



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



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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RESULTS SUMMARY

EFFECT OF THE RENTAR IN-LINE-FUEL CATALYST ON ELEMENTAL
AND ORGANIC CARBON CAPTURED FROM THE TAILPIPE 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

Test Number	EC	Grams per Mile	
		OC	Total Carbon
2	0.065	0.298	0.363
5	0.066	0.302	0.368
Average	0.0655	0.300	0.3655

90 Hours with Device

Test Number	EC	Grams per Mile	
		OC	Total Carbon
90 hrs	0.053	0.297	0.350
5	0.053	0.284	0.337
Average	0.053	0.291	0.344

100 Hours with Device

Test Number	EC	Grams per Mile	
		OC	Total Carbon
1	0.046	0.251	0.297
5	0.044	0.251	0.295
Average	0.045	0.251	0.296

Change % at 100 hours	-31.3	-16.3	-19.02
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TABLE 1
(Continued)

Steady-State 55 MPH

Baseline Data

Test Number	OC	Grams per Cubic Meter	
		EC	Total Carbon
1	0.0059	0.0013	0.0072
6	0.0059	0.0017	0.0076
Average	0.0069	0.0016	0.0074

90 Hours with Device

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

100 Hours with Device

Test Number	OC	Grams per Cubic Meter	
		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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ANALYTICAL REPORT

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Date FEB 17 2004
 Laboratory Group Name Q3T-2985-03
 Account No. 07350

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

FAX _____
 Telephone (714) 774-3569
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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/m ³	Elemental Carbon mg/m ³	Total Carbon mg/m ³	Air Volume L	
2A	03I35706	FILTER	1100	240	1300	12.	2.6	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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ANALYTICAL REPORT

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02170408222122RX

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 cm² 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.

RESULTS SUMMARY

EFFECT OF THE RENTAR IN-LINE-FUEL CATALYST ON ELEMENTAL AND ORGANIC CARBON CAPTURED FROM THE TAILPIPE 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

Test Number	EC	Grams per Mile	
		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

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

100 Hours with Device

Test Number	EC	Grams per Mile	
		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



ANALYTICAL REPORT

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FEB 17 2004

Date _____
 Laboratory Group Name 03I-2985-04
 Account No. 07350

Olson Engineering
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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 µg/m ³	Elemental Carbon µg/m ³	Total Carbon µg/m ³	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



ANALYTICAL REPORT

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Page 2 of 2
02170408233358RX

Date FEB 17 2004
Laboratory Group Name 03I-2985-04

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 cm² 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 1A (03I35708) with sample 1B (03I35709).
Blank corrected sample 6A (03I35713) with sample 6B (03I35714).
Blank corrected sample 120803 1A (03I38624) with sample 120803 1B (03I38625).
Blank corrected sample S.S. 2A (03I42192) with sample S.S. 2B (03I42193).

Sample Comments

Laboratory Number	Comment
03I35708	See set comment.
03I35709	See set comment. Not blank corrected.
03I35713	See set comment.
03I35714	See set comment. Not blank corrected.
03I38624	See set comment.
03I38625	See set comment. Not blank corrected.
03I42192	See set comment.
03I42193	See set comment. Not blank corrected.
03I42195	See set comment. 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.

