

ISO 9001:2000 Registered

Final Report

Emission and Fuel Consumption Testing Comparison Data With Pureflow System Installed on a Caterpillar Diesel Engine

Testing by the ISO 8178 8-Mode Test Protocol

For Pureflow Technologies, Inc.

Revised August 12, 2005

By

Olson-EcoLogic Engine Testing Laboratory



Introduction:

This emissions and fuel consumption testing project was funded by PureFlow Technologies, Inc. The purpose was to evaluate the PureFlow retrofit system installed in the fuel delivery line of a diesel engine. This system is intended to restore or improve engine performance, particularly in the presence of fuel delivery system problems such as air entrainment or fuel supply line cavitation.

Test Protocol:

All specific test protocols were based on the official ISO 8178 8-mode test procedure. This is the test protocol that is used for EPA certification of heavy-duty engines for off-road applications. It consists of 8 steady-state operating modes conducted with the engine in a fully warmed up condition. Exhaust emissions and fuel consumption are measured continuously for each mode and the last two minutes of a six-minute cycle are averaged and weighted to provide the composite results reported in mass per brake horsepower-hour. Fuel is measured for each mode gravimetrically and all gaseous emissions are corrected for humidity and temperature and reported in mass per bhp-hr. Particulates (PM) are captured on a pre-weighed filter media and reweighed at the end of each test.

Testing Conditions:

The test engine was supplied by Olson EcoLogic. It was a Caterpillar 3045 direct injection diesel engine, installed in a steady-state test cell at Olson EcoLogic. The engine had low operating hours and was in good condition. This engine was rated at 90 hp @ 2400 rpm. It uses a rotary-type fuel injection pump that is typical of engines in this class. The test setup was typical of steady state engine testing. The test instrumentation was calibrated before testing and operated according to the ISO 8178 protocol.

This project was conducted with major client participation in setting up the fuel delivery system. Except for baseline testing, all tests were conducted with fuel system modifications installed by the client representatives. The specific tests conducted were according to client direction, and included the following scenarios as defined by the client:

- A. Test the stock diesel fuel system to develop a baseline.
- B. Add the PureFlow system to an otherwise unmodified engine to see if PureFlow changed this baseline.
- C. Introduce a controlled “problem” for the PureFlow to solve. The fuel system was modified by the client to provide air entrainment in diesel fuel. Test the “problem” condition without the PureFlow to determine impact on baseline conditions. Note that one test originally labeled as a “C” scenario obviously does not match “C” tests. Accordingly, it is listed as an unknown scenario in the summary table.
- D. Add the PureFlow to determine if the air entrainment “problem” is solved.
- E. Test fuel line restriction or cavitation effect by removing the PureFlow and inducing a known restriction in the fuel supply line.



F. Add the PureFlow to determine if the cavitation “problem” is solved.

Results:

The results are summarized in Table 1 and individual tests are provided in the Appendix. This emission and fuel consumption testing project was funded by Pureflow Technologies, Inc. to evaluate their retrofit system installed in the fuel delivery line for improving performance based on the Pureflow device treatment of agitated or severely vibrated fuel.



Table 1
Pureflow Technologies, Inc.
Data Summary of all ISO 8178 8-Mode Emission Tests
Olson-Ecologic Engine Testing Laboratory

Test No.	Date	Description	Scenario	Wtd. HPGrams per BHP-Hour.....				
					THC	CO	NOx	Fuel	PM
PB01 B/L	5/26/2005	Baseline	A	45.66	0.17	8.47	3.80	214.76	
PB02 B/L	5/26/2005	Baseline	A	45.59	0.18	8.00	4.11	215.70	
PB03 B/L	5/26/2005	Baseline	A	45.57	0.19	8.55	4.21	219.48	
			Average	45.61	0.18	8.34	4.04	216.65	
			Std.Dev.	0.047	0.011	0.297	0.214	2.499	
			95% C.L.	0.053	0.012	0.337	0.242	2.827	
PF C	5/27/2005	Air - no PF	C	36.02	0.23	8.54	7.78	215.02	
PB C part2	5/27/2005	Air w/ PF	D	45.69	0.19	8.34	4.19	212.43	
PF Aerator only	5/27/2005	Air - no PF	C	39.18	0.26	8.43	7.45	220.12	
B 01	5/31/2005	No air w/ PF	B	45.71	0.19	9.34	4.14	220.07	
C 01	5/31/2005	No air w/ PF	B	45.7	0.19	8.44	4.23	217.28	0.363
D 01	5/31/2005	Air w/ PF	D	45.7	0.20	8.62	4.13	214.78	0.366
E 01	5/31/2005	Cavitation - no PF	E	35.2	0.23	10.39	3.68	231.06	0.459
F 01	5/31/2005	Cavitation w/ PF	F	45.7	0.19	8.65	4.18	219.9	0.284

This 8-mode test was originally listed as Scenario C, but does not match the previous scenarios and is therefore of an unknown adjustment

PF Aerator 02	5/27/2005	Unknown		27.95	0.53	14.76	9.72	347.27	
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APPENDIX

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Scenario A - Baseline Data Test # 1**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	Fuelln degF
1	2399.4	204.8	93.6	8.11	1247.16	613.09	587.25	38.36	303.5	254.7	745.2	1.1	71.1	29.90	0.037972	541.9	96.4
2	2399.6	154.7	70.7	6.70	1146.87	450.76	426.25	50.68	249.5	243.0	686.7	1.1	72.3	29.90	0.031613	394.8	99.6
3	2399.8	103.0	47.1	5.28	1255.08	265.47	242.86	59.15	194	237.5	597.6	1.1	71.9	29.90	0.025223	230.7	98.1
4	2399.9	20.2	9.2	2.82	888.74	214.56	191.21	42.26	89.75	204.4	360.8	1.1	71.2	29.90	0.013741	184.2	92.4
5	1399.9	219.0	58.4	8.26	1458.93	394.52	372.36	43.69	175.5	137.1	630.6	1.1	73.8	29.90	0.038744	348.4	97.8
6	1399.7	162.4	43.3	6.87	1143.05	301.85	284.00	39.00	131.25	124.6	582.5	1.1	74.9	29.90	0.032384	263.7	98.1
7	1399.8	107.9	28.8	5.39	1702.98	248.39	220.86	64.25	95.25	111.0	504.5	1.1	74.3	29.90	0.02595	215.1	94.4
8	955.5	0.2	0.0	1.57	759.46	110.57	95.76	54.97	14.75	54.3	238.6	1.1	74.9	29.90	0.007834	93.0	86.9

WT. FAC %	Mode No	----- GRAMS/HOUR-----						NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST	
15.00	1	8.5	558.4	398.5	381.7	18210	498280	0.04
15.00	2	11.1	510.1	288.4	272.8	14970	489014	0.05
15.00	3	12.7	547.5	165.3	151.3	11640	473610	0.09
10.00	4	7.8	332.8	113.3	101.0	5385	397698	0.11
10.00	5	5.5	370.0	145.1	137.0	10530	282602	0.06
10.00	6	4.4	260.9	98.9	93.0	7875	251308	0.06
10.00	7	6.6	354.4	73.5	65.4	5715	226182	0.11
15.00	8	2.9	82.4	16.6	14.4	885	113977	0.13

WTD AVG BHP = 45.66 KW = 34.05

	HC	CO	KNOX	KNO	FUEL	EXHAUST
WTD AVG GM/H =	7.72	386.56	173.42	163	9806	352011
AVG GM/BHPH =	0.17	8.47	3.80	3.56	214.76	
AVG GM/KWH =	0.23	11.35	5.09	4.78	288.00	

WT AVG NO2/NOX RATIO = 0.080843792

Olson-Ecologic.
Fullerton, CA
Date : 5/26/2005
Time : 11:49:14 AM
Test Number : PURFLOWO1BASE
Tech : M.B.
Fuel Type : Diesel
Engine Type : CATERPILLAR
Engine Number :
Engine Model : 3054
HP : 90
Torque : 188
Max RPM : 2400
Idle RPM : 968

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Scenario A - Baseline Data Test # 2**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	FuelIn degF
1	2399.4	204.5	93.4	8.34	1219.92	671.21	651.11	41.55	308.5	252.7	720.4	1.2	75.7	29.90	0.038983	593.0	97.9
2	2399.7	155.3	71.0	6.93	1144.98	475.07	454.48	56.33	247.5	242.4	682.5	1.2	77.4	29.90	0.03267	414.5	102.2
3	2400.8	103.0	47.1	5.48	1201.06	282.69	264.12	61.50	194	236.5	606.7	1.2	78.1	29.90	0.026116	243.4	103.9
4	2399.9	20.0	9.2	2.91	841.79	224.93	204.41	46.07	90.5	203.9	366.6	1.2	76.3	29.90	0.014139	190.6	103.6
5	1399.9	215.4	57.4	8.47	1436.43	555.38	535.78	49.71	171.5	136.3	630.4	1.2	76.6	29.90	0.039667	490.9	102.4
6	1399.5	162.4	43.3	7.06	1083.62	393.30	374.52	44.32	132	124.2	574.5	1.2	77.9	29.90	0.033211	343.3	103.3
7	1399.7	108.1	28.8	5.45	1597.79	262.86	238.44	65.08	97.75	110.8	505.8	1.2	77.5	29.90	0.026208	226.6	103.0
8	956.5	0.2	0.0	1.59	675.12	115.20	103.60	57.10	14.75	54.3	240.8	1.2	78.1	29.90	0.007885	96.0	101.7

WT. FAC %	Mode No	GRAMS/HOUR-----						NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST	
15.00	1	9.1	540.2	431.4	418.4	18510	493892	0.03
15.00	2	11.9	488.3	290.4	277.8	14850	469921	0.04
15.00	3	12.8	505.5	168.3	157.2	11640	457857	0.07
10.00	4	8.3	308.7	114.8	104.3	5430	389934	0.09
10.00	5	5.9	347.4	195.0	188.1	10290	270004	0.04
10.00	6	4.9	242.3	126.1	120.1	7920	246674	0.05
10.00	7	6.8	337.8	78.7	71.4	5865	229915	0.09
15.00	8	3.0	72.8	17.0	15.3	885	113252	0.10

WTD AVG BHP =

45.59

KW =

34.00

WTD AVG GM/H =

8.11

364.65

187.52

179

9833

343891

AVG GM/BHPH =

0.18

8.00

4.11

3.92

215.70

AVG GM/KWH =

0.24

10.73

5.52

5.26

289.26

WT AVG NO2/NOX RATIO =

0.062662012

Olson-Ecologic.
Fullerton, Ca
Date : 5/26/2005
Time : 2:26:22 PM
Test Number : PURFLOWO2BASE
Tech : M.B.
Fuel Type : Diesel
Engine Type : CATERPILLAR
Engine Number :
Engine Model : 3054
HP : 90
Torque : 188
Max RPM : 2400
Idle RPM : 968

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Scenario A - Baseline Data Test # 3**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	Fuelln degF
1	2399.3	205.4	93.8	8.33	1372.87	668.32	616.50	48.43	316	252.8	712.0	1.2	75.5	29.90	0.03899	590.53	93.8
2	2400.2	155.0	70.8	6.85	1189.42	474.67	430.57	58.10	254	242.8	675.9	1.2	77.3	29.90	0.032314	413.93	98.1
3	2399.4	103.0	47.1	5.41	1227.17	282.74	249.90	64.24	195.5	236.6	587.7	1.2	76.4	29.90	0.025848	244.21	99.6
4	2399.8	20.1	9.2	2.87	849.92	224.66	193.74	47.87	91.25	203.1	366.6	1.2	75.4	29.90	0.013973	190.81	99.3
5	1400.0	214.3	57.1	8.40	1419.04	551.40	505.39	49.70	171.75	135.8	622.3	1.2	77.4	29.90	0.039315	486.86	98.0
6	1399.7	161.8	43.1	7.00	1104.56	390.66	353.95	44.50	137	123.9	564.0	1.2	78.2	29.90	0.032945	340.65	99.0
7	1399.6	107.8	28.7	5.42	1648.65	265.39	227.88	67.79	94.75	110.9	506.1	1.2	76.8	29.90	0.026077	229.11	98.6
8	959.4	0.2	0.0	1.58	684.71	114.88	99.60	52.69	16	54.7	240.1	1.2	76.8	29.90	0.007852	96.17	97.3

WT. FAC %	Mode No	----- GRAMS/HOUR-----						NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST	
15.00	1	10.8	622.7	440.0	405.9	18960	505805	0.08
15.00	2	12.7	526.6	301.0	273.1	15240	487419	0.09
15.00	3	13.6	526.1	172.0	152.0	11730	466060	0.12
10.00	4	8.8	318.1	117.3	101.2	5475	397769	0.14
10.00	5	6.0	346.8	195.5	179.2	10305	272722	0.08
10.00	6	5.1	258.5	131.0	118.7	8220	258016	0.09
10.00	7	6.9	339.6	77.5	66.6	5685	223948	0.14
15.00	8	3.1	80.4	18.6	16.1	960	123367	0.13

WTD AVG BHP = 45.57 KW = 33.98

WTD AVG GM/H = 8.71 389.67 191.85 174 10002 352643

AVG GM/BHPH = 0.19 8.55 4.21 3.81 219.48

AVG GM/KWH = 0.26 11.47 5.65 5.11 294.33

WT AVG NO2/NOX RATIO = 0.108565948

Olson-Ecologic.
Fullerton, CA
Date : 5/26/2005
Time : 4:05:50 PM
Test Number : PURFLOWO3BASE
Tech : M.B.
Fuel Type : Diesel
Engine Type : CATERPILLAR
Engine Number :
Engine Model : 3054
HP : 90
Torque : 188
Max RPM : 2400
Idle RPM : 968

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Scenario "C" - Air with no PureFlow**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	Fuelln degF
1	2400.5	127.6	58.3	5.42	770.44	886.40	827.14	41.64	201.5	237.0	567.1	1.2	73.8	29.96	0.025633	770.18	88
2	2400.7	106.4	48.6	4.89	765.21	743.28	689.00	45.11	176	231.1	530.4	1.2	74.5	29.96	0.023205	642.56	88
3	2401.3	88.4	40.5	4.46	818.86	604.79	559.19	50.74	143.5	226.8	495.4	1.2	74.7	29.96	0.021287	521.17	88
4	2402.2	19.4	8.9	2.78	893.42	234.82	211.31	51.92	93	205.6	359.1	1.2	74.3	29.96	0.013568	200.34	88
5	1401.4	216.3	57.7	8.18	1394.72	560.51	538.88	59.21	164	138.8	669.0	1.2	75.1	29.96	0.038345	495.37	86
6	1401.8	162.1	43.3	6.77	1113.04	408.94	387.67	52.45	145	124.8	617.9	1.2	77.1	29.96	0.031925	356.85	86
7	1404.8	108.7	29.1	5.06	852.29	962.52	896.62	53.58	93	103.5	443.3	1.2	76.4	29.96	0.024066	829.83	86
8	993.7	0.3	0.0	1.63	5613.79	80.94	55.45	291.13	9.5	57.7	237.8	1.2	75.7	29.96	0.010576	68.41	86

WT. FAC %	Mode No	----- GRAMS/HOUR-----						NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST	
15.00	1	9.2	343.2	563.5	525.9	12090	484336	0.07
15.00	2	9.6	329.6	454.7	421.5	10560	466198	0.07
15.00	3	9.6	314.1	328.4	303.6	8610	413577	0.08
10.00	4	10.1	351.1	129.3	116.4	5580	417360	0.10
10.00	5	7.0	334.1	194.9	187.4	9840	266773	0.04
10.00	6	6.6	284.8	150.0	142.2	8700	281549	0.05
10.00	7	5.8	186.9	299.0	278.5	5580	237731	0.07
15.00	8	7.5	291.4	5.8	4.0	570	54533	0.31

WTD AVG BHP = 36.02 KW = 26.86

WTD AVG GM/H = 8.32 307.45 280.19 261 7745 333138

AVG GM/BPH = 0.23 8.54 7.78 7.24 215.02

AVG GM/KWH = 0.31 11.45 10.43 9.71 288.34

WT AVG NO2/NOX RATIO = 0.105445636

Olson-Ecologic.
Fullerton, CA
Date : 5/27/2005
Time : 11:21:26 AM
Test Number : PUREFLOWTEST-C
Tech : JS
Fuel Type : Diesel
Engine Type : CATERPILLAR
Engine Number :
Engine Model : 3054
HP : 90
Torque : 188
Max RPM : 2400
Idle RPM : 968

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Scenario "D" - Air with PureFlow**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	Fuelln degF
1	2399.7	206.0	94.1	8.28	1441.20	663.78	616.06	53.64	285	253.1	809.5	1.2	76.1	29.96	0.038831	586.51	85
2	2399.8	154.8	70.7	6.80	1206.41	466.23	427.01	61.64	246	242.7	722.0	1.2	77.4	29.96	0.0321	406.66	86
3	2413.7	105.6	48.0	5.30	1146.30	347.50	311.52	55.74	200.5	231.0	633.8	1.2	77.0	29.96	0.025262	299.70	87
4	2400.2	20.2	9.2	2.85	822.77	232.43	202.60	47.26	85	202.0	369.7	1.2	75.3	29.96	0.013851	197.65	87
5	1399.9	212.3	56.6	8.29	1435.61	547.98	504.91	49.49	177.5	135.4	680.2	1.2	77.6	29.96	0.038863	483.70	88
6	1400.0	161.6	43.1	6.96	1072.21	394.74	359.17	45.12	134.5	123.6	624.7	1.2	79.2	29.96	0.032757	343.88	88
7	1399.7	107.5	28.7	5.37	1599.98	265.56	229.74	67.41	100	110.1	511.3	1.2	78.0	29.96	0.025816	228.79	89
8	952.4	0.2	0.0	1.57	645.28	105.60	90.31	65.64	15.5	54.0	240.2	1.2	77.7	29.96	0.00778	88.18	89

WT. FAC %	Mode No	GRAMS/HOUR-----						NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST	
15.00	1	10.9	592.1	395.8	367.4	17100	458001	0.07
15.00	2	13.1	520.8	288.4	264.1	14760	475129	0.08
15.00	3	12.4	515.9	221.6	198.6	12030	488824	0.10
10.00	4	8.2	289.4	114.2	99.5	5100	373753	0.13
10.00	5	6.2	367.0	203.1	187.2	10650	285024	0.08
10.00	6	5.1	247.8	130.6	118.8	8070	254727	0.09
10.00	7	7.3	351.4	82.5	71.4	6000	238701	0.13
15.00	8	3.7	74.1	16.6	14.2	930	120617	0.14

WTD AVG BHP = 45.69 KW = 34.07

	HC	CO	KNOX	KNO	FUEL	EXHAUST
WTD AVG GM/H =	8.71	381.01	191.40	174	9705	346606
AVG GM/BHPH =	0.19	8.34	4.19	3.82	212.43	
AVG GM/KWH =	0.26	11.18	5.62	5.12	284.87	

WT AVG NO2/NOX RATIO = 0.103856938

Olson-Ecologic.
Fullerton, CA
Date : 5/27/2005
Time : 1:55:18 PM
Test Number : PUREFLOWTESTCPARTC
Tech : M.B.
Fuel Type : Diesel
Engine Type : CATERPILLAR
Engine Number :
Engine Model : 3054
HP : 90
Torque : 188
Max RPM : 2400
Idle RPM : 968

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Scenario "C" - Air with no PureFlow**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	Fuelln degF
1	2400.3	155.4	71.0	6.18	847.46	1079.46	969.60	76.06	230	239.7	607.3	1.2	73.5	29.96	0.029133	943.03	88
2	2400.5	125.6	57.4	5.40	781.49	894.40	804.17	56.02	194	233.9	577.7	1.2	74.8	29.96	0.025544	775.37	88
3	2400.4	85.7	39.2	4.47	835.33	560.40	497.92	54.77	160	225.2	503.2	1.2	74.3	29.96	0.021318	483.41	88
4	2400.5	20.1	9.2	2.91	914.01	174.31	148.93	52.61	92	211.3	378.8	1.2	74.8	29.96	0.014164	148.61	88
5	1401.2	221.1	59.0	8.32	1409.83	546.38	504.40	53.88	185	140.1	676.6	1.2	75.5	29.96	0.038999	483.23	88
6	1400.3	162.5	43.3	6.88	1097.99	372.88	341.41	49.36	139.5	124.8	620.8	1.2	77.2	29.96	0.03242	325.62	88
7	1399.7	108.4	28.9	5.35	1583.39	258.61	224.74	67.73	101.5	111.2	510.0	1.2	77.1	29.96	0.025728	223.26	88
8	987.7	0.2	0.0	1.56	1148.56	92.59	74.24	71.49	29	56.6	271.1	1.2	77.8	29.96	0.007972	77.36	88

WT. FAC %	Mode No	GRAMS/HOUR-----						NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST	
15.00	1	16.7	377.9	690.7	620.4	13800	488070	0.10
15.00	2	11.9	336.4	548.2	492.9	11640	467896	0.10
15.00	3	11.5	356.8	339.1	301.3	9600	460473	0.11
10.00	4	9.7	340.2	90.9	77.6	5520	395735	0.15
10.00	5	7.1	374.3	210.7	194.5	11100	296077	0.08
10.00	6	5.9	266.0	129.6	118.7	8370	266864	0.08
10.00	7	7.5	354.2	82.0	71.3	6090	243086	0.13
15.00	8	7.4	240.9	26.7	21.4	1740	220273	0.20

WTD AVG BHP = 39.18 KW = 29.22

	HC	CO	KNOX	KNO	FUEL	EXHAUST
WTD AVG GM/H =	10.15	330.26	292.03	262	8625	365683
AVG GM/BHPH =	0.26	8.43	7.45	6.68	220.12	
AVG GM/KWH =	0.35	11.30	9.99	8.95	295.19	

WT AVG NO2/NOX RATIO = 0.120632918

Olson-Ecologic.
Fullerton, CA
Date : 5/27/2005
Time : 3:32:26 PM
Test Number : PURE_FLOW_AIRETOR_ONLY
Tech : M.B.
Fuel Type : Diesel
Engine Type : CATERPILLAR
Engine Number :
Engine Model : 3054
HP : 90
Torque : 188
Max RPM : 2400
Idle RPM : 968

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Scenario "B" - No air with PureFlow**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	Fuelln degF
1	2399.4	207.7	94.9	8.46	1757.73	659.19	643.91	50.93	325.5	256.4	883.3	1.2	78.9	29.96	0.03977	582.36	72
2	2399.9	154.5	70.6	6.70	1272.61	436.08	416.64	59.42	260	243.6	778.3	1.2	77.7	29.96	0.031674	379.93	72
3	2403.9	103.4	47.4	5.33	1229.80	295.94	274.76	55.88	193.5	236.2	642.9	1.2	75.0	29.96	0.025475	256.34	72
4	2400.2	20.5	9.4	2.82	825.91	242.83	220.58	44.77	93.75	202.4	367.9	1.2	74.4	29.96	0.013688	207.04	73
5	1400.0	212.6	56.7	8.26	1476.95	506.26	501.41	49.72	167.5	135.5	678.1	1.2	76.3	29.96	0.038728	447.20	73
6	1400.2	161.9	43.2	6.92	1068.36	361.86	355.47	42.99	130.75	123.7	607.3	1.2	77.6	29.96	0.032572	315.80	74
7	1399.6	107.1	28.5	5.33	1653.15	259.32	239.64	67.29	87	110.3	497.0	1.2	77.0	29.96	0.025658	223.79	74
8	961.1	0.2	0.0	1.53	648.35	98.40	89.43	58.83	19.25	54.7	245.9	1.2	76.6	29.96	0.007599	82.50	74

WT. FAC %	Mode No	GRAMS/HOUR-----						NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST	
15.00	1	11.5	804.8	438.0	427.8	19530	511199	0.02
15.00	2	13.6	588.8	288.7	275.9	15600	508721	0.04
15.00	3	11.9	529.6	181.3	168.4	11610	467904	0.07
10.00	4	8.7	324.3	133.5	121.3	5625	417075	0.09
10.00	5	5.9	357.6	177.9	176.2	10050	269870	0.01
10.00	6	4.8	241.5	117.2	115.2	7845	248990	0.02
10.00	7	6.4	317.9	70.7	65.3	5220	208912	0.08
15.00	8	4.2	94.7	19.8	18.0	1155	153342	0.09

WTD AVG BHP =

45.71

KW =

34.08

PARTIC. WT, MG =
PARTIC. SAMPLE VOL., STD LITERS =

AVG HUMID = 1.22

HC CO KNOX KNO FUEL EXHAUST

#DIV/0! MG/SL

WTD AVG GM/H =

8.76 426.80 189.11 181 10058 360660

WTD AVG GM/H = #DIV/0!

AVG GM/BHPH =

0.19 9.34 4.14 3.97 220.07

AVG GM/BHPH = #DIV/0!

AVG GM/KWH =

0.26 12.52 5.55 5.32 295.11

AVG GM/KWH = #DIV/0!

WT AVG NO2/NOX RATIO = 0.054057564

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Scenario "B" - No air with PureFlow**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	Fuelln degF
1	2400.5	207.2	94.7	8.39	1364.79	691.00	669.50	46.03	290	251.8	786.9	1.0	78.8	30.00	0.0392572	607.93	86
2	2399.9	154.9	70.8	6.85	1183.46	485.25	464.81	56.77	226.5	241.1	684.0	1.0	81.2	30.00	0.0322963	419.67	86
3	2399.3	103.1	47.1	5.40	1173.34	287.97	269.35	61.25	196.5	234.1	603.7	1.0	80.8	30.00	0.0257573	245.70	86
4	2400.1	20.1	9.2	2.86	822.67	238.86	216.25	46.39	81	201.4	371.9	1.0	79.0	30.00	0.0138855	199.86	86
5	1399.7	214.2	57.1	8.48	1577.00	562.36	539.50	50.78	255	134.5	627.5	1.0	82.6	30.00	0.0397812	494.14	86
6	1399.6	162.4	43.3	7.07	1074.79	408.15	387.30	43.98	124	122.5	564.1	1.0	83.3	30.00	0.0332543	352.82	86
7	1399.4	108.0	28.8	5.44	1593.71	271.08	245.41	64.39	84.5	109.4	483.4	1.0	82.5	30.00	0.0261284	230.72	85
8	971.6	0.2	0.0	1.55	614.10	119.82	105.95	48.21	28	55.4	252.1	1.0	81.1	30.00	0.007665	98.31	84

WT. FAC %	Mode No	GRAMS/HOUR-----						NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST	
15.00	1	9.4	564.1	412.7	399.9	17400	461057	0.03
15.00	2	11.1	467.5	272.3	260.8	13590	434787	0.04
15.00	3	13.1	507.4	174.5	163.2	11790	469966	0.06
10.00	4	7.7	275.0	109.8	99.4	4860	355203	0.09
10.00	5	9.0	565.4	291.0	279.2	15300	400275	0.04
10.00	6	4.6	225.5	121.6	115.4	7440	231386	0.05
10.00	7	5.8	292.1	69.5	62.9	5070	199299	0.09
15.00	8	5.0	129.3	34.0	30.1	1680	221069	0.12

WTD AVG BHP =

45.73 KW = 34.10

PARTIC. WT, MG = 1.9
PARTIC. SAMPLE VOL., STD LITERS = 31.54

AVG HUMID = 0.96

WTD AVG GM/H =

HC CO KNOX KNO FUEL EXHAUST
8.48 386.04 193.22 184 9936 356648

WTD AVG GM/H = 16.59

AVG GM/BPH =

0.19 8.44 4.23 4.02 217.28

AVG GM/BPH = 0.363

AVG GM/KWH =

0.25 11.32 5.67 5.39 291.38

AVG GM/KWH = 0.49

WT AVG NO2/NOX RATIO =

0.0661552

Olson-Ecologic.
Fullerton, CA
Date : 5/31/2005
Time : 2:29:09 PM
Test Number : PUREFLOWB07
Tech : M.B.
Fuel Type : Diesel
Engine Type : CATERPILLAR
Engine Number :
Engine Model : 3054
HP : 90
Torque : 188
Max RPM : 2400
Idle RPM : 968

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Scenario "D" - Air with PureFlow**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	FuelIn degF
1	2399.3	205.7	94.0	8.34	1415.35	680.69	631.19	49.22	285	250.9	792.3	1.0	79.8	30.00	0.0390466	598.85	88
2	2400.3	155.5	71.1	6.88	1202.65	486.54	444.36	58.79	245	241.2	686.5	1.0	82.5	30.00	0.0324353	420.69	88
3	2399.6	103.1	47.1	5.38	1167.16	286.12	258.64	61.22	195	235.9	606.0	1.0	79.4	30.00	0.0256551	245.09	88
4	2400.2	20.1	9.2	2.85	833.63	230.02	201.91	47.17	95	201.6	368.7	1.0	77.2	30.00	0.0138303	193.81	88
5	1400.1	215.1	57.3	8.41	1524.74	546.90	514.06	50.93	190	135.4	610.3	1.0	78.9	30.00	0.0394089	481.77	88
6	1399.5	162.4	43.3	7.03	1087.25	387.36	357.92	45.65	107.5	123.2	562.4	1.0	80.7	30.00	0.0330535	336.18	88
7	1399.9	107.8	28.7	5.39	1611.97	259.14	225.76	66.32	95	109.3	469.2	1.0	79.8	30.00	0.0259174	221.89	88
8	970.0	0.2	0.0	1.55	615.76	113.03	97.00	50.36	40	55.2	250.8	1.0	80.7	30.00	0.0076871	93.03	88

WT. FAC %	Mode No	GRAMS/HOUR-----						NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST	
15.00	1	9.9	578.1	401.8	372.6	17100	455495	0.07
15.00	2	12.3	511.6	294.0	268.5	14700	468384	0.09
15.00	3	13.0	502.9	173.5	156.8	11700	468227	0.10
10.00	4	9.2	328.2	125.3	110.0	5700	418268	0.12
10.00	5	6.8	411.3	213.5	200.7	11400	300977	0.06
10.00	6	4.1	199.0	101.1	93.4	6450	201792	0.08
10.00	7	6.8	335.0	75.7	66.0	5700	225859	0.13
15.00	8	7.5	184.7	45.8	39.3	2400	314939	0.14

PARTIC. WT, MG = 1.9
PARTIC. SAMPLE VOL.,STD LITERS = 32.54

WTD AVG BHP =

45.68 KW = 34.06

WTD AVG GM/H =

HC CO KNOX KNO FUEL EXHAUST
9.10 393.94 188.82 173 9810 370746

AVG GM/BPH =

0.20 8.62 4.13 3.78 214.78

AVG GM/KWH =

0.27 11.57 5.54 5.07 288.02

WT AVG NO2/NOX RATIO =

0.098299529

Olson-Ecologic.

Fullerton, CA

Date : 5/31/2005

Time : 12:59:24 PM

Test Number : PUREFLOWC06

Tech : M.B.

Fuel Type : Diesel

Engine Type : CATERPILLAR

Engine Number :

Engine Model : 3054

HP : 90

Torque : 188

Max RPM : 2400

Idle RPM : 968

AVG HUMID = 1.04

WTD AVG GM/H = 16.72

AVG GM/BPH = 0.366

AVG GM/KWH = 0.49

0.058390 MG/SL

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Scenario "E" - Cavitation with no PureFlow**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	FuelIn degF
1	2402.0	152.9	69.9	6.91	1356.45	438.13	401.12	58.21	182.75	246.0	716.5	1.1	79.5	29.70	0.0326702	380.91	82
2	2400.7	83.7	38.3	4.92	1219.47	246.41	221.96	52.90	161.75	235.1	577.3	1.1	79.7	29.70	0.0235953	210.30	82
3	2400.8	77.3	35.3	4.74	1256.89	208.34	183.06	58.06	187.25	234.9	588.0	1.1	80.3	29.70	0.022773	177.29	82
4	2400.3	19.8	9.0	2.84	792.86	240.96	209.33	45.74	84.75	201.5	373.3	1.1	81.2	29.70	0.0137863	200.77	82
5	1400.5	207.8	55.4	8.23	1516.64	528.20	486.69	51.01	205.5	134.6	639.6	1.1	83.2	29.70	0.0386145	463.56	82
6	1400.1	161.7	43.1	6.95	1048.15	393.02	359.83	44.93	158.5	123.5	571.9	1.1	82.4	29.70	0.0326864	340.41	81
7	1399.9	107.9	28.8	5.35	1597.56	265.16	229.77	64.88	86	110.0	494.3	1.1	81.0	29.70	0.0257319	226.71	81
8	962.5	0.2	0.0	1.54	595.45	121.03	103.98	52.93	14.5	54.8	249.5	1.1	80.6	29.70	0.0075872	99.79	81

WT. FAC %	Mode No	GRAMS/HOUR-----						NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST	
15.00	1	9.1	427.3	197.1	180.4	10965	346967	0.08
15.00	2	10.2	474.8	134.5	121.2	9705	421476	0.10
15.00	3	13.4	587.5	136.1	119.6	11235	505133	0.12
10.00	4	8.0	279.4	116.2	100.9	5085	374341	0.13
10.00	5	7.5	451.9	226.9	209.1	12330	331997	0.08
10.00	6	6.1	286.1	152.6	139.8	9510	300782	0.08
10.00	7	6.1	302.8	70.6	61.2	5160	205913	0.13
15.00	8	2.9	65.6	18.1	15.5	870	115665	0.14

WTD AVG BHP =	35.16	KW =	26.22	Olson-Ecologic, Fullerton, CA Date : 5/31/2005 Time : 5:47:10 PM Test Number : PUREFLOWE09 Tech : M.B. Fuel Type : Diesel Engine Type : CATERPILLAR Engine Number : Engine Model : 3054 HP : 90 Torque : 188 Max RPM : 2400 Idle RPM : 968	PARTIC. WT, MG = 2 PARTIC. SAMPLE VOL.,STD LITERS = 31.54 AVG HUMID = 1.12 0.063412 MG/SL			
WTD AVG GM/H =	8.08	365.30	129.50	117	8125	329689	WTD AVG GM/H =	16.14
AVG GM/BPH =	0.23	10.39	3.68	3.32	231.08		AVG GM/BPH =	0.459
AVG GM/KWH =	0.31	13.93	4.94	4.45	309.88		AVG GM/KWH =	0.62
WT AVG NO2/NOX RATIO =	0.10966554							

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Scenario "F" - Cavitation with PureFlow**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	Fuelln degF
1	2400.4	207.6	94.9	8.39	1383.33	680.97	633.65	45.80	292.5	252.6	776.7	1.0	81.3	29.70	0.0392671	598.76	80
2	2400.6	154.9	70.8	6.78	1206.19	470.49	432.81	58.29	241	242.7	680.0	1.0	79.9	29.70	0.0320242	407.87	80
3	2400.8	103.5	47.3	5.35	1199.21	282.47	253.06	61.80	239.5	236.6	609.5	1.0	79.8	29.70	0.025545	241.71	80
4	2400.7	19.9	9.1	2.82	803.56	239.14	207.99	45.50	115.75	201.2	369.7	1.0	79.2	29.70	0.0137125	200.19	80
5	1400.3	212.8	56.7	8.28	1600.81	539.45	496.86	48.50	175.5	135.3	646.1	1.0	81.8	29.70	0.038876	473.74	80
6	1400.0	162.1	43.2	6.95	1058.65	388.04	354.72	41.45	127	123.5	589.0	1.0	83.3	29.70	0.0326915	335.36	80
7	1400.1	108.2	28.8	5.36	1572.79	259.85	226.07	62.33	98	110.5	516.8	1.0	82.4	29.70	0.0257444	221.29	80
8	969.0	0.2	0.0	1.53	620.52	114.20	97.99	49.96	0.25	55.2	249.8	1.0	81.0	29.70	0.0075915	93.86	80

WT. FAC %	Mode No	----- GRAMS/HOUR-----						NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST	
15.00	1	9.4	576.5	409.9	381.4	17550	464957	0.07
15.00	2	12.2	511.4	284.1	261.3	14460	466465	0.08
15.00	3	16.2	637.4	211.0	189.1	14370	577494	0.10
10.00	4	10.9	388.8	159.1	138.4	6945	513947	0.13
10.00	5	6.0	404.6	196.7	181.1	10530	281674	0.08
10.00	6	4.5	231.5	120.5	110.1	7620	240952	0.09
10.00	7	6.6	339.5	78.5	68.3	5880	234518	0.13
15.00	8	0.0	1.2	0.3	0.3	15	1993	0.14

WTD AVG BHP =

45.73 KW = 34.10

PARTIC. WT, MG = 1.5
PARTIC. SAMPLE VOL., STD LITERS = 31.5
AVG HUMID = 1.05

WTD AVG GM/H =

HC CO KNOX KNO FUEL EXHAUST
8.48 395.42 191.27 175 10057 353745

Olson-Ecologic.
Fullerton, CA
Date : 5/31/2005
Time : 7:25:19 PM
Test Number : PUREFLOWF10
Tech : M.B.
Fuel Type : Diesel
Engine Type : CATERPILLAR
Engine Number :
Engine Model : 3054
HP : 90
Torque : 188
Max RPM : 2400
Idle RPM : 968

WTD AVG GM/H = 13.01

AVG GM/BPH =

0.19 8.65 4.18 3.82 219.90

AVG GM/BPH = 0.284

AVG GM/KWH =

0.25 11.59 5.61 5.12 294.89

AVG GM/KWH = 0.38

WT AVG NO2/NOX RATIO =

0.101851397

0.047619 MG/SL

**I.S.O. 8178 - 8-Mode Emission Data
Caterpillar Model 3054 Diesel Engine
Pureflow Technologies, Inc.
Olson-Ecologic Engine Testing Laboratories
Unknown Scenario**

Mode	EngSpd RPM	DynTrq lb-ft	EngPwr Hp	CO2 %	CO ppm	NOx ppm	NO ppm	HC FID ppm	FUEL RT GM/MIN	AirMas scfm	EngExh deg/F	ABSHUM GM/KG	Air In degF	Baro P InHga	f/aCAL FACTOR	KNOx PPM	FuelIn degF
1	2400.8	113.4	51.8	5.12	766.51	803.79	706.45	85.22	285	233.7	533.7	1.2	72.8	29.96	0.024306	698.62	85
2	2400.6	79.6	36.4	4.34	856.35	511.45	445.17	63.26	246	225.6	489.1	1.2	73.6	29.96	0.02074	441.52	86
3	2400.2	60.4	27.6	3.92	949.49	301.21	258.89	57.98	200.5	221.5	461.9	1.2	73.6	29.96	0.018863	259.40	87
4	2400.6	20.6	9.4	2.92	923.55	160.59	134.69	56.53	85	212.8	382.2	1.2	73.0	29.96	0.014214	137.69	88
5	1402.6	109.4	29.2	5.42	1441.88	264.90	231.68	73.27	177.5	114.5	524.4	1.2	74.2	29.96	0.025977	230.10	88
6	1401.4	143.3	38.2	6.32	1264.75	315.10	277.83	67.91	134.5	122.2	555.6	1.2	73.8	29.96	0.02998	275.47	88
7	1402.1	107.9	28.8	5.25	1126.32	271.99	238.40	65.50	100	111.2	499.6	1.2	74.2	29.96	0.025051	235.96	89
8	964.3	0.3	0.1	1.55	1055.34	92.46	74.06	118.49	15.5	55.3	209.4	1.2	73.6	29.96	0.007908	78.46	89

WT. FAC %	Mode No	----- GRAMS/HOUR-----							NO2/NOX RATIO
		HC	CO	KNOX	KNO	FUEL	EXHAUST		
15.00	1	28.0	510.0	763.5	671.0	17100	721494	0.12	
15.00	2	21.1	578.4	489.8	426.3	14760	727319	0.13	
15.00	3	17.4	575.7	258.4	222.1	12030	650588	0.14	
10.00	4	9.6	316.5	77.5	65.0	5100	364350	0.16	
10.00	5	14.0	558.5	146.4	128.0	10650	421133	0.13	
10.00	6	8.5	320.3	114.6	101.0	8070	277582	0.12	
10.00	7	7.3	255.0	87.8	76.9	6000	245811	0.12	
15.00	8	6.6	119.3	14.6	11.7	930	118682	0.20	

WTD AVG BHP = 27.95 KW = 20.84

WTD AVG GM/H = 14.89 412.53 271.56 237 9705 463600

AVG GM/BPH = 0.53 14.76 9.72 8.47 347.27

AVG GM/KWH = 0.71 19.80 13.03 11.36 465.69

WT AVG NO2/NOX RATIO = 0.141377742

Olson-Ecologic.
Fullerton, CA
Date : 5/27/2005
Time : 5:20:42 PM
Test Number : PURE_FLOW_AIRETOR_02
Tech : M.B.
Fuel Type : Diesel
Engine Type : CATERPILLAR
Engine Number :
Engine Model : 3054
HP : 90
Torque : 188
Max RPM : 2400
Idle RPM : 968