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WATER VAPOR PERMEABILITY OF PLASTIC FAST PACKS,(U)
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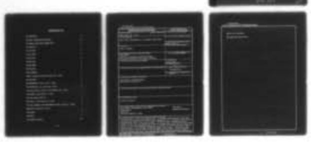

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WATER VAPOR PERMEABILITY OF PLASTIC FAST PACKS

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ABSTRACT

The objective of this investigation was to perform nondestructive tests that quantitatively measured the water vapor permeability of a plastic (high density polyethylene) Type I Fast Pack design. The water vapor transmission rate (WVTR) of the new pack design was found to be much less than the 0.02 grams/100 square inch/24 hour maximum allowed for the MIL-B-131 barrier material bags or pouches used in the original fiberboard Type I Fast Packs. The plastic Fast Pack container, itself, acts as the low WVTR barrier which protects against moisture penetration while the polyurethane foam cushioning affords mechanical and physical protection.

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INTRODUCTION

The purpose of this test study was to evaluate the water vapor seal provided by plastic fast packs manufactured under contract with Thermodyne International, Ltd., and to determine whether they meet the WVTR requirements of the original fiberboard fast packs with MIL-B-131 barrier protection. The fiberboard fast packs have a Category II reusable container rating (approx. 10 trips) while the plastic containers have a Category I container rating, i.e., they are designed for 100 trips. This greater reusability provides a more economical life cycle cost effectiveness since the fast packs are reused for so many items.

TEST PROCEDURE

An accelerated environmental study of the new plastic fast packs was conducted at the Air Force Packaging Evaluation Agency (AFPEA), using the high temperature/humidity walk-in environmental chamber. The test was conducted in compliance with ASTM D 1008-64 standard test method. Figure 1 shows the 12 test containers positioned in the chamber. New, dry, one unit desiccant bag(s) were placed in each fast pack as per calculation and closed immediately. Fourteen, 1 inch x 1 inch x 0.016 inch, thick-polished steel specimens were prepared

FIGURE 1. PLASTIC FAST PACKS INSIDE TEST CHAMBER

and kept dry in a desiccator. Twelve, fresh, new NSN 6685-752-8240 humidity indicator spot cards, MS 20003-2, were also placed in the same desiccator. Steel specimens and spot cards were removed from the desiccator and placed in each of the 12 fast pack containers. The remaining two steel specimens were placed on top of the fast packs to rust in an extreme high temperature/humidity atmosphere.

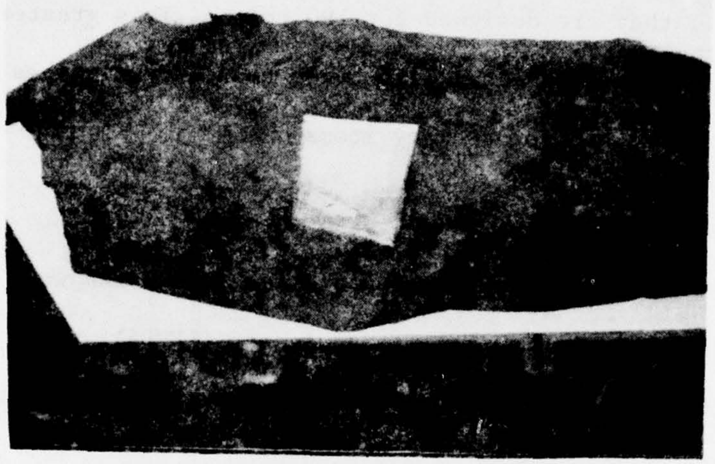


FIGURE 2. DESICCANT BAG WRAPPED
IN SARAN

Next, the desiccant units were removed from one fast pack at a time and wrapped in a numbered and tare weighed sheet of saran film (see Figure 2). This was then accurately weighed on an analytical balance to the nearest milligram (see Figure 3). After all desiccant was weighed, recorded, and returned to the respective numbered fast packs, the fast packs were placed in the environmental chamber (see Figure 1).

DESCRIPTION OF TEST SPECIMENS

Two each of the following sizes of plastic Fast Packs (see Figure 1) were evaluated in this study: A. 6" x 6" x 10"; B. 8" x 8" x 12"; C. 10" x 10" x 12"; D. 12" x 12" x 14"; E. 12" x 12" x 18"; F. 14" x 14" x 16".

FIGURE 3. SARAN WRAPPED DESICCANT WEIGHED ON ANALYTICAL BALANCE

These Fast Packs met the preproduction sample test requirements of GS-055-10520 contract purchase description. The minimum units of desiccant used in each size container was calculated in accordance with Formula II in MIL-P-116. Containers A, B, and C each had one unit of desiccant, D had two units, and E and F each had three units because of their larger volume.

Two units of fresh desiccant were heat sealed in four MIL-B-131 barrier pouches (see Figure 4). Each was identified with a numbered marking and independently weighed on the analytical balance. These standards were then placed on top of the fast packs with the two metal specimens. The chamber was set at 100°F and 90%RH. The test was begun on 15 December 1977 at 1200 hours. After 146 hours the 12 containers, 4 standard MIL-B-131 pouch bags and the two unprotected steel specimens were removed and placed in a low humidity room for two hours to reach thermal equilibrium. The unprotected steel specimens were observed to be rusted. Next, the desiccant from each fast pack was wrapped in the tared saran wraps and accurately weighed on the analytical balance, recording the weight gain with respect to time. The spot cards and steel specimens in the fast packs indicated no moisture damage (spots all blue and no rust on steel). The desiccated fast packs were returned to the 100°F/90%RH test chamber for another six-day interval and the weighing of desiccants from each container was repeated. Successive weighings were made at suitable intervals. This was continued according to the ASTM D 1008-64 test procedure until a constant rate of gain was attained as indicated by a graphical plot of at least three successive points in a relatively straight line. Figure 5 is a plot of the weight gain of each of the 12 containers with respect to time.

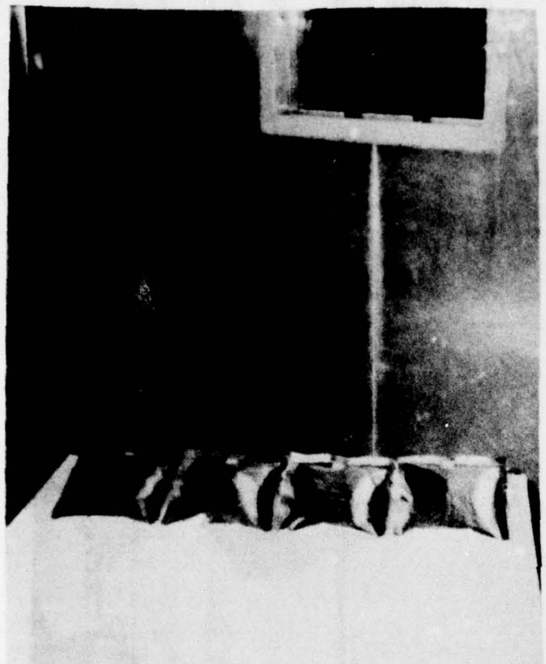


FIGURE 4. DESICCANT SEALED IN MIL-B-131 BAGS USED AS A STANDARD

We see from this plot that a constant rate of gain was attained after 312 hours and continued to remain the same throughout this investigation that continued for a total of 838 hours.

RESULTS

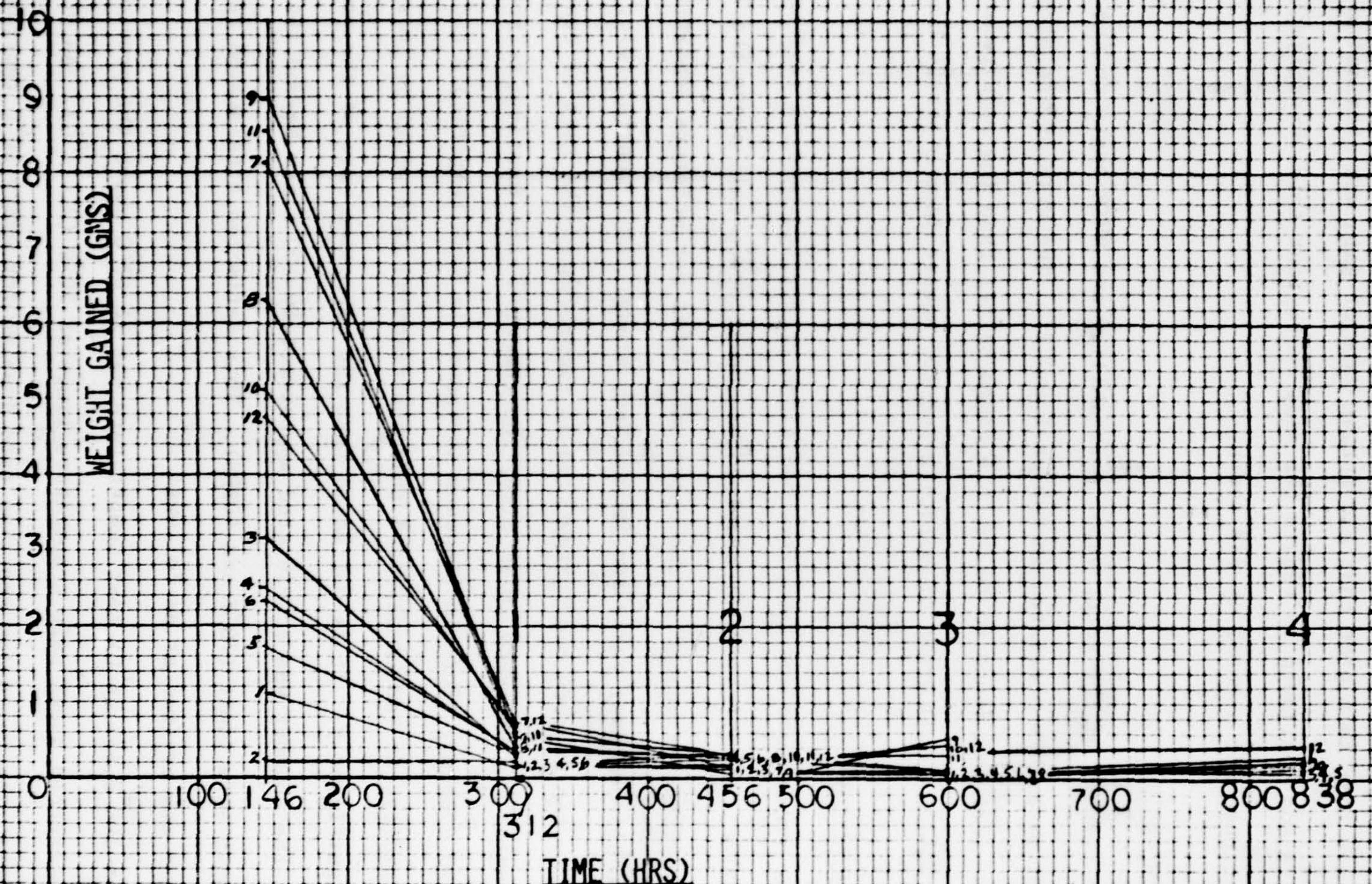
The results of the water vapor permeability and WVTR tests on the plastic fast packs are presented in Tables I and II. The WVTR of the plastic fast pack was found to be 3½ to 5 times better than the requirement of MIL-B-131 (0.02 grams of moisture per 100 square inches per 24 hours).

DISCUSSION

The temperature and humidity conditions prescribed by this test method (100°F, 90%RH) represent accelerated conditioning well above the 70°F and 40%RH designated as the upper safe limit for moisture sensitive items, established many years ago from a Navy study. As a general rule, for every ten degrees centigrade rise in temperature, the rate of reaction doubles. With every 10%RH rise, the reaction rate (rusting, corroding) also doubles. For simultaneous increases in both temperature and humidity, it can be expected that the reaction rate would be increased significantly. It is estimated that the corrosion rate of the atmosphere in the chamber was accelerated approximately 100 times beyond that at the upper safe limit (70°F and 40%RH). This estimated accelerated rate of test was arrived at as follows:

The 100°F (37.78°C) test temperature was 16.67°C above the previously referenced upper safe temperature limit of 70°F (21.11°C). As stated above, the corrosion reaction rate doubles for every 10°C increase. Thus, an accelerated corrosion rate factor of 3.18 can be established

FIGURE 5. SUCCESSIVE WEIGHINGS OF DESICCANT (WEIGHT GAINED VS. TIME)



Hours In Test Chamber	*Standard (desiccant in sealed MIL-B-131 bags)	WVTR (gm/100 in^2/24 hr) Fast Packs (A) 6x6x10 #1	(A) 6x6x10 #2	(B) 8x8x12 #1	(B) 8x8x12 #2	(C) 10x10x12 #1	(C) 10x10x12 #2	(D) 12x12x14 #1	(D) 12x12x14 #2	(E) 12x12x18 #1	(E) 12x12x18 #2	(F) 14x14x16 #1	(F) 14x14x16 #2
312	.001	.008	.009	.008	-	.005	.007	.011	.006	.007	.008	.005	.007
456	.003	.004	.004	.003	.004	.003	.004	.003	.004	.001	.004	.003	.004
30" Drop Tested - Then Returned to Chamber													
600	.002	.004	.005	.003	.004	.003	.004	.002	.002	.008	.006	.004	.005
30" Drop Tested - Then Returned to Chamber													
838	.001	-	-	.002	.003	.003	.004	-	-	-	.002	-	.003
Average	.002	.006		.004		.004		.005		.005		.004	
Requirement (Max)	.02												
Times Better Than MIL-B-131 Max. Allowed		3 1/3 x		5x		5x		4x		4x		5x	

TABLE I. RESULTS OF WATER VAPOR TRANSMISSION RATE (WVTR) Test of Plastic Fast Packs

*Four Standards were run; each number represents an average of four readings.

TABLE II. 30-DAY WATER VAPOR PERMEABILITY TEST OF PLASTIC FAST PACKS

Days	Grams Water Vapor Fast Packs			
	(B) 8x8x12 (512 In^2 Area)	(C) 10x10x12 (680 In^2 Area)	(E) 12x12x18 (1152 In^2 Area)	(F) 14x14x16 (1288 In^2 Area)
7	.140	.201	.357	.435
13	.260	.373	.662	.808
19	.380	.545	.967	1.181
29	.579	.832	1.467	1.701
30	.591	.861	1.561	1.760
WVTR gm/100 In^2 /24 hr	.004	.004	.005	.004
Times Better Than MIL-B-131 Maximum Allowed	5x	5x	4x	5x

for this rise in temperature. If the temperature were 20°C above optimum, then a factor of 4 (or 2^2) would be used.

The 90%RH was 50%RH above the upper safe humidity limit of 40%RH. As stated above, the corrosion reaction rate doubles with every 10%RH increase. Thus, an accelerated corrosion rate that is a factor of 32 (or 2^5) can be presumed for this rise in humidity. The product of these two factors (3.18 x 32), represents a combined acceleration factor of 101.8.

CONCLUSION

Based on the results of this study, it is concluded that the Type I plastic fast pack can safely be used for moisture sensitive items providing protection in shipment and storage as good as or better than desiccated MIL-B-131 heat-sealed pouches placed in fiberboard fast packs.

RECOMMENDATIONS

To assure that the polyurethane cushioning insert of the fast pack is in a dried condition, it is recommended that at least 20% to 25% additional desiccant be added to the container when they are closed for shipment. Containers could be left unlatched or opened (see Figure 6) before an item is inserted into the foamed container for shipment.

FIGURE 6. UNLATCHED, OPENED FAST PACKS

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