TECHNICAL SERVICE REPORT
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To: Dr. H. B. Rhodes

Date: June 25, 1976

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NB File No.: 2119-2, 2138-7, 530-68 Reg No. 115

INVESTIGATION OF CORROSIVE PROPERTIES ATTRIBUTED TO HPO IN METAL SUBSTRATE APPLICATIONS

INTRODUCTION

During the period of September - October 1975, Parr, Inc. and Rapid Systems Company, both located in the Ohio area, reported corrosion problems attributed to the use of High Purity asbestos (HPO). Rapid Systems Company has since concluded that the problem is not as serious as originally thought and unrelated to the use of HPO. Parr, Inc., on the other hand, provided evidence that strongly supported their claim that HPO promotes corrosion (refer Figure 1). Some work was subsequently performed in our laboratory which substantiated their findings (Technical Service Report, B. L. Ingalls, December 5, 1975). Preliminary data indicated that HPO promoted corrosion or some similar action to a greater degree than other chrysotile materials evaluated (Carey 7RF-9, 7TF-8, California Floral and Hedman Fiber).

More recent tests during January and February 1976 failed to show any evidence of corrosion by HPO over periods of 20 to 36 days. Previous tests exhibited rusting within one to two weeks. Possible variations in humidity between the periods the two tests were run was suspected as the cause for the discrepancy, but was unsubstantiated. Moisture content of the HPO samples was determined to be $\lesssim 2\%$ whereas the Canadian asbestos samples exhibited moistures of $<1\%$. Further tests have since been completed including detailed analysis of the various products and are reported herein.

SUMMARY AND CONCLUSIONS

Several samples of HPO and various Canadian asbestos products typical of that used by Parr, Inc. were tested for corrosive properties and analyzed for impurities. In summary, the findings showed that under conditions of high humidity, all of the asbestos products tested promoted corrosion of the steel Q-Panels. "Calidria" asbestos tended to adsorb "free" water by a slightly higher degree than the Canadian products, 1.5-2.0% as opposed to 1.0-1.8%, which is probably due to the higher purity and available surface area of the "Calidria" product. Aside from magnitite, no significant differences were detected in the amounts of minor impurities in the asbestos products evaluated. It is concluded that trace amounts of Cl and S in the asbestos and/or tape compound can produce etching of the steel surface. Corrosion by oxidation appears to be by the action of "free" water available via adsorption on the surface of the asbestos. The results indicate that the critical level of adsorbed water at which corrosion evolves is in the range of 1.0 to 1.5% depending on the type of chrysotile product.

RECOMMENDATIONS

Chrysotile asbestos is highly hygroscopic and typically processed materials will equalibrate between 0.8 and 2.5% moisture depending upon ambient conditions. Predrying of the asbestos material prior to incorporation in the resin tape compound would retard the degree to which "free" water can be adsorbed, thus limiting the source of corrosion. Another possibility is the use of a corrosion inhibitor. Since the corrosion appears to be dependent on minute quantities of water, an inhibitor would most likely be very effective in this type of application.

DISCUSSION

Several tests for corrosion of steel test plaque (Q-Panels R-35.032 CR) were performed (June 19, 1976) with samples of "Calidria" High Purity asbestos, Hedman Fiber, Carey 7RF-9 and 7TF-8. The various products were prepared simultaneously between individual 3 x 5 inch Q-Panels and observed periodically. All of the test panels showed evidence of corrosion within 72 hours (refer Figures 2 and 3). The HPO test plaques were slightly more pitted than the Canadian test samples, however, all the panels exhibited substantial evidence of corrosion.(1) Determinations for "free" water adsorbed on the asbestos surface showed 1.7% moisture on the HPO products, 1.0% on Hedman material and 1.3 and 1.4% for the Carey 7TF-8 and 7RF-9 products. A relative comparison of the degree to which "free" water is adsorbed on the various products over the course of several months beginning March 1976 is illustrated in Table I. It is interesting to note that the Canadian materials promoted corrosion at moisture levels of 1.0-1.4% whereas HPO showed no signs of corrosion (January, February 1976) at similar levels of moisture. Apparently the level of "free" water at which corrosion evolves is not absolute but relative and dependent on the type of chrysotile product and available surface area. In effect, the results indicate that the Canadian products promote corrosion at lower levels of percent moisture than High Purity asbestos.

1. Similar tests performed during January and February 1976 with samples of the same HPO products showed no evidence of corrosion over extended periods of 20 to 36 days.

All the asbestos products were also tested for corrosive properties after having been predried at 105°C for 18 hours. The samples were placed between Q-Panels immediately after removal from the oven. All the test panels exposed to "Calidria" HPO and Canadian products showed signs of corrosion within 24 hours (refer Figures 2a and 3a). Ambient conditions were ~88% RH at 24.5°C. Percent moisture of the predried asbestos samples after standing 24 hours were determined as follows:

PERCENT MOISTURE OF PREDRIED ASBESTOS PRODUCTS AFTER 48 HOURS AT 88% RH AND 24.5°C

	HPO (Oct. 73)	HPO (Sept. 74)	HPO (Oct. 75)	Hedman	Carey 7RF-9	Carey 7Tf-8
% Moisture	1.75	2.29	2.47	1.08	1.48	1.77

The asbestos products were also analyzed for major and minor elements. Spectrographic analyses showed no irregularities in the percent major or minor elements in the HPO samples (refer Table II). However, small quantities of sulfur, acetic acid and trace amounts of chloride were detected in both HPO and the Canadian products (refer Table III).

Sample test panels submitted by Parr, Inc. which had been exposed to resin tape compounds containing HPO and Canadian asbestos were observed with a scanning electron microscope (S.E.M.). The surface of the steel Q-Panels were also analyzed by EDAX (Energy Dispersion Analysis of X-rays) for chemical composition. The surface of the panel exposed to resin tape containing HPO is shown in Figure 4. The darker oxidized areas are easily detectable. The white particulate is residue of the resin tape compound. Figure 4a shows major peaks of an EDAX scan of the area photographed in Figure 4. Major elements detected were: Mg, Si, Cl, Ca and Fe. Figures 5 and 5a show an area of the same panel at 200x containing tape residue. The EDAX showed peaks for Mg, Si, S, Cl and Ca as predominent. Figures 6 and 7 are photos of the panel surface at a magnification of 1000x. The area in Figure 6 had considerable oxidation and tape residue and demonstrated major peaks for Mg, Si, Cl, Ca and Fe (refer Figure 6a). Figure 7 shows a relative clean area of the panel surface. As shown in Figure 7a, only Fe was detectable.

Figures 8 and 9 are demonstrative of the panel surface exposed to tape compound containing Hedman asbestos. A minimum of pitting was evident, however, the surface showed considerable signs of etching. According to Dr. K. S. Chopra, of our Metallographic Research Department, etching of steel similar to that observed on the panel can be caused by trace amounts of sulfur or chlorides. An EDAX scan of the area photographed demonstrated no major peaks other than Fe as shown in Figures 8a and 9a.

TABLE I

PERCENT MOISTURE OF ASBESTOS PRODUCTS[1]

Date Tested	HPO (Oct. 73)	HPO (Sept. 74)	HPO (Oct. 75)	Hedman (74)	Carey 7RF-9	Carey 7TF-8 (Parr 74)
11/15/75	--	--	1.50	--	--	--
3/18/76	1.70	2.02	1.40	0.82	0.99	0.93
4/15/76	1.55	1.43	1.52	0.88	1.09	0.95
5/14/76	1.65	1.66	1.63	0.93	1.22	1.17
6/17/76	1.76	1.75	1.76	1.00	1.38	1.31
6/24/76[2]	2.11	2.09	2.14	1.19	1.86	1.76

1. The products were spread out in open containers in the laboratory for a period of several months. Periodic tests for % moisture were run as indicated.

2. Relative humidity (RH) 88% Ambient temperature 24.5°C

TABLE II

SPECTROGRAPHIC ANAYLSIS

	HPO		Oct. 75	HPO		Oct. 73	HPO		Sept. 74
Ag		ND*			ND			ND	
Al	.08	-	.8	.08	-	.8	.08	-	.8
As		ND			ND			ND	
Au		ND			ND			ND	
B	.001	-	.01	.001	-	.01	.001	-	.01
Ba		ND			ND			ND	
Be		ND			ND			ND	
Bi		ND			ND			ND	
Ca	.02	-	.2	.02	-	.2	.02	-	.2
Cb		ND			ND			ND	
Cd		ND			ND			ND	
Co		ND			ND			ND	
Cr	.04	-	.4	.04	-	.4	.04	-	.4
Cu		ND			ND			ND	
Fe	.08	-	.8	.08	-	.8	.08	-	.8
Ga		ND			ND			ND	
Ge		ND			ND			ND	
Hf		ND			ND			ND	
Hg		ND			ND			ND	
In		ND			ND			ND	
Ir		ND			ND			ND	
Mg	M			M			M		
Mn	.01	-	.1	.01	-	.1	.01	-	.1
Mo		ND			ND			ND	
Na		ND			ND			ND	
Ni	.08	-	.8	.08	-	.8	.08	-	.8
Os		ND			ND			ND	
P		ND			ND			ND	
Pb		ND			ND			ND	
Pd		ND			ND			ND	
Pt		ND			ND			ND	
Rh		ND			ND			ND	
Sb		ND			ND			ND	
Si	M			M			M		
Sn		ND			ND			ND	
Sr		ND			ND			ND	
Ta		ND			ND			ND	
Th		ND			ND			ND	
Ti		ND			ND			ND	
Tl		ND			ND			ND	
U		ND			ND			ND	
V		ND			ND			ND	
W		ND			ND			ND	
Zn		ND			ND			ND	
Zr		ND			ND			ND	

*ND - Not Detectable

TABLE III

ANALYTICAL RESULTS

Sample	pH	% Sulfur	% Chloride	% Acetic Acid	L.O.I.
HPO (Rapid Systems) (Nov. 75)	9.7	0.039	Trace	NE*	-
California Flosal (Oct. 73)	8.3	0.030	Trace	0.22	-
HPO (Oct. 75)	9.6	0.051	<0.05	0.16	14.3
HPO (Sept. 74)	9.5	0.056	<0.05	0.13	13.7
HPO (Oct. 73)	9.3	0.062	<0.05	0.17	14.1
Hedman Asbestos (74)	9.7	0.013	<0.05	-	12.3
Carey 7RF-9	9.7	0.041	<0.05	-	15.3
Carey 7TF-8 (Parr 74)	-	0.035	<0.05	-	15.5

*NE - No evidence by determination

UC 149-2

CC: W. C. Thurber Save

UNION CARBIDE INTERNAL CORRESPONDENCE

MINING AND METALS DIVISION • P. O. BOX 579, NIAGARA FALLS, NEW YORK 14302

To (Name) Mr. G. L. Dickson
Division UCC Metals
Location Niagara Falls, NY

Date April 15, 1975

Originating Dept. "Calidria" Asbestos

Answering letter date

Copy to Messrs. R. E. Byrne, Jr.
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Subject Technical Service - Physical Properties of Carey 7TF-8 Asbestos Sample from Parr, Inc., Cleveland, OH

The physical test properties of Carey 7TF-8 received from Parr, Inc. are reported in the attached table. Typical properties of RG-110 and HPO are included for relative comparisons.

The results show Carey 7TF-8 to be coarser than the "Calidria" asbestos products, as evidenced by tap water and dispersed wet screening, available and ultimate fiber tests. Reflectance and wet bulk values of 7TF-8 are significantly lower than either "Calidria" asbestos product. Dry bulk and % magnitite of the Carey product were much higher by comparison. In conclusion, 7TF-8 exhibits neither the purity nor degree of fiber liberation typical of the "Calidria" asbestos products.

B. L. Ingalls

BLI:cjb
Attachment

PRODUCT PROPERTIES

	Carey 7TF-8	Typical RG-110	Typical HPO
Tap Water Screen			
% +65	0.4	<1	1
% +100	1.9	<1	<3
% +200	20.8	4	10
% +325	47.4	10	20
Dispersed Wet Screen			
% +65	0.5	<1	<1
% +100	1.6	<1	2
% +200	16.7	2	7
% +325	38.9	6	13
Reflectance (%)	65.0	71	73
Wet Bulk			
(10g/250ml)	74	200+	200+
(2g/liter)	90	700+	900+
Dry Bulk (lbs./ft.^{3})	14.6	4.5	5
Magnitite (%)	4.4	1.3	0.5
Available Fiber (%)	25.6	60	60
Ultimate Fiber (%)	42.9	85	95