at 100 hours	**-11.4**	**+3.6**	**+0.3**

DATA CHEM LABORATORIES
A Sorenson Company

ANALYTICAL REPORT

Form ARF-AL
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Part 1 of 1
021704082333358RX

Date FEB 17 2004
Laboratory Group Name 03I-2985-04
Account No. 07350

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Sampling Collection and Shipment

Sampling Site Ecologic Engine Lab Date of Collection

Date Samples Received at Laboratory November 20, 2003

Analysis

Method of Analysis NMAM 5040

Date(s) of Analysis November 23, 2003 - December 23, 2003

Analytical Results

Field Sample Number	Laboratory Number	Sample Type	Organic Carbon µg/sample	Elemental Carbon µg/sample	Total Carbon µg/sample	Organic Carbon mg/m³	Elemental Carbon mg/m³	Total Carbon mg/m³	Air volume L		
1A	03I35708	FILTER	450	98.	550	16.	3.5	19.	28.33		†
1B	03I35709	FILTER	37.	ND	37.	1.3	<0.046	1.3	28.33		†
6A	03I35713	FILTER	1000	290	1300	18.	5.1	23.	56.67		†
6B	03I35714	FILTER	55.	ND	55.	0.97	<0.023	0.97	56.67		†
120803 1A	03I38624	FILTER	970	200	1200	5.7	1.2	6.9	170		†
120803 1B	03I38625	FILTER	100	11.	110	0.61	0.065	0.67	170		†
S.S. 2A	03I42192	FILTER	950	230	1200	5.6	1.3	6.9	170		†
S.S. 2B	03I42193	FILTER	59.	1.9	61.	0.35	0.011	0.36	170		†
S.S. 4	03I42195	FILTER	1100	200	1300	6.7	1.2	7.9	170		†
Reporting Limit			5.2	1.3	6.5						

† See comment on last page.
ND Parameter not detected above LOD.
NR Parameter not requested.
NA Parameter not applicable.

** See comment on last page.
( ) Parameter between LOD and LOQ.

Analyst: Mei Qi Huang

Reviewer: Penny A. Foote

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