

California Environmental Protection Agency



**PERMEATION RATES OF FLUORINATED
WEDCO HIGH DENSITY POLYETHYLENE
PORTABLE FUEL CONTAINERS**

Engineering and Certification Branch
Monitoring and Laboratory Division

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PERMEATION RATES OF FLUORINATED WEDCO HIGH DENSITY POLYETHYLENE PORTABLE FUEL CONTAINERS

Introduction

The California Air Resources Board (CARB) staff tested several Wedco High-Density Polyethylene (HDPE) portable fuel containers (containers) to determine average permeation rates. Wedco submitted several 1.25 gallon, 2.5 gallon and 5 gallon portable fuel containers to the CARB staff for evaluation. All the containers were barrier surface treated, at different levels, with fluorination. Containers were preconditioned with commercial fuel, refilled with Phase II California Reformulated Certification (CERT) fuel, and subjected to a variable temperature profile. Permeation rates were then determined gravimetrically during the month of September.

Test Protocol

Wedco submitted 48 containers in June 2000. In June all containers underwent the durability and preconditioning process, using commercial fuel, per CARB Test Method 513. All containers were stored at ambient temperature and pressure in flammable storage cabinets. Only 36 containers were tested on September 8th. The remaining 12 Briggs & Stratton containers were tested on September 23rd. During the month of June container L-4-8 became missing and could not be tested. After four weeks of ambient preconditioning, the containers were emptied; blown dry with compressed zero air, and immediately refilled with CERT fuel. The containers were then sealed using a hand held fusion welder and 1/4" thick HDPE coupons and leak tested as specified in Test Method 513 (a copy can be found at the CARB web site: <http://www.arb.ca.gov/regact/spillcon/spillcon.htm>).

Weight loss was used to determine relative permeation rates. Sealed containers were weighed using a high capacity balance with a sensitivity of ± 0.1 grams. After each container was weighed and the weight recorded, they were placed in the Sealed Housing for Evaporative Determination (SHED) and exposed to a 1-day/24-hour/1440-minute variable temperature profile (see Attachment 1). This process is considered our diurnal cycle (recurring every day). Containers were then post weighed after each 24-hour diurnal cycle and the weight loss calculated.

Results

Cumulative weight losses were determined for each container as a function of time. The containers underwent a total of thirteen diurnal cycles, but results are calculated using only ten cycles, each cycle is 24-hours. The first three days of test data were not used in determining individual per container permeation rates

due to high variability. A summary of all test results can be found in Attachments 2, 3, 4 and 5.

The average permeation rate from the 5 gallon containers designated L-3-10, L-3-11 and L-3-12 was determined to be 0.16 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 5 gallon containers designated L-4-10, L-4-11 and L-4-12 was determined to be 0.12 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 5 gallon containers designated L-5-4, L-5-5 and L-5-6 was determined to be 0.09 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 5 gallon containers designated SPAL4, SPAL5 and SPAL6 was determined to be 0.04 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 2.5 gallon containers designated L-3-1, L-3-2 and L-3-3 was determined to be 0.50 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 2.5 gallon containers designated L-4-1, L-4-2 and L-4-3 was determined to be 0.48 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 2.5 gallon containers designated L-5-1, L-5-2 and L-5-3 was determined to be 0.24 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 2.5 gallon containers designated SPAL1, SPAL2 and SPAL3 was determined to be 0.05 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 1.25 gallon containers designated L-3-4, L-3-5 and L-3-6 was determined to be 0.50 grams/gallon/day. This rate is based

on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 1.25 gallon containers designated L-4-4, L-4-5 and L-4-6 was determined to be 0.36 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 1.25 gallon containers designated L-5-7, L-5-8 and L-5-9 was determined to be 0.24 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 1.25 gallon containers designated SPAL7, SPAL8 and SPAL9 was determined to be 0.07 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 2.5 gallon containers designated L-3-7, L-3-8 and L-3-9 was determined to be 0.20 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 2.5 gallon containers designated L-4-7 and L-4-9 was determined to be 0.17 grams/gallon/day. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles. Missing container L-4-8 was not tested.

The average permeation rate from the 2.5 gallon containers designated L-5-10, L-5-11 and L-5-12 was determined to be 0.15 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 2.5 gallon containers designated SPAL10, SPAL11 and SPAL12 was determined to be 0.02 grams/gallon/day. This rate is based on data averaged from tests of three individual containers and represents a total of 30 individual 24-hour diurnal cycles.

Attachment 1

1 Day / 24 Hour / 1440 Minute Variable Temperature Profile

HOUR	MINUTE	ELAPSE TIME (MINUTES)	TEMPERATURE (°F)
0	0	1440	65.0
1	60	1380	66.6
2	120	1320	72.6
3	180	1260	80.3
4	240	1200	86.1
5	300	1140	90.6
6	360	1080	94.6
7	420	1020	98.1
8	480	960	101.2
9	540	900	103.4
10	600	840	104.9
11	660	780	105.0
12	720	720	104.2
13	780	660	101.1
14	840	600	95.3
15	900	540	88.8
16	960	480	84.4
17	1020	420	80.8
18	1080	360	77.8
19	1140	300	75.3
20	1200	240	72.0
21	1260	180	70.0
22	1320	120	68.2
23	1380	60	66.5
24	1440	0	65.0

Attachment 2

PERMEATION TEST RESULTS

September 2000

Diurnal Cycles* (# 24 hr cycles)	Container Identification	Container Mfg.	Container Volume	Treatment Level	Test Dates	Fuel Type	Avg. Loss (g/gal/day)
10	L-3-10	Wedco	5 gallon	3	9/8 - 9/22	CERT	0.15
10	L-3-11	Wedco	5 gallon	3	9/8 - 9/22	CERT	0.11
10	L-3-12	Wedco	5 gallon	3	9/8 - 9/22	CERT	0.23
Average							0.16
10	L-4-10	Wedco	5 gallon	4	9/8 - 9/22	CERT	0.15
10	L-4-11	Wedco	5 gallon	4	9/8 - 9/22	CERT	0.11
10	L-4-12	Wedco	5 gallon	4	9/8 - 9/22	CERT	0.11
Average							0.12
10	L-5-4	Wedco	5 gallon	5	9/8 - 9/22	CERT	0.10
10	L-5-5	Wedco	5 gallon	5	9/8 - 9/22	CERT	0.11
10	L-5-6	Wedco	5 gallon	5	9/8 - 9/22	CERT	0.05
Average							0.09
10	SPAL4	Wedco	5 gallon	SPAL	9/8 - 9/22	CERT	0.04
10	SPAL5	Wedco	5 gallon	SPAL	9/8 - 9/22	CERT	0.04
10	SPAL6	Wedco	5 gallon	SPAL	9/8 - 9/22	CERT	0.04
Average							0.04

*The results are based on 10 diurnal cycles, although 13 were performed. The first 3 days were not included because of high variability.

Attachment 3

PERMEATION TEST RESULTS

September 2000

Diurnal Cycles* (# 24 hr cycles)	Container Identification	Container Mfg.	Container Volume	Treatment Level	Test Dates	Fuel Type	Avg. Loss (g/gal/day)
10	L-3-1	Wedco	2.5 gallon	3	9/8 - 9/22	CERT	0.54
10	L-3-2	Wedco	2.5 gallon	3	9/8 - 9/22	CERT	0.60
10	L-3-3	Wedco	2.5 gallon	3	9/8 - 9/22	CERT	0.36
Average							0.50
10	L-4-1	Wedco	2.5 gallon	4	9/8 - 9/22	CERT	0.42
10	L-4-2	Wedco	2.5 gallon	4	9/8 - 9/22	CERT	0.58
10	L-4-3	Wedco	2.5 gallon	4	9/8 - 9/22	CERT	0.44
Average							0.48
10	L-5-1	Wedco	2.5 gallon	5	9/8 - 9/22	CERT	0.23
10	L-5-2	Wedco	2.5 gallon	5	9/8 - 9/22	CERT	0.27
10	L-5-3	Wedco	2.5 gallon	5	9/8 - 9/22	CERT	0.23
Average							0.24
10	SPAL1	Wedco	2.5 gallon	SPAL	9/8 - 9/22	CERT	0.05
10	SPAL2	Wedco	2.5 gallon	SPAL	9/8 - 9/22	CERT	0.04
10	SPAL3	Wedco	2.5 gallon	SPAL	9/8 - 9/22	CERT	0.04
Average							0.05

*The results are based on 10 diurnal cycles, although 13 were performed. The first 3 days were not included because of high variability.

Attachment 4

PERMEATION TEST RESULTS

September 2000

Diurnal Cycles* (# 24 hr cycles)	Container Identification	Container Mfg.	Container Volume	Treatment Level	Test Dates	Fuel Type	Avg. Loss (g/gal/day)
10	L-3-4	Wedco	1.25 gallon	3	9/8 - 9/22	CERT	0.48
10	L-3-5	Wedco	1.25 gallon	3	9/8 - 9/22	CERT	0.55
10	L-3-6	Wedco	1.25 gallon	3	9/8 - 9/22	CERT	0.47
Average							0.50
10	L-4-4	Wedco	1.25 gallon	4	9/8 - 9/22	CERT	0.23
10	L-4-5	Wedco	1.25 gallon	4	9/8 - 9/22	CERT	0.28
10	L-4-6	Wedco	1.25 gallon	4	9/8 - 9/22	CERT	0.58
Average							0.36
10	L-5-7	Wedco	1.25 gallon	5	9/8 - 9/22	CERT	0.26
10	L-5-8	Wedco	1.25 gallon	5	9/8 - 9/22	CERT	0.23
10	L-5-9	Wedco	1.25 gallon	5	9/8 - 9/22	CERT	0.23
Average							0.24
10	SPAL7	Wedco	1.25 gallon	SPAL	9/8 - 9/22	CERT	0.06
10	SPAL8	Wedco	1.25 gallon	SPAL	9/8 - 9/22	CERT	0.05
10	SPAL9	Wedco	1.25 gallon	SPAL	9/8 - 9/22	CERT	0.10
Average							0.07

*The results are based on 10 diurnal cycles, although 13 were performed. The first 3 days were not included because of high variability.

Attachment 5

PERMEATION TEST RESULTS

September/October 2000

Diurnal Cycles* (# 24 hr cycles)	Container Identification	Container Mfg.	Container Volume	Treatment Level	Test Dates	Fuel Type	Avg. Loss (g/gal/day)
10	L-3-7	Wedco (B&S)	2.5 gallon	3	9/26 - 10/7	CERT	0.18
10	L-3-8	Wedco (B&S)	2.5 gallon	3	9/26 - 10/7	CERT	0.22
10	L-3-9	Wedco (B&S)	2.5 gallon	3	9/26 - 10/7	CERT	0.21
Average							0.20
10	L-4-7	Wedco (B&S)	2.5 gallon	4	9/26 - 10/7	CERT	0.17
-	L-4-8**	Wedco (B&S)	2.5 gallon	4	-	-	-
10	L-4-9	Wedco (B&S)	2.5 gallon	4	9/26 - 10/7	CERT	0.16
Average							0.17
10	L-5-10	Wedco (B&S)	2.5 gallon	5	9/26 - 10/7	CERT	0.29
10	L-5-11	Wedco (B&S)	2.5 gallon	5	9/26 - 10/7	CERT	0.09
10	L-5-12	Wedco (B&S)	2.5 gallon	5	9/26 - 10/7	CERT	0.09
Average							0.15
10	SPAL10	Wedco (B&S)	2.5 gallon	SPAL	9/26 - 10/7	CERT	0.03
10	SPAL11	Wedco (B&S)	2.5 gallon	SPAL	9/26 - 10/7	CERT	0.03
10	SPAL12	Wedco (B&S)	2.5 gallon	SPAL	9/26 - 10/7	CERT	0.02
Average							0.02

Briggs & Stratton model (B&S)

*The results are based on 10 diurnal cycles, although 13 were performed. The first 3 days were not included because of high variability.

**Data not available because of missing container.