FINAL REPORT

Permeation Testing of Injection Molded Walk Behind Mower (WBM) Fuel Tanks using California's TP-901 Procedures

for

Fluoro-Seal International, LLP
16360 Park Ten Place, Suite 325
Houston, Texas 77084-5046

(281) 578-1440

by

Automotive Testing Laboratories, Inc
263 S. Mulberry St
Mesa, Arizona 85202
(480) 649-7906

Dennis McClement
Project Manager

August 30, 2005

Permeation Testing of Injection Molded Walk Behind Mower (WBM) Fuel Tanks using California's TP-901 Procedures

August 30, 2005

Introduction

California regulations require control of permeation emissions from the fuel tanks of small off-road gasoline powered engines. The Walk Behind lawn Mower application (WBM) is included in this category.

The California Air Resources Board (ARB) has defined TP-901 as the procedure to be used to measure permeation emissions.

Fluor-Seal International LLP has for many years supplied fuel tank permeation control treatments to the US automotive industry. This program was performed to measure the effectiveness of their technology to typical injection molded tanks used with WBM engines.

Fluoro-Seal purchased regular production Service Part fuel tanks directly from the dealer network of a large US manufacturer of walk behind lawn mower engines. The samples were treated with Fluor-Seal's fluorination process. The tanks were marked with a sticker identifying the treatment level used as "SPAL". The treated tanks were then provided to Automotive Testing Laboratories (ATL). ATL performed testing of the tanks in accordance with ARB TP-901 Test Procedures for permeation evaporative emissions. This report describes the tanks tested, the procedures used, and the results of the test program.

Test Protocol

Fluoro-Seal provided four fuel tanks for testing in this program. All were treated by Fluoro-Seal. Three tanks were used for testing in accordance with TP-901. The fourth tank was used as a "trip blank", as required by TP-901.

California regulations require all tanks to receive durability testing prior to permeation measurements. The three tanks selected for California testing were filled with California Phase II certification test fuel, subjected to 1,000,000 slosh cycles as defined in TP-901, and soaked for a total of 140 days at 30+/-5° C. At the end of 140 days the tanks were drained, filled with fresh California Certification test fuel, stabilized at 40°C and promptly sealed by fusion welding of a coupon over the tank inlet.

TP-901 testing includes daily weighing for 11 consecutive days, and performing a regression analysis of the corrected cumulative weight loss versus time, taking into consideration changes "trip blank" tank weights. The attached data sheets detail the results of these weighings, the calculations used to correct the raw data, and the results of the regressions.

Tanks 2 and 3 were tested between 7/30/2005 and 8/8/2005. Unusually high results obtained with tank 1 during this period were traced to a leaking weld of the coupon. The coupon was

removed and rewelded and the testing was repeated with fresh fuel. The second series of tests was performed between 8/10/2005 and 8/19/2005.

Results of the TP-901 testing were:

Tank	R^2	Grams/ Day	Surface Area (m^2)	grams/ m^2/day
1	0.9978	-0.0384	0.1390	0.276
2	0.9952	-0.0361	0.1390	0.260
3	0.9943	-0.0375	0.1390	0.269

The R^2 results are required to be greater than 0.95. The slope of the regression line provides the average grams/day weight change. The slope is divided by the fuel tank internal surface area to arrive at the final permeation rate expressed in units of grams/square meter/day.

TP 901 Field Data Sheet
SPAL Treatment
WBM Tank #1

Full Tank Data

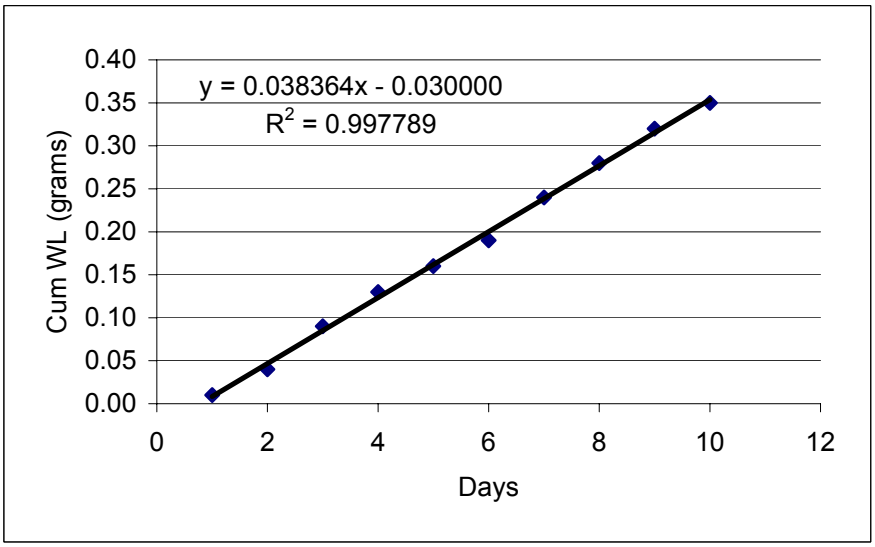
Date/Time Start		Date/Time End		Initial Weight W_{if} (grams)	Final Weight W_{ff} (grams)	Difference D_f (grams)	Weight Loss WL (grams)
8/10	9:15	8/11	9:15	1046.52	1046.47	1046.51	0.01
8/11	9:15	8/12	9:15	1046.47	1046.44	1046.44	0.03
8/12	9:15	8/13	9:15	1046.44	1046.40	1046.39	0.05
8/13	9:15	8/14	9:15	1046.40	1046.34	1046.36	0.04
8/14	9:15	8/15	9:15	1046.34	1046.30	1046.31	0.03
8/15	9:15	8/16	9:15	1046.30	1046.28	1046.27	0.03
8/16	9:15	8/17	9:15	1046.28	1046.22	1046.23	0.05
8/17	9:15	8/18	9:15	1046.22	1046.18	1046.18	0.04
8/18	9:15	8/19	9:15	1046.18	1046.14	1046.14	0.04
8/19	9:15	8/20	9:15	1046.14	1046.10	1046.11	0.03

$WL = (W_{if} - D_f)$, $D_f = (W_{ff} + D_e)$, $D_e = (W_{ie} - W_{fe})$

$= (W_{if} - W_{ff}) - (W_{ie} - W_{fe})$

Empty Tank Data

Date/Time Start		Date/Time End		Initial Weight W_{ie} (grams)	Final Weight W_{fe}grams)	Difference D_e (grams)	RH (%)	Baro. Press
8/10	9:15	8/11	9:15	418.38	418.34	0.04	30%	28.62
8/11	9:15	8/12	9:15	418.34	418.34	0.00	26%	28.65
8/12	9:15	8/13	9:15	418.34	418.35	-0.01	26%	28.68
8/13	9:15	8/14	9:15	418.35	418.33	0.02	26%	28.65
8/14	9:15	8/15	9:15	418.33	418.32	0.01	24%	28.54
8/15	9:15	8/16	9:15	418.32	418.33	-0.01	24%	28.60
8/16	9:15	8/17	9:15	418.33	418.32	0.01	24%	28.64
8/17	9:15	8/18	9:15	418.32	418.32	0.00	24%	28.64
8/18	9:15	8/19	9:15	418.32	418.32	0.00	23%	28.62
8/19	9:15	8/20	9:15	418.32	418.31	0.01	21%	28.56
							20%	28.47



Day	Cum WL (grams)
1	0.01
2	0.04
3	0.09
4	0.13
5	0.16
6	0.19
7	0.24
8	0.28
9	0.32
10	0.35

slope	0.0384
r^2	0.9978
Area	0.1390
Rate	**0.276**

TP 901 Field Data Sheet
SPAL Treatment
WBM Tank #2

Full Tank Data

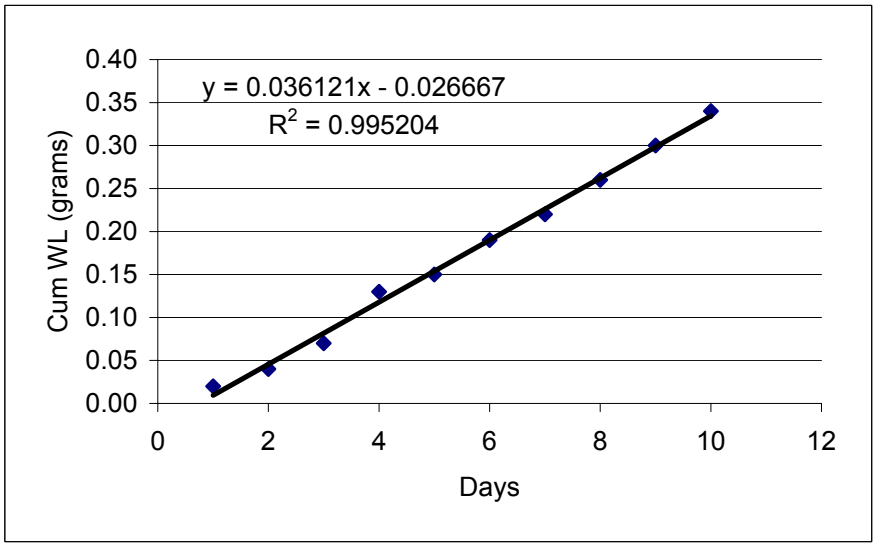
Date/Time Start		Date/Time End		Initial Weight W_{if} (grams)	Final Weight W_{ff} (grams)	Difference D_f (grams)	Weight Loss WL (grams)
7/30	9:15	7/31	9:15	1054.14	1054.11	1054.12	0.02
7/31	9:15	8/1	9:15	1054.11	1054.08	1054.09	0.02
8/1	9:15	8/2	9:15	1054.08	1054.05	1054.05	0.03
8/2	9:15	8/3	9:15	1054.05	1054.01	1053.99	0.06
8/3	9:15	8/4	9:15	1054.01	1053.97	1053.99	0.02
8/4	9:15	8/5	9:15	1053.97	1053.93	1053.93	0.04
8/5	9:15	8/6	9:15	1053.93	1053.90	1053.90	0.03
8/6	9:15	8/7	9:15	1053.90	1053.86	1053.86	0.04
8/7	9:15	8/8	9:15	1053.86	1053.82	1053.82	0.04
8/8	9:15	8/9	9:15	1053.82	1053.78	1053.78	0.04

$WL = (W_{if} - D_f)$, $D_f = (W_{ff} + D_e)$, $D_e = (W_{ie} - W_{fe})$

$= (W_{if} - W_{ff}) - (W_{ie} - W_{fe})$ 0.034

Empty Tank Data

Date/Time Start		Date/Time End		Initial Weight W_{ie} (grams)	Final Weight W_{fe}grams)	Difference D_e (grams)	RH (%)	Baro. Press
7/30	9:15	7/31	9:15	418.24	418.23	0.01	24%	28.62
7/31	9:15	8/1	9:15	418.23	418.22	0.01	35%	28.65
8/1	9:15	8/2	9:15	418.22	418.22	0.00	24%	28.68
8/2	9:15	8/3	9:15	418.22	418.24	-0.02	26%	28.65
8/3	9:15	8/4	9:15	418.24	418.22	0.02	30%	28.54
8/4	9:15	8/5	9:15	418.22	418.22	0.00	26%	28.60
8/5	9:15	8/6	9:15	418.22	418.22	0.00	24%	28.64
8/6	9:15	8/7	9:15	418.22	418.22	0.00	25%	28.64
8/7	9:15	8/8	9:15	418.22	418.22	0.00	27%	28.62
8/8	9:15	8/9	9:15	418.22	418.22	0.00	27%	28.56
							28%	28.47



Day	Cum WL (grams)
1	0.02
2	0.04
3	0.07
4	0.13
5	0.15
6	0.19
7	0.22
8	0.26
9	0.30
10	0.34

slope	0.0361
r^2	0.9952
Area	0.1390
Rate	**0.260**

TP 901 Field Data Sheet
SPAL Treatment
WBM Tank #3

Full Tank Data

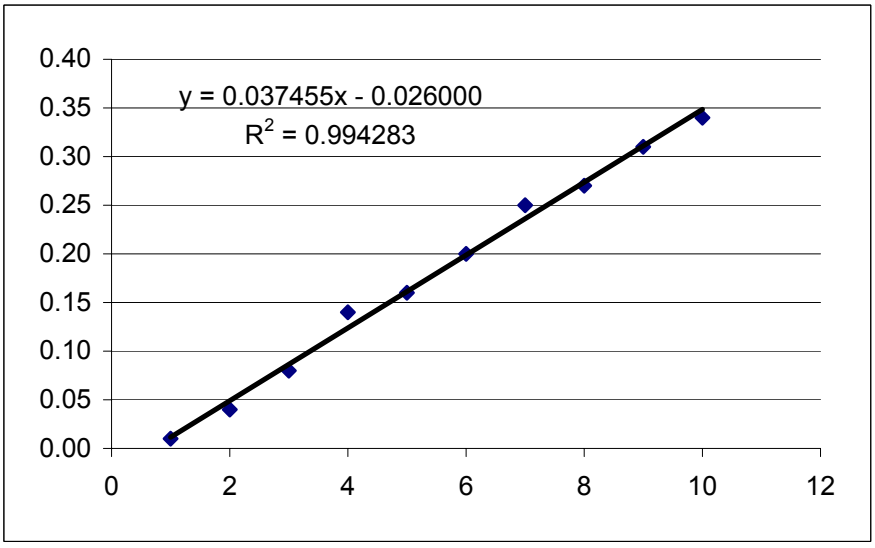
Date/Time Start		Date/Time End		Initial Weight W_{if} (grams)	Final Weight W_{ff} (grams)	Difference D_f (grams)	Weight Loss WL (grams)
7/30	9:15	7/31	9:15	1073.00	1072.98	1072.99	0.01
7/31	9:15	8/1	9:15	1072.98	1072.94	1072.95	0.03
8/1	9:15	8/2	9:15	1072.94	1072.90	1072.90	0.04
8/2	9:15	8/3	9:15	1072.90	1072.86	1072.84	0.06
8/3	9:15	8/4	9:15	1072.86	1072.82	1072.84	0.02
8/4	9:15	8/5	9:15	1072.82	1072.78	1072.78	0.04
8/5	9:15	8/6	9:15	1072.78	1072.73	1072.73	0.05
8/6	9:15	8/7	9:15	1072.73	1072.71	1072.71	0.02
8/7	9:15	8/8	9:15	1072.71	1072.67	1072.67	0.04
8/8	9:15	8/9	9:15	1072.67	1072.64	1072.64	0.03

$WL = (W_{if} - D_f)$, $D_f = (W_{ff} + D_e)$, $D_e = (W_{ie} - W_{fe})$

$= (W_{if} - W_{ff}) - (W_{ie} - W_{fe})$ 0.034

Empty Tank Data

Date/Time Start		Date/Time End		Initial Weight W_{ie} (grams)	Final Weight W_{fe}grams)	Difference D_e (grams)	RH (%)	Baro. Press
7/30	9:15	7/31	9:15	418.24	418.23	0.01	24%	28.62
7/31	9:15	8/1	9:15	418.23	418.22	0.01	35%	28.65
8/1	9:15	8/2	9:15	418.22	418.22	0.00	24%	28.68
8/2	9:15	8/3	9:15	418.22	418.24	-0.02	26%	28.65
8/3	9:15	8/4	9:15	418.24	418.22	0.02	30%	28.54
8/4	9:15	8/5	9:15	418.22	418.22	0.00	26%	28.60
8/5	9:15	8/6	9:15	418.22	418.22	0.00	24%	28.64
8/6	9:15	8/7	9:15	418.22	418.22	0.00	25%	28.64
8/7	9:15	8/8	9:15	418.22	418.22	0.00	27%	28.62
8/8	9:15	8/9	9:15	418.22	418.22	0.00	27%	28.56
							28%	28.47



Day	Cum WL (grams)
1	0.01
2	0.04
3	0.08
4	0.14
5	0.16
6	0.20
7	0.25
8	0.27
9	0.31
10	0.34

slope	0.0375
r^2	0.9943
Area	0.1390
Rate	**0.269**