SPAN-WORLD DISTRIBUTION

Engineering Tomorrow's Environment

March 10, 1997

Mr. Robert C. Dreisig
Material Engineer
Engineering Material Section
Procter & Gamble Company
6300 Center Hill Ave.
Cincinnati, OH 45224

RE: **Bonding Test and Study on TEMP-COAT' Ceramic Insulation**

Dear Mr. Dreisig:

We at Span-World want to thank you for the extensive testing and findings about the superior quality of our liquid ceramic insulation and the economic benefit of the product for Procter & Gamble.

In response to your request, our people will prepare 4" sq. coupons of Type 316SS and 4 " sq. coupons of 1018 carbon steel.

Our recommendation is that the test bed be based on actual thickness, which represent thermal barrier actuality at a minimum of 60 mils (60/ 1000 inch) and at a high average thickness of 120 mils (120/ 1000 inch) of TEMP-COAT. Our logic here is that where a 15 or 30 mil thickness may disbond under your severe "worse case" analysis, we will never know what will happen at recommended & standard thicknesses for high heat insulations. Coupons will also be enclosed at the suggested thickness of 15 & 30 mils if you decide to proceed in that manner.

For the record we are applying TEMP-COAT' under similar wet conditions and have done so since 1990 without a failure or warranty claim. We look forward to receiving your results and thank you for keeping us in the loop.

Very truly yours,

Morris I. Meyer

Cc, Mr. John Beavers PhD, CC Technologies Lab., Inc.
Mr. Tom Bullington, Fluor Daniels

September 7, 1997
The test under discussion was run by CC Technologies as a worse case scenario on coupons of 15 & 30 mils.

In consideration that 60 mils or more will be applied to all P & G piping, TEMP-COAT"" performed superbly.

Test results would have been profound at 60 and 120 mils demonstrating the superior bonding capability of TEMP-COAT™.

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CC Technologies

Solving Materials Problems
Through Innovation

June 13, 1997

Mr. Robert C. (Dreisig, Materials Engineer
Engineering Materials Section
THE PROCTER AND GAIMBLE COMPANY
Winton Hill Technical Center
6300 Center Hill Road
Cincinnati, Ohio 45224

Re: *Evaluation of TEMPCOAT*™ (T 123-02)

Dear Bob,

CC Technologies Laboratories, Inc. *(CC Technologies)* is pleased to submit this Letter Report summarizing the results of testing performed on the TEMPCOAT™ insulating material. The objective of the work was to evaluate the barrier coating properties of the TFMPCOAT™ insulating material. It is our understanding that there is considerable cost savings in using this product as an alternative to currently-used thermal insulation for Steam piping and other components of your paper machines. However, Procter and Gamble has concerns that the product may disbond from the metal surfaces, leading to a loss in insulating performance, and possibly, corrosion of the metal substrate.

APPROACH

The tests were designed to simulate hot steam piping on which service water is dripping. Tests were performed with two metal substrates; carbon steel and Type 316 stainless steel and two coating thicknesses 15 and 30 mils. Plate samples of these two materials, 4" x 4” x 0.125", were prepared by your contractor. One side was coated with TEMPCOAT™ using the manufacturer's recommended procedures. The carbon steel samples were primed with approximately I mil of a high heat primer (Rustoleum Brand) prior to coating.

The four samples were placed on a hot plate and the metal temperature was controlled to 73^{o}C +\- 3^{o}C. Plexiglass cylinders were loosely placed on the sample surface and the cylinder was continuously refreshed with a wet fog generated using an ultrasonic humidifier and tap water.

After 0 hours, 14 days, and 59 days, the samples were removed from the hot plate. A plexiglass cell (with a sealing O-ring) was lightly. clamped to the coated side of each sample, filled with tap water, and an AC Impedance test was performed on the coating. Following the first two tests, the samples were returned to the hot plate and the fog exposures were continued. The test panels also were optically examined and photographed at the end of the test.

RESULTS AND DISCUSSION

During the test, condensation was evident on the surfaces of the samples. Optical photographs of the specimens, after testing, are given in Figures 1 to 4. All of the panels were covered with thick adherent hard water scale, which was deposited from the evaporating tap water. Red rust deposits also were evident on the surface of the 1018 carbon steel sample with the 15 mil coating, and on the unprotected edges of the other three samples. On the other hand, there was no evidence of obvious disbondment of any of the coatings.

Results of the AC Impedance tests are summarized in Table 1. These data show that the pore resistance of the stainless steel samples decreased more than an order of magnitude after fourteen days of exposure but increased over the final exposure period. For comparison purposes, the charge transfer resistance of an uncoated stainless steel sample also was measured and found to be about 514 K-Ohm-cm^2. The pore resistances of the coated stainless steel samples were below this value after fourteen days, indicating that the resistance of the coating was actually below this value. Essentially, we were measuring the resistance of the substrate. The increase in the pore resistance over the last exposure period for the stainless steel samples was probably the result of the growth of the thick hard water deposits.

The pore resistance of the carbon steel sample with the 15 mil thick coating decreased progressively over the exposure period. The final value measured approached the expected corrosion rate of carbon steel in this environment (a few mils per year). Therefore, the 15 mil coating was not a very effective barrier coating. On the other hand, the 30 mil coating on the carbon steel substrate performed much better than the 15 mil coating. While the pore resistance progressively decreased over the test period, it remained four orders of magnitude higher than the 15 mil coating. This combination actually performed better than the stainless steel samples, which may be a reflection of the fact that the carbon steel samples were primed before coating.

In conclusion, the TEMP-COAT™ coating did not exhibit particularly good barrier coating properties in these severe, but realistic, tests. The best performance was observed with the 30 mil coating on the primed carbon steel substrate. On the other hand, the coatings did not exhibit obvious evidence of disbondment or failure, with the exception of the surface rust evident on the carbon steel sample with the 15 mil coating.

Table 1. Pore Resistance As A Function Of Exposure Time And Coating Thickness For Samples Of Stainless Steel And Carbon Steel Coated With TEMPCOAT™.

Alloy	Coating Thickness Mils.	Exposure Time Days	Pore Resistance K-Ohm-cm^2
Stainless Steel	15	0.1	3.421
Stainless Steel	15	14	108
Stainless Steel	15	59	716
Stainless Steel	30	0.1	8 288
Stainless Steel	30	14	172
Stainless Steel	30	59	4 783
Carbon Steel	15	0.1	3 444
Carbon Steel	15	14	51.0
Carbon Steel	15	59	5.18
Carbon Steel	30	0.1	60 354
Carbon Steel	30	14	75 301
Carbon Steel	30	59	54 474

It is recommended that, in applications where dripping of water onto heated piping is likely to occur, the TEMPCOAT™ coating be protected by an over-coating.

As always, it has been a pleasure working with you on this project. If you have questions or need additional inform, please feel free to call me at (614) 761-1214.

Sincerely,
CC TECHNOLOGIES LABORATORIES,

John A. Beavers, Ph.D.
Vice President, Research and Development

cc: Garry Koch