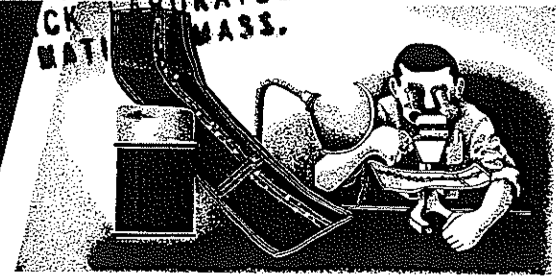
containers



CANNED BREAD CAN BE CORROSION-FREE

The blot on the 'scutcheon as regards canned bread was easy to identify—it was corrosion. Removing the blot was a more tedious task than might be suspected. This article describes the various difficulties encountered and overcome prior to solving the problem.

By Donald Coppy

Demand for canned bread resulted from the desire of the Military to relieve the monotony of crackers which occur in every operational ration. The acceptability of bread as an alternate is self-evident. In working on this problem, it was demonstrated at least as early as 1948 that bread could be successfully baked in cans. The Subsistence Division, Container Laboratories, became concerned, however, when tests showed that after short storage periods, corrosion developed on the interiors of the cans. The solution of this problem required approximately two years of coordinated effort between the Armed Forces and the manufacturers of sanitary food cans.

corrosion sounds the attack

In January 1949, canned bread was produced for inclusion in the Ration, Individual, In-Flight (IF-2). An examination of cans from this ration in July 1949 revealed that corrosion had developed on the can interiors during storage. This corrosion deposited stains on the surface of the bread where it was in contact with the corroded portions of the container. These stains, while in themselves non-harmful, made the product unsightly and would have seriously limited field acceptance of this item. Figure 1 exhibits representative examples of this can corrosion and Figure 2 demonstrates its transfer to the bread. Examination reveals that the predominant occurrence of corrosion is at the side seam and score line.

coordinated counterattack

Numerous meetings were held during which the can manufacturers made available to the Institute their experiences with regard to problems of a similar nature. As a result, a test program was set up in August 1949 to be conducted by the Institute in cooperation with can manufacturers. The testing procedure contained many of the suggestions of the can manufacturers.

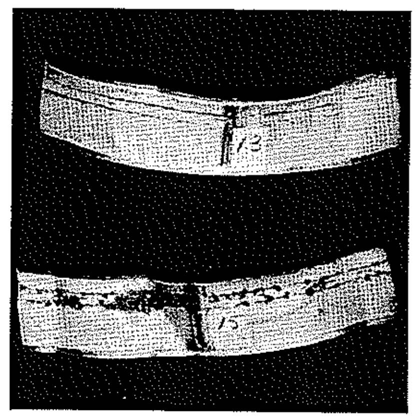


Figure 1. Example of can corrosion.

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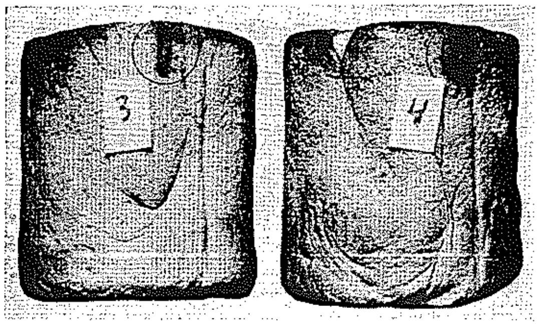


Figure 2. Canned bread showing evidence of corrosion (circles).

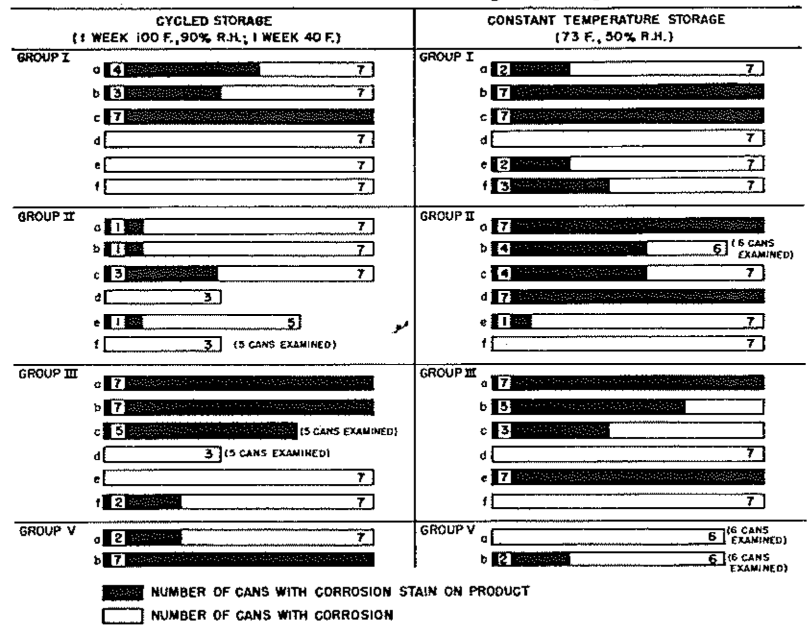
The program as set up includes five main groups of cans with varying numbers of subgroups as outlined in Chart I. Cans used were round, hermetically-sealed, open-top style, metal cans, size 401 by 411 with soldered side seam and compound-lined double-seamed ends. All cans with the exception of Group V were key-scored. The cans were made throughout from commercial 1.25-pound hot-dipped tin plate, coated inside, with the exception of Group IV, with an enamel specified by the can

Chart I. Description of Canned Bread Test Groups—1st Test Plan

Group No.		*Key Scoring*		*Inside Enameling*	*Vacuum*			*Greasing*		*Liner*	
		Outside	*Inside*		*16-20"*	*10-15"*	*0"*	*Can*	*Dough*	*Waxed Paper*	*Parchment*
I	a	X		X	X				x		
	b							x			
	c							x	x		
	d									x	
	e								x		x
	f							x	x		x
II	a		X	X	X				x		
	b							x			
	c							x	x		
	d									x	
	e								x		x
	f							x	x		x
III	a		X	X		X			x		
	b							x			
	c							x	x		
	d									x	
	e								x		x
	f							x	x		x
IV	a		X				X		x		
	b							x			
V[1]	a			X	X				x		
	b					X			x		

[1] Cans were not key-scored but did have key-opening tabs.

Chart II. Can Examination After Six Months Storage (Showing Cans with Corrosion)



UNLESS OTHERWISE INDICATED 7 CANS OF EACH GROUP WERE EXAMINED

manufacturer, and outside with a gold lacquer. In the preparation of samples, grease was applied to the dough only; can only; both can and dough; or it was not used at all. Vacuum groups were 16 to 20 inches Hg; ten to 15 inches Hg; or no vacuum. A vacuum of 16 to 20 inches Hg was achieved by allowing the cans to cool nine to ten minutes before closing. A vacuum of ten to 15 inches Hg was achieved by allowing the cans to cool 21 minutes before closing. Zero vacuums were achieved by allowing the cans to cool to 90° F. before closing. In some groups, a waxed paper liner was used and in other groups an unwaxed vegetable parchment liner was used. The waxed paper had a base sheet of 24 pounds per ream, waxed with six pounds per ream of a fully refined paraffin wax to a finished basis weight of 30 pounds per ream (24 x 36—500). The vegetable parchment had a basis weight of 29 pounds per ream (24 x 36—500). The ends of the cans were not lined. The baking of the bread in this test conformed in all respects with Specification JAN-B-1070, dated 10 May 1949.

During clinching and double-seaming operations, representatives of the can companies were present to inspect can seams for proper closure. Representatives of the can companies also attended subsequent examinations. Initial moisture and pH determinations were made on all prepared samples of all groups to test conformance with specification requirements. These determinations were also made at all examination periods.

The test was scheduled to extend over a six month period. Twenty-six cans of each group were placed in storage under two conditions:

a. One week at 100° F. ± 2° F. followed by a week at 40° F. ± 2° F.; cycling continued throughout the test. This condition was selected to promote moisture condensation in the can.

b. 72° F. ± 1° F.

Three cans of each group were examined after one and two months' storage, and seven cans of each group were examined after three, five, and six months' storage.

The examination procedures were as follows: Cans were removed from storage at prescribed intervals and vacuums were taken using a puncture-type vacuum gauge after the bread had reached room temperature. The cans were then opened and the interiors examined for corrosion. Where corrosion existed, the bread was examined

Chart III. Description of Canned Bread Test Groups—2nd Test Plan

Group	*Vacuum* [1]	*Side Seam Stripping*	*Liner* [2]	*Weight of Tinplate*
1	H	SA-4	None	1.25
2	H	SA-4	None	1.25 (Oven bake)
3	H	SA-4	A	1.25
4	H	SA-4	P	1.25
5	H	SA-4	None	0.50
6	H	SA-4	None	0.25
7	H	SA-3	None	1.25
8	H	SA-3	A	1.25
9	H	SA-3	P	1.25
10	H	None	None	1.25
11	H	None	A	1.25
12	H	None	P	1.25
13	H	None	P	0.50
14	H	None	P	0.25
15	H	SA-4	A	0.50
16	H	SA-4	A	0.25
17	H	None	AIS	1.25
18	M	SA-4	None	1.25
19	M	SA-4	A	1.25
20	M	SA-4	P	1.25
21	M	SA-3	None	1.25
22	M	SA-3	A	1.25
23	M	SA-3	P	1.25
24	M	None	None	1.25
25	M	None	A	1.25
26	M	None	P	1.25

[1] H = High Vacuum, 25 + inches
M = Medium Vacuum, 16-20 inches
[2] A = 1 Mil Aluminum Foil Liner, Vinyl Coated
P = Waxed Parchment Liner

for transfer of the corrosion to the bread. Chart II outlines the result of the six month examination. It can be seen from a survey of this chart that none of the methods were successful in inhibiting corrosion development on the interior of the cans nor its subsequent transfer to the product. Moisture and pH characteristics of the bread fell within the requirements of the specification throughout the test. Utilizing the results obtained from this test, a new series of tests was planned.

if at first you don't succeed . . .

The second test plan was established in May 1951 and was coordinated with the same members of industry as the first. This plan encompassed a larger number of variables, as outlined in Chart III, and was scheduled for one year. In the preparation of samples, 26 groups of 61 cans each were produced. Following were the variables used in packaging:

Vacuums: Vacuum in Groups 1 through 17 was a minimum of 25 inches Hg and as close to 28 inches Hg as possible. Vacuums in Group 18 through 26 were between 16 and 20 inches Hg, as required in Specification JAN-B-1070A, "Bread, Canned," dated 7 December 1950. A survey of results of the first test indicated that a higher vacuum would materially reduce or possibly eliminate corrosion. This may be due to the fact that the amount of oxygen present is reduced.

Side Seam Striping: Since previous observations had established that corrosion had centered about the side seam, two types of enamel were used in striping the interior side seams of the cans in an effort to study possible protection afforded by these enamels. The enamels will be referred to as SA-3 and SA-4.

Can Liners: Liners in the can were again tried and were of two types.

(1) 0.001 inch thick aluminum foil coated with vinyl on both sides.

(2) A waxed parchment consisting of a 27 pound unwaxed paper, waxed with a fully refined paraffin wax to 37 pounds (24 x 36—500).

Purpose of the liners was to protect the product from corrosion stain in the event that other methods failed to completely eliminate corrosion formation.

Weight of Tin Plate: Three weights of tin plate were used:

(1) 1.25-lb. hot dip.
(2) 0.50-lb. electrolytic.
(3) 0.25-lb. electrolytic.

The majority of the groups of cans were made from 1.25-lb. hot dipped tin plate, the lower weights being included in the test to explore the possibility of reducing the weight of tin plate coating.

Other Variables. Group 2 was the same as Group 1 except that the cans were placed in an oven for 30 minutes at a temperature of 350° F. to force dry the enamel used for side seam striping. This was done to minimize the possibility of contamination of the product by residues of volatile solvent (in manufacturing the enamel was air dried).

Group 17 had an 0.001-inch thick aluminum foil tab (one by two inches) incorporated in the top double seam of the can, positioned over the side seam. The purpose of this tab was to develop a galvanic cell between the can and the foil, thereby minimizing the possibility of corrosion forming on the can interior.

The following are the constants in the packaging test:

Cans: The cans used were round, hermetically-sealed, open-top style, No. 2 metal cans, size 307 by 409, key scored inside with soldered side seam and compound lined ends. The compound for the ends was grease and heat resistant. The interior was coated with a C-type enamel recommended by the can manufacturer and the outside with a gold lacquer. All cans had a base weight of metal of 95 pounds per base box, a weight higher than normally used for No. 2 cans but necessary to prevent excessive paneling due to high vacuums incurred.

Bread: The bread formula and baking process were also uniform and complied with Specification JAN-B-1070A, dated 7 December 1950.

Vacuums were attained by sealing the cans of Groups 1 through 17 immediately upon removal from the oven. No can remained unsealed for more than 70 seconds. Groups 18 through 26 had a cooling period of seven minutes; cooling was performed at room temperature under rapidly circulating air. Storage of the cans was under two conditions as in the first test:

(a) One week at 100° F. ± 2° F. followed by one week at 40° F. ± 2° F.; cycling continued throughout the test. This condition was selected to promote moisture condensation in the can.

(b) 72° F. ± 1° F.

examination days! . . .

Examinations of the cans took place prior to storage and after one, three, six, and 12 months. The examination prior to storage was concerned primarily with vacuum requirements and bread quality. At subsequent examinations, after vacuum readings were taken, the can interior, the product, and the liner (when used) were examined for the presence of corrosion or other miscellaneous defects. To facilitate visual examinations and to insure uniformity by examining personnel, Chart IV was designed. It makes extent of corrosion easier to record and analyze. For examination purposes, the interior surfaces of the cans were divided into six distinct areas and the degree of corrosion present in each area was determined visually. The degrees of corrosion were described as "none," "light," "medium," and "heavy." To aid in the final analyses of the data, numerical weights were assigned to the different degrees of corrosion as follows: none = 0, light = 1, medium = 2, and heavy = 3. The corrosion weights assigned the six distinct areas of the interior surfaces in all the cans examined in a particular group were added. This summation was then divided by the number of cans examined. The resultant number was defined as the corrosion value. The cor-

Chart IV. Record of Corrosion

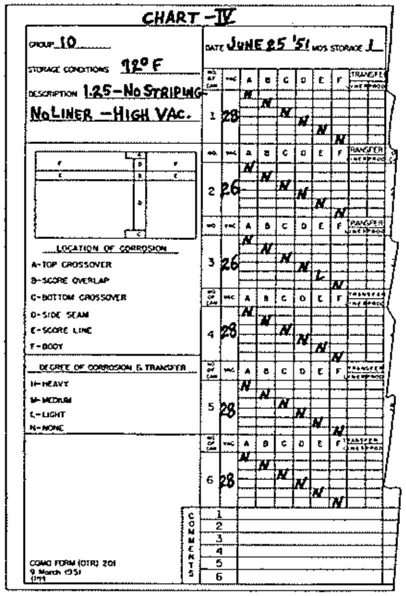


Chart V. Summary of Corrosion Values of Test Groups

Group No.	Vacuum Range	Side Seam Stripping	Liner	Weight of Tin Plate	Storage at 72°F.: Total Number of Cans Examined	Storage at 72°F.: Corrosion Values for Each Examination Period, Months: 1	3	6	12	Storage at 100° F.; 40° F., Cycled Weekly: Total Number of Cans Examined	Storage at 100° F.; 40° F., Cycled Weekly: Corrosion Values for Each Examination Period, Months: 1	3	6	12
1	25" +	SA4	None	1.25	21	0	0	0	0	17	0	0	0	0
2	"	SA4	None	1.25	18	0	0	0	0	18	0	0	.60	0
3	"	SA4	A	1.25	20	0	0	0	0	18	0	0	0	0
4	"	SA4	P	1.25	22	0	0	.40	0	23	0	0	0	0
5	"	SA4	None	0.50	24	0	0	0	0	24	0	0	0	0
6	"	SA4	None	0.25	23	.20	0	0	0	22	.16	.20	0	0
7	"	SA3	None	1.25	24	0	0	0	0	22	0	0	0	0
8	"	SA3	A	1.25	22	0	0	.66	0	19	0	0	.20	0
9	"	SA3	P	1.25	22	0	0	.16	0	18	0	0	0	0
10	"	None	None	1.25	21	.16	0	.20	0	19	0	2.2	0	0
11	"	None	A	1.25	21	.66	0	.25	0	18	0	0	0	0
12	"	None	P	1.25	18	0	0	0	0	21	0	.20	0	0
13	"	None	P	0.50	21	0	0	0	0	21	0	0	0	0
14	"	None	P	0.25	22	0	0	.20	0	19	0	0	0	0
15	"	SA4	A	0.50	24	1.5	.33	1.7	0	21	1.0	0	.60	0
16	"	SA4	A	0.25	22	1.7	0	.60	0	21	0	0	9.5	0
17	"	None	Als	1.25	22	0	0	0	0	18	0	.60	0	0
18	16"–20"	SA4	None	1.25	19	.20	.20	5.5	8.2	19	.40	3.5	5.5	5.2
19	"	SA4	A	1.25	22	.60	2.8	8.4	9.3	20	5.0	3.4	3.2	2.0
20	"	SA4	P	1.25	22	.33	8.0	2.5	6.0	23	.33	1.0	.66	1.5
21	"	SA3	None	1.25	21	1.2	2.0	5.4	6.0	19	1.6	2.5	3.8	5.0
22	"	SA3	A	1.25	23	2.4	7.6	8.8	8.5	19	2.8	4.8	2.8	3.6
23	"	SA3	P	1.25	22	.16	2.4	3.4	4.7	21	0	1.0	2.0	1.3
24	"	None	None	1.25	18	3.2	7.8	12.5	9.3	19	4.8	6.0	8.3	8.6
25	"	None	A	1.25	23	9.0	12.2	11.0	12.3	23	8.8	6.4	7.5	6.5
26	"	None	P	1.25	22	2.0	5.0	10.0	8.3	19	7.4	3.8	3.2	3.2

rosion value is used in determining relative effectiveness of each variable in preventing corrosion. The maximum corrosion value possible for a single group is 18.0.

At each examination period in any particular group, cans having less than the desired vacuum level for that group were excluded from the final evaluation. Chart V gives a resumé of the corrosion values for the test. In each examination where doubt existed as to the presence of a light trace of corrosion, a microscope of 40 power magnification was used for closer examination.

the sixty-four dollar answer

An examination of Chart V reveals that a high vacuum is the most important factor in eliminating corrosion from the interiors of cans for bread. Side seam striping and liners were not effective in preventing corrosion formation. The liners did impede corrosion transfer to the product when corrosion was present. Oven drying of the side seams proved unnecessary, since no off-taste or odors developed in any of the groups using SA-3 or SA-4 enamels. The aluminum tab also proved unnecessary. There are indications that the lower weights of tin plate may be satisfactory. However, because of the critical nature of the product, additional studies would be necessary before any recommendations could be made. It will be noted that the final examination for the high vacuum groups indicates no corrosion formation, while at the one-, three-, and six-month periods some corrosion is indicated in various high vacuum groups. This is due to the fact that a supercritical attitude was taken in the first three examinations because it was the intention of this study to eliminate all traces of corrosion. The degree of corrosion tallied "light" ranged from a faint trace to an obvious amount confined to a small area. The corrosion described as a faint trace but tallied as "light" was common to some of the high vacuum groups only, and at no time did this corrosion approach the status of the light corrosion common to the medium vacuum groups. For the purpose of this test program faint traces of corrosion can be defined as negligible or nonexistent since the corrosion could be observed only by trained inspectors or under microscopic inspection. In no instance was there evidence of this corrosion staining the product. Degree of corrosion was tallied as "medium" or "heavy" if the corrosion was present throughout an area being studied or if a heavy local concentration existed. A word of explanation might be in order regarding the relatively high corrosion values for some of the high vacuum groups with foil liners: the corrosion condition apparent in all the high vacuum groups with foil liners was neither the type of corrosive condition which prompted the initiation of this test program nor was it comparable to the corrosive condition present in any of the can groups, other than those with foil liners with medium vacuums.

passing grades from industry

As the canned bread for this test was baked in the laboratory, it was possible to achieve the very high vacuums desired through quick closing. Canned bread with this high vacuum, 25 inches + Hg, had never been manufactured by industry. Because of this, it was necessary to have a test production run to insure the feasibility of requiring a high vacuum. Five thousand 300 x 200 cans of bread were manufactured by a commercial bakery in accordance with MIL-B-1070A. A 300 x 200 size can was chosen because it loses heat more rapidly than a larger size can and would be the most troublesome in large-scale manufacture. The cans were divided into three groups for three distinct production runs and were handled on equipment of the type which would be used in large-scale production. Although some difficulty was encountered with the first run due to the inexperience of the men in handling the cans, the second and third runs were accomplished with ease. The cans produced in runs two and three had the high vacuum aimed for. The test proved conclusively that canned bread with a high vacuum, 25 inches + Hg, can be produced in large quantities commercially. The information gained from this series of tests helps immeasurably in packaging other baked products such as canned pound cake, and is being utilized at the present time.

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