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Chemcel Plant

Operating Technical Report

SUBJECT: Corrosion Tests of Various Gasket Materials

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By: E. V. Kunkel
R. C. Schueler

COPIES TO: Mr. Bowen
Mr. Anwyll
Mr. Lederer
Mr. Lindsey
Mr. Mayfield
Mr. Rogers
Mr. Wilson
Engineering Department

Mr. Fennebresque (2)
Mr. Schnabel
Mr. Schneider
Mr. Dice

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PURPOSE: To determine the reaction of various gasket materials when used with stainless steels under specific conditions.

SUMMARY: For overall rating of each gasket material in each of the three tests reported on see Tables IA, IVA and VIIA at the end of this report.

Teflon again was consistently rated good, however, it cannot be recommended as an all purpose gasket material because of the price of approximately $14.00 per pound. Teflon should be used only in services where it can be economically justified.

Crane 888 tested best, or at least among the best, in each of the separate exposures. Data from these tests at present is insufficient to state that Crane 888 is superior to other neoprene asbestos sheet. Garlock 7228 and Sterling 417 are definitely inferior to Crane 888 as they induced stress cracking in the stainless. Results indicate, however, that Crane 888 aggravates corrosion to a somewhat lesser degree than the other materials tested.

It is believed that no one specific gasket material will be found economically feasible for use as a standard material and that it will be necessary to prescribe several different materials for a limited number of corrosive conditions -- each one being the best for a specific service or services.

DISCUSSION: Data is presented to show the results of three additional tests of gasket materials exposed in (1) SO-6-T ~~Base;~~ (2) SO-6-T Reboiler; and (3) AR-3-T Base.

The design of the test racks and procedure followed were the same as described under "Discussion" in Operating Technical Report #67 with the exception of the surface finish of racks 7, 8, and 9 as described below.

I. SO-6-T Base -

Test racks #5 and #6 were exposed in the base of SO-6-T from October 14, 1948 until April 20, 1949. When the tower was opened for removal of the test specimens, the racks and holddown bars had completely corroded away leaving only the gasket materials. Thus the results of this test show only the effect of the corrosive media upon the gasket materials and no data is available concerning the reaction between the materials and the stainless in this service.

The materials found to be most resistant to the corrosive media in this test were, in the order named:

1. Teflon
2. Crane 999
3. Garlock 22
4. Crane 998
5. Crane 888
6. Ankorite 450.

Table IA at the end of this report lists the rating of each of the materials tested with respect to the effect of the corrosive media on the gasket materials only.

Table IIA lists the test conditions and data. Material types and evaluation of the remaining gasket materials are listed in Table IIIA.

II. SO-6-T Reboiler -

Test rack #7 was exposed to the media in the SO-6-T reboiler from June 22, 1949 until August 22, 1949.

The test rack was modified before assembly by grinding all gasket surfaces with 120 grit paper in order to make all metal surfaces uniform.

Two of the holddown studs failed completely during exposure and as a result four holddown bars and four gasket specimens were lost. The remaining study had corroded at varying rates but were still in place. However, the effect of the gasket material on the stainless plate before loss of the specimens remained for evaluation.

Table IVA lists the overall rating of each of the materials tested.

Table VA lists the test conditions and data. Material types and results are listed in Table VIA.

The photographs in Figures 1A and 2A show the results of the test. No gasket materials are shown here because most of them were broken or damaged in disassembling the rack.

The effect of each material on the stainless plate and holddown bars appears to be of less severity than was expected. This is probably due to early failure of the holddown studs which allowed the gasket materials to become loosened and allowed a more or less free flow of the liquid, thus upsetting the conditions contributing to a maximum corrosion of the pitting type.

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Severe stress cracking and light stress cracking were noted on the stainless in contact with specimens 1 and 2. This can be seen from Figure 7A (photo of specimen 1 on rack #7). Stress cracking normally occurs in a direction perpendicular to a tensile stress. Stress was set up during preparation of the plate by grinding. This cold working of the surface in the longitudinal direction caused the greater tensile stress to occur in that direction. The major stress cracks which occurred were perpendicular to the direction of grinding. With a residual tensile stress and probably a chloride from the gasket material, conditions were suitable to cause stress cracking. The best possible means to avoid stress cracking under these conditions would obviously be to eliminate the source of the chloride since a tensile stress alone is usually not sufficient to cause cracking of this type to occur.

The best material on test rack #7 was found to be Crane 888 although it was not completely satisfactory due to the fact that the material was hard and brittle at the completion of the test.

III. AR-3-T Base -

Test racks #8 and #9 were exposed in the base of AR-3-T from July 7, 1949 until September 29, 1949.

These test racks were given the same 120 grit surface finish as rack #7.

Teflon, Durabla, RM K670, and Crane 888, tested previously in this service on test racks #3 and #4, gave essentially the same result this time. On racks #8 and #9 the Teflon was still rated "good" and the Durabla was slightly better than before. The RMK670 was still unsatisfactory and the Crane 888 was not quite as good. This slight variation in results is probably due to the lowering of the acid content of the corrosive media, the longer test period, and the difference in thickness of the Crane 888 and Durabla specimens. The longer test period is definitely the cause of the greater comparative amount of corrosion on the test plates of racks #8 and #9.

Table VIIA lists the overall rating of each of the materials tested.

Table VIIIA lists the test conditions and data. Material types and results are tabulated in Table IXA.

Photos in Figures 3A, 4A, 5A and 6A show the plates, holddown bars and gasket materials after exposure.

Stress cracking was noted on the stainless plate in contact with specimens 5 and 6 (Sterling 417) although they were not as severe as the stress cracks noted on rack #7. Specimens 1 and 2 (Garlock 7228).

Teflon was found to be the best overall material in this service, with Durabla, Crane 888, and Ankorite 425, all being only slightly better than unsatisfactory.

CONCLUSION: Of the three tests reported on, only Teflon was consistently rated "good". However, as an all-purpose gasket material it cannot be recommended because of the price of approximately $14.00 per pound. Teflon should be used therefore only in services where it can be economically justified.

The results obtained from this test indicate that Crane 888 tested best or at least among the best in each of the separate exposures. Thus if one material were to be recommended for use in all of the three services tested, Crane 888 would be the logical choice. However, there is insufficient data on these test racks to definitely state that other neoprene asbestos sheets are all inferior to Crane 888. Garlock 7228 and Sterling 417 are definitely inferior as they induced stress cracking. However, even the Crane 888 is not completely satisfactory in that it does not prevent, and to some extent actually aggravates the corrosion of the metallic surfaces. The conclusion is that the Crane 888 aggravates the corrosion to a somewhat lesser degree in most instances than the other materials tested.

It is very plausible to believe that no one specific gasket material will be found economically feasible for use as a standard material and that it will be necessary to prescribe several different materials for a limited number of corrosive conditions -- each one being the best for a specific service or services.

In future testing of gasket materials an attempt will be made to expose the test racks in as many different corrosive media as possible. All neoprene asbestos sheets which we have available will be tested against Crane 888 on these racks. The only exceptions to this are Garlock 7228 and Sterling 417 which induce stress cracking. In addition to this hycar bonded sheets and wire inserted hycar and neoprene rubber sheets will be tested.

TABLE I A - Racks 5 and 6 - SO-6-T Base

Rating of the different types of gasket materials from the standpoint of effect of corrosive media on the material.

Material	Rating
Teflon	G
Crane 999	F
Garlock 22	F
Crane 998	F
Crane 888	F
Ankorite 450	F-
R. M. 670	U
Durabla	U
Ankorite 425	U
U.S. 1771	U

G - Good
F - Fair
U - Unsatisfactory

TABLE II A - Test Data and Conditions - Racks 5 and 6

Location - SO-6-T Base
Length of Exposure - 188 days (10-14-48 - 4-20-49)
Corrosive Media:
Acetic Acid - 40-45%
Formic Acid - 4-6%
Methyl Acetate - 1%
H_2O - Remainder
Aeration - None
Agitation - Rapid
Temperature - 220° F.

TABLE III A - Results Racks 5 and 6 - SO-6-T Base

Brand & Type of Material	Condition of Material
Teflon (Polytetrafluoroethylene)	Small blisters containing liquid. Flexible.
Crane 999 (Neoprene Rubber)	Hard on surface but soft and resilient inside.
Garlock 22 (Red rubber)	Hard on surface, soft inside.
Crane 998 (Neoprene, Duck reinforced)	Fabric attacked slightly.
Crane 888 (Neoprene asbestos comp.sheet)	Hard, but strong.
Ankorite 450 (Neoprene asbestos comp.sheet)	Not as hard as 888, but has less strength.
R M 670 (Asbestos composition sheet)	Hard, lost most of strength.
Durabla (Asbestos composition sheet)	Slightly worse than RM 670.
Ankorite 425 (Rubber asbestos sheet)	Same as Durabla.
US 1771 (Coil resistant rubber)	Very bad.

TABLE IV A - Rack #7, SO-6-T Reboiler

Overall rating of the different types of gasket materials tested from the standpoint of conditions listed "under Discussion" in Report #67 for ideal gasket material:

Material	Rating
Garlock 7228	U
RMK 670	U
KM 238	F-
RM K68	Lost
Ankorite 450	F-
Crane 888	F

G - Good
F - Fair
U - Unsatisfactory

TABLE V A - Test Data and Conditions - Rack #7

Location - SO-6-T Reboiler
Length of Exposure - 1370 hours (6-22-49 to 8-22-49)
Corrosive Media:
Acetic Acid - 55-60%
Formic Acid - 1-3%
Methyl Acetate - 0.5%
H_2O - Remainder
Aeration - None
Agitation - Rapid
Temperature - 220-240° F.

TABLE VI A - Results - Rack #7, SO-6-T Reboiler

Spec. No.	Brand and Type of Mat'l	Thickness of Mat'l (in)	Type of Attack on Plate	Type of Attack on Bar	Depth of Attack on Plate (in)	Depth of Attack on Bar (in)	Condition of Material	% Loss or Gain in Weight
1	Garlock 7228 (Neoprene Asbestos Sheet)	.065	Severe stress cracking	Lost	-	-	Lost	-
2	Garlock 7228 (Neoprene Asbestos Sheet)	.065	Light stress cracking	Lost	-	-	Lost	-
3	RM 670 (Asbestos Comp.Sheet)	.126	Excessive pitting on outer edges of gasket surface	Light Pitting	Less than .001	Less than .001	No longer flexible hardened	-30.6
4	RM 670 (Asbestos Comp.Sheet)	.126	Excessive pitting on outer edges of gasket surface	Light Pitting	Less than .001	Less than .001	No longer flexible, hardened	-34.0
5	KM 238 (Neoprene Asbestos Sheet)	.061	Minor pitting	No pits	Less than .001	-	Hard, brittle	-37.5
6	KM 238	.061						

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TABLE VI A - Results - Rack #7, SO-6-T Reboiler

Spec. No.	Brand and Type of Mat'l	Thickness of Mat'l (in)	Type of Attack on Plate	Type of Attack on Bar	Depth of Attack on Plate (in)	Depth of Attack on Bar (in)	Condition of Material	% Loss or Gain in Weight
8	RM K 68 (Neoprene Asbestos Composition	.063	No noticeable attack	Lost	-	-	Lost	-
9	Ankorite 450 (Neoprene Asbestos Comp. Sheet)	.062	No noticeable attack	No pits	-	-	Hard, brittle	-37.8
10	Ankorite 450 (Neoprene Asbestos Comp.Sheet)	.063	3 small pits	Several minor pits	Less than .001	Less than .001	Hard, brittle	-38.0
11	Crane 888 (Neoprene Asbestos Comp.Sheet)	.062	No attack	Minor pits	-	Less than .001	Hard, brittle	-13.6
12	Crane 888 (Neoprene Asbestos Comp.Sheet)	.062	Several minor pits along two edges	No attack	Less than .001	-	Hard, brittle	-15.8

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TABLE VII A - Racks 8 and 9 - AR-3-T Base

Overall rating of the different types of gasket materials tested from the standpoint of conditions listed under "discussion" in Report #67 for ideal gasket materials.

Material	Rating
Teflon	G
Durabla	F-
Crane 888	F-
Garlock 900	U
U.S. F.O.P. 899	U
Ankorite 450	U
Ankorite 425	F-
Sterling 417	U
Garlock 7228	U
RM K 670	U
KM 238	U
RM K 68	U

G - Good
F - Fair
U - Unsatisfactory

TABLE VIII A - Test Data and Conditions - Racks 8 and 9

Location - AR-3-T Base
Length of Exposure - 1912 hours (80 days)
(7-7-49 to 9-29-49)
Corrosive Media:
Acetic Acid - 0.2%
Formic Acid - 1.0%
H_2O - Remainder
Aeration - None
Agitation - Rapid
Temperature - 230° F.

TABLE IX A - Results - Racks 8 and 9, AR-3-T Base

Spec. No.	Brand and Type of Material	Thickness of Material (in)	Type of Attack on Plate	Type of Attack on Bar	Depth of attack on Plate (in)	Depth of attack on bar (in)	Condition of Material
1	Teflon (polytetra-fluoroethy-lene)	.063	Minor attack on edges	No notice-able attack	Less than .001	-	Good. Serviceable.
2	Teflon (polytetra-fluoroethy-lene)	.061	Minor attack on edges	No notice-able attack	Less than .001	-	Good. Serviceable.
3	RM K 670 (Asbestos Comp.Sheet)	.128	Numerous pits. Deeper around outer edges.	Numerous pits. Deeper around outer edge	.005 maximum	.004 maximum	Hard, brittle.
4	RM K 670 (Asbestos Comp.Sheet)	.129	Numerous pits. Deeper around outer edges.	Numerous pits. Deeper around outer edge	.004 maximum	.003 maximum	Hard, brittle
5	Sterling 417 (Neoprene Asbestos Composition)	.063	Irregular pits. Major pits in from edges stress crack	Elongated pits	.016 maximum	.007 maximum	Flexible on edges. Hardened slightly in center.
6	Sterling 417 (Neoprene Asbestos Composition)	.061	Irregular pits. Large shallow pits Small deep pits. Stress cracks.	Pitted on one end unaffected on other end.	.017 maximum	.008 maximum	Flexible on edges. Hardened slightly in center.
7	Garlock 7228 (Neoprene Asbestos Comp.	.066	General pitting over entire surface. Most shallow, few deep.	General pitting.	.013	.002	Somewhat flexible. Considerably harder than original. Soft around edges.

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 TABLE IX A - Results - Racks 8 and 9 - AR-3-T Base

Spec. No.	Brand and Type of Material	Thickness of Material (in)	Type of Attack on Plate	Type of Attack on Bar	Depth of Attack on Plate (in)	Depth of Attack on Bar (in)	Condition of Material
8	Garlock 7228 (Neoprene Asbestos Composition)	.065	General Pitting. Many shallow - few deep.	General shallow pitting	.022 maximum	.003	Somewhat flexible. Considerably harder than original Soft around edges.
9	Ankorite 425 (Rubber Comp. Sheet)	.057	General pitting. Both shallow and deep.	Deep and shallow pits	.007 maximum	.003 maximum	Hardened in center. Soft & pliable around edges
10	Ankorite 425 (Rubber Comp. Sheet)	.056	General pitting. Both shallow and deep.	Deep and shallow pits	.007 maximum	.004 maximum	Hardened in center. Soft and pliable around edges
11	Durabla (Rubber Comp. Sheet)	.064	Elongated Pits	Elongated pits	.007 maximum	.010 maximum	Slightly hardened, soft at edge
12	Durabla (Rubber Comp. Sheet)	.064	Elongated Pits	Elongated pits	.005 maximum	.009 maximum	Slightly hardened, soft at edge
13	Ankorite 450 (Neoprene Asbestos Comp.)	.064	Irregular pits over entire surface some shallow, some deep	General irregular Shallow pits	.024 maximum	.017 maximum	Slightly hardened, edges flexible
14	Ankorite 450 (Neoprene Asbestos Comp.)	.064	Irregular pits over entire surface, some shallow, some deep	General irregular shallow pits	.008 maximum	.007 maximum	Slightly hardened, edges flexible.
15	Crane 888 (Neoprene Asbestos Comp.)	.063	Pits on one side	Irregular pitting	.008 maximum	.006	Slightly hardened, edges flexible

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 TABLE IX A - Results - Racks 8 and 9 - AR-3-T Base

RCS: fw

Spec No.	Brand and Type of Material	Thickness of Material (in)	Type of Attack on Plate	Type of Attack on Bar	Depth of Attack on Plate (in)	Depth of Attack on Bar (in)	Condition of Material
16	Crane 888 (Neoprene Asbestos Comp.)	.062	Irregular pits with deep pits on one side	Long shallow pits	.009 maximum	.007 maximum	Slightly hardened. Edges flexible .
17	KM 238 (Neoprene Asbestos Comp.)	.063	Irregular pitting, shallow and deep	Irregular shallow pits	.009 maximum	.012 maximum	Slightly hardened, Flexible on edges.
18	KM 238 (Neoprene Asbestos Comp.)	.063	Irregular pits	Irregular pits	.009 maximum	.005 maximum	Slightly hardened, flexible on edges.
19	Garlock 900 (Rubber asbestos comp.)	.060	Elongated pits	Elongated pits	.028 maximum	.009 maximum	Flexible on edges. Slightly hardened in center.
20	Garlock 900 (Rubber asbestos comp)	.060	Irregular pits	Elongeted pits	.005 maximum	.006 maximum	Flexible on edges. Slightly hardened in center.
21	U.S. F.C.P. 809 (Rubber Asbestos Comp)	.065	Pitting over entire gasket surface.	Same as on plate	.007 maximum	.007 maximum	Hardened.
22	US FOP 899 (Rubber Asbestos Comp)	.065	Pitting over entire gasket surface.	Same as on plate	.013 maximum	.005 maximum	Hardened.
23	RM K68 (Neoprene Asbestos Comp)	.065	Irregular pits	Pits on one end. None on other.	.012 maximum	.004 maximum	Flexible
24	RM K68 (Neoprene asbestos Comp.)	.065	General pitting	General pitting	.007 maximum	.013	Slightly hardened in cent. Edges flexible

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