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ANODIZATION OF PROCESS TUBES

TO
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FROM

E.C. Pitzer

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ANODIZATION OF PROCESS TUBES

Observations and Experiments Leading up to the Order Placed with Columbia Electric and Manufacturing Company for the Anodization of 200 Process Tubes

I. Introduction

The presence of corrosion products upon aluminum process tubes removed from wet portions of F Pile led to the suspicion that the tubes might be corroding at an accelerated rate because of water entrapped in the channels between the tubes and the graphite blocks. Corrosion was especially noted on those tubes that were tightly stuck within the blocks. Analysis of the corrosion products showed that the major constituent was a hydrated aluminum oxide, containing iron oxide, calcium carbonate, and other substances in lower concentrations.

II. Experimental

Experiments in the corrosion laboratory, using eight-inch sections of process tubing inserted into six-inch graphite blocks exposed to water dripping into the annulus between the process tube and the block, demonstrated that the tubes became firmly cemented into the block because of accumulation of corrosion product upon the tubes. No data are yet available upon the length of time necessary for

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perforation or partial collapse of a tube, but experiments at 90°C show that the corrosion process continues at a practically undiminished rate during an observation period of two months. One tube section that has been repeatedly cycled between room temperature and 90°C, and between incipient flooding and complete dehydration at 90°C, demonstrates the fact that a stuck tube will not necessarily loosen after the tube and block are thoroughly dried.

Several types of protective barriers have been compared in the laboratory as a means of combatting the corrosion of tube sections in contact with wet graphite. Colloidal graphite and sprayed zinc have proved inadequate. Anodic coatings, either sealed or unsealed, have appeared more favorable.

Among the many recipes for the anodization of aluminum, the standard Alumilite process was chosen because of its ease of operation at room temperature or slightly lower. Two other types of anodic coating of superior hardness and abrasion resistance have been produced in the laboratory on a small scale: the Alumilite Hard Coat, a grayish, lustrous deposit, requiring a bath temperature of 40°F; and the Martin Hard Coat, a black deposit, extremely resistant to a knife blade or file, for which a bath temperature of 28°F is recommended. It is believed that the efficiency of the present equipment can be improved so as to maintain these lower temperatures, but a complete evaluation of a Hard Coat could not be made in time to justify its specification for the process tubes.

III. Evaluation of Anodic Coatings

Two criteria were used in the comparison of plain and anodized process tubes in contact with wet graphite:

1. The flow of current produced by the galvanically coupled aluminum and graphite, an indirect but continuous measure of the rate of corrosion of the aluminum.
2. The force necessary to remove the process tube section from the graphite block after exposure to dripping water.

It was found that the electrical output of the assemblies containing anodized tubes was negligible in comparison with the output of those containing unanodized aluminum. The minimum current flow was observed from tubes that had been anodized and subsequently sealed in dichromate solution. The advantages of dichromate, however, are open to question and the sealing operation is not recommended for this application.

The forces necessary to dislodge anodized tube sections from the graphite blocks were likewise smaller than those required to remove the unanodized sections. Using a universal testing machine, eight-inch tube sections, and six-inch graphite blocks, forces between 40 and 177 pounds were required to remove the unanodized specimens, whereas anodized sections were dislodged by application of zero to ten pounds. Intentional scratches in the anodic coatings did not substantially increase the binding force between the aluminum and graphite.

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IV. Specifications for Anodization of Full-Length Process Tubes

It was decided, on the basis of construction costs, material shortages, and manpower requirements, that a commercial anodizing firm should be sought for anodization of the full-size tubes. The Columbia Electric and Manufacturing Company of Spokane agreed to do the work in accordance with our specifications, as follows:

A coating one mil in thickness will be deposited, at a current density of 12 amperes per square foot, from a bath containing 15 percent H_2SO_4 at a temperature of preferably $60^\circ F$ and not exceeding $70^\circ F$. It is estimated that approximately one hour will be required to anodize a tube, but by operating with two or more tubes in parallel, 16 or more tubes may be completed in a day.

Inspection procedures applicable to full-length process tubes will be developed by the Corrosion Group, and a member of the group will be assigned as inspector for the duration of the work.

An order was placed by the Manufacturing Department for the anodization of 200 process tubes, plus four 12-foot lengths of tube, two of which would be anodized on the exterior and two on the interior. The 12-foot lengths will serve for preliminary inspection purposes, thereby decreasing the magnitude of the extrapolation to full length tubes.

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In Charge, Corrosion
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