

California Environmental Protection Agency



**PERMEATION RATES OF SCEPTER
SELAR[®] RB HIGH DENSITY POLYETHYLENE PORTABLE FUEL CONTAINERS**

Engineering and Certification Branch
Monitoring and Laboratory Division

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Permeation Rates of Scepter Selar[®] RB High Density Polyethylene Portable Fuel Containers

Introduction

The California Air Resources Board (CARB) staff tested several Scepter High-Density Polyethylene (HDPE) portable fuel containers (containers) to determine average permeation rates. Scepter submitted several 1 gallon, 2 gallon, 5 gallon and 6 gallon portable fuel containers to the CARB staff for evaluation. All the containers were treated, at different percentage levels, with Selar[®] RB (Selar). 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 December 2000.

Test Protocol

Scepter submitted a total of 52 containers in October 2000. In October, 52 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. 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 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 Attachment 2.

The average permeation rate from the 1 gallon containers with 8% Selar designated 1A8-1 and 1A8-2, 1B8-1 and 1B8-2, 1C8-1 and 1C8-2 was determined to be 0.21, 0.90, and 0.19 grams/gallon/day, respectively. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal

cycles. The container 1B8-2 had a high permeation rate of 1.66 grams/gallon/day and was leak checked after the first 5-consecutive days of testing. No leak was detected before, during and after testing.

The average permeation rate from the 1 gallon containers with 10% Selar designated 1D10-1 and 1D10-2, 1E10-1 and 1E10-2, 1F10-1 and 1F10-2 was determined to be 0.18, 0.19, and 0.24 grams/gallon/day, respectively. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles.

The average permeation rate from the 1 gallon containers with 12% Selar designated 1G12-1 and 1G12-2, 1H12-1 and 1H12-2, 1I12-1 and 1I12-2 was determined to be 0.29, 0.21, and 0.13 grams/gallon/day, respectively. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles.

The average permeation rate from the 2 gallon containers with 6% Selar designated 2G6-1 and 2G6-2, 2H6-1 and 2H6-2, 2I6-1 and 2I6-2, and 2R6-1 through 2R6-3 was determined to be 0.09, 0.11, 0.08, and 0.46 grams/gallon/day, respectively. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles. The 2R6-1, 2R6-2 and 2R6-3 rates are based on data averaged from three individual containers and represent a total of 30 individual 24-hour diurnal cycles.

The average permeation rate from the 2 gallon containers with 8% Selar designated 2D8-1 and 2D8-2, 2E8-1 and 2E8-2, 2F8-1 and 2F8-2 was determined to be 0.12, 0.06, and 0.09 grams/gallon/day, respectively. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles.

The average permeation rate from the 2 gallon containers with 10% Selar designated 2A10-1 and 2A10-2, 2B10-1 and 2B10-2, 2C10-1 and 2C10-2 was determined to be 0.07, 0.06, and 0.13 grams/gallon/day, respectively. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles.

The average permeation rate from the 5 gallon containers with 4% Selar designated 5C4-1 and 5C4-2, 5R4-1 and 5R4-2, was determined to be 0.09 and 0.16 grams/gallon/day, respectively. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles.

The average permeation rate from the 5 gallon containers with 6% Selar designated 5RRS756-1 and 5RRS756-2, 5RS756-1 and 5RS756-2, 5RS926-1 and 5RS926-2 was determined to be 0.14, 0.07, and 0.07 grams/gallon/day, respectively. This rate is based on data averaged from tests of two individual containers and represents a total of 20 individual 24-hour diurnal cycles.

The average permeation rate from the 6 gallon containers designated 6A8 at 8% Selar, 6B6 at 6% Selar, and 6C4 at 4% Selar was determined to be 0.06, 0.07, and 0.10 grams/gallon/day, respectively. This rate is based on data averaged from tests of one individual container and represents a total of 10 individual 24-hour diurnal cycles.

Attachment 1

SHED Temperature Test Profile

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

Attachment 2

PERMEATION TEST RESULTS December 2000

Diurnal Cycles* (# 24 hr cycles)	Container Identification	Container Mfg.	Treatment	Selar Resin Percentage	Container Volume	Test Dates	Fuel Type	Avg. Loss (g/gal/day)
10	1A8-1	Scepter	Selar	8%	1 gallon	12/8 - 12/21	CERT	0.21
10	1A8-2	Scepter	Selar	8%	1 gallon	12/8 - 12/21	CERT	0.21
							Average =	0.21
10	1B8-1	Scepter	Selar	8%	1 gallon	12/8 - 12/21	CERT	0.14
10	1B8-2	Scepter	Selar	8%	1 gallon	12/8 - 12/21	CERT	1.66
							Average =	0.90
10	1C8-1	Scepter	Selar	8%	1 gallon	12/8 - 12/21	CERT	0.17
10	1C8-2	Scepter	Selar	8%	1 gallon	12/8 - 12/21	CERT	0.21
							Average =	0.19
10	1D10-1	Scepter	Selar	10%	1 gallon	12/8 - 12/21	CERT	0.15
10	1D10-2	Scepter	Selar	10%	1 gallon	12/8 - 12/21	CERT	0.21
							Average =	0.18
10	1E10-1	Scepter	Selar	10%	1 gallon	12/8 - 12/21	CERT	0.19
10	1E10-2	Scepter	Selar	10%	1 gallon	12/8 - 12/21	CERT	0.19
							Average =	0.19
10	1F10-1	Scepter	Selar	10%	1 gallon	12/8 - 12/21	CERT	0.23
10	1F10-2	Scepter	Selar	10%	1 gallon	12/8 - 12/21	CERT	0.26
							Average =	0.24
10	1G12-1	Scepter	Selar	12%	1 gallon	12/8 - 12/21	CERT	0.23
10	1G12-2	Scepter	Selar	12%	1 gallon	12/8 - 12/21	CERT	0.35
							Average =	0.29
10	1H12-1	Scepter	Selar	12%	1 gallon	12/8 - 12/21	CERT	0.20
10	1H12-2	Scepter	Selar	12%	1 gallon	12/8 - 12/21	CERT	0.21
							Average =	0.21
10	1I12-1	Scepter	Selar	12%	1 gallon	12/8 - 12/21	CERT	0.13
10	1I12-2	Scepter	Selar	12%	1 gallon	12/8 - 12/21	CERT	0.14
							Average =	0.13

Attachment 2 (Continued)

Diurnal Cycles* (# 24 hr cycles)	Container Identification	Container Mfg.	Treatment	Selar Resin Percentage	Container Volume	Test Dates	Fuel Type	Avg. Loss (g/gal/day)
10	2G6-1	Scepter	Selar	6%	2 gallon	12/8 - 12/21	CERT	0.07
10	2G6-2	Scepter	Selar	6%	2 gallon	12/8 - 12/21	CERT	0.10
Average =								0.09
10	2H6-1	Scepter	Selar	6%	2 gallon	12/8 - 12/21	CERT	0.11
10	2H6-2	Scepter	Selar	6%	2 gallon	12/8 - 12/21	CERT	0.11
Average =								0.11
10	2I6-1	Scepter	Selar	6%	2 gallon	12/8 - 12/21	CERT	0.06
10	2I6-2	Scepter	Selar	6%	2 gallon	12/8 - 12/21	CERT	0.10
Average =								0.08
10	2R6-1	Scepter	Selar	6%	2 gallon	12/8 - 12/21	CERT	0.44
10	2R6-2	Scepter	Selar	6%	2 gallon	12/8 - 12/21	CERT	0.47
10	2R6-3	Scepter	Selar	6%	2 gallon	12/8 - 12/21	CERT	0.45
Average =								0.46
10	2D8-1	Scepter	Selar	8%	2 gallon	12/8 - 12/21	CERT	0.09
10	2D8-2	Scepter	Selar	8%	2 gallon	12/8 - 12/21	CERT	0.16
Average =								0.12
10	2E8-1	Scepter	Selar	8%	2 gallon	12/8 - 12/21	CERT	0.07
10	2E8-2	Scepter	Selar	8%	2 gallon	12/8 - 12/21	CERT	0.04
Average =								0.06
10	2F8-1	Scepter	Selar	8%	2 gallon	12/8 - 12/21	CERT	0.05
10	2F8-2	Scepter	Selar	8%	2 gallon	12/8 - 12/21	CERT	0.12
Average =								0.09
10	2A10-1	Scepter	Selar	10%	2 gallon	12/8 - 12/21	CERT	0.06
10	2A10-2	Scepter	Selar	10%	2 gallon	12/8 - 12/21	CERT	0.08
Average =								0.07
10	2B10-1	Scepter	Selar	10%	2 gallon	12/8 - 12/21	CERT	0.06
10	2B10-2	Scepter	Selar	10%	2 gallon	12/8 - 12/21	CERT	0.07
Average =								0.06
10	2C10-1	Scepter	Selar	10%	2 gallon	12/8 - 12/21	CERT	0.13
10	2C10-2	Scepter	Selar	10%	2 gallon	12/8 - 12/21	CERT	0.14
Average =								0.13

Attachment 2 (Continued)

Diurnal Cycles* (# 24 hr cycles)	Container Identification	Container Mfg.	Treatment	Selar Resin Percentage	Container Volume	Test Dates	Fuel Type	Avg. Loss (g/gal/day)
10	5C4-1	Scepter	Selar	4%	5 gallon	12/8 - 12/21	CERT	0.09
10	5C4-2	Scepter	Selar	4%	5 gallon	12/8 - 12/21	CERT	0.08
Average =								0.09
10	5R4-1	Scepter	Selar	4%	5 gallon	12/8 - 12/21	CERT	0.16
10	5R4-2	Scepter	Selar	4%	5 gallon	12/8 - 12/21	CERT	0.17
Average =								0.16
10	5RRS756-1	Scepter	Selar	6%	5 gallon	12/8 - 12/21	CERT	0.17
10	5RRS756-2	Scepter	Selar	6%	5 gallon	12/8 - 12/21	CERT	0.12
Average =								0.14
10	5RS756-1	Scepter	Selar	6%	5 gallon	12/8 - 12/21	CERT	0.07
10	5RS756-2	Scepter	Selar	6%	5 gallon	12/8 - 12/21	CERT	0.08
Average =								0.07
10	5RS926-1	Scepter	Selar	6%	5 gallon	12/8 - 12/21	CERT	0.07
10	5RS926-2	Scepter	Selar	6%	5 gallon	12/8 - 12/21	CERT	0.07
Average =								0.07
10	6A8	Scepter	Selar	8%	6 gallon	12/8 - 12/21	CERT	0.06
10	6B6	Scepter	Selar	6%	6 gallon	12/8 - 12/21	CERT	0.07
10	6C4	Scepter	Selar	4%	6 gallon	12/8 - 12/21	CERT	0.10

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