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CANADA

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SURFACE OXIDATION OF ALUMINUM PIPE AND SHEET EXPOSED TO AIR AND GAMMA RADIATION

by

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PHYSICAL METALLURGY DIVISION

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SUMMARY OF RESULTS

Two 65S aluminum samples, which had been exposed to gamma radiation, were examined metallographically and one (Sample Wall Chamber) was found to be pitted on the inside surface. The remainder of the corrosion attack was general and superficial only. The composition of the corrosion deposit was not determined but it was amorphous and probably consisted mainly of aluminum hydroxide.

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INTRODUCTION

Two aluminum alloy samples were received from Atomic Energy of Canada Limited, Commercial Products Division (Mr. C. E. Makepeace). In a covering letter dated 24 January, 1966, it was stated that one was a 65S Aluminum Sample Wall Chamber from a Cobalt Irradiator, which had been in service for eight years, and the other(specimen holder assembly) had been in service for six months.

Both specimens had been exposed to air and gamma radiation in service and in these conditions ozone and oxides of nitrogen would be expected to be present.

It was requested that the specimens be examined to determine the depth of any corrosion attack and, if possible, the nature of the corrosion product.

VISUAL EXAMINATION

The 65S Aluminum Sample Wall Chamber, which was a tube section, approximately 6 in. diameter and 1/4 in. wall thickness, showed considerable dark coloured, powdery deposit on the inside (which was exposed to the environment mentioned above). The outside of the tube, although slightly discoloured and abraded, showed little corrosion attack.

The aluminum sheet of the specimen holder assembly (approximately 0.090 in. thick) had, in the parts which had been exposed to radiation, a matte surface lighter in colour than the rest of the sheet and a rough, non-uniform yellowish coating.

CHEMICAL ANALYSIS

Samples from each part were submitted for chemical analysis. The results are as shown in the following table.

TABLE 1

Chemical Analysis Results (Per Cent)

	Mg	Si	Cu	Fe	Mn	Cr
Sample Wall Chamber	0.81	0.57	0.28	0.34	0.05	0.21
Specimen Holder	0.92	0.59	0.25	0.30	0.10	0.18
GS11N (65S)	0.80-1.2	0.40-0.80	0.15-0.40	0.7 max.	0.15 max.	0.15-0.35

It will be seen that the composition of both alloys falls within that of 65S (CSA.GS 11N).

METALLOGRAPHIC EXAMINATION

Sections from each specimen were mounted and polished for metallographic examination.

The Sample Wall Chamber showed extensive intergranular pitting on the inside surface (see Figures 1 and 2). The maximum pit depth in the sections examined was about 0.0055 in. No pitting was observed on the outside surface of the tube.

Sections from the specimen holder sheet showed no pitting and only general, uniform attack.

SPECTROGRAPHIC AND X-RAY DIFFRACTION ANALYSIS

Scrapings from the surface of each sample were analysed spectrographically but the results only reflect the composition of the base alloy in each case. This method of analysis has only limited usefulness for this type of material as it can only be expected to reveal heavier, non-volatile elements. However, the absence of these in large amounts was confirmed by the results.

X-ray diffraction analysis of the corrosion deposits was also attempted but only amorphous material was apparently present since no useful pattern was obtained.

DISCUSSION

Metallographic examination of the two specimens has shown that in the specimen holder the attack was general and superficial, whereas in the Sample Wall Chamber some pitting occurred on the inner surface which had been exposed to gamma radiation.

As mentioned earlier, the effect of gamma radiation on air is to produce oxides of nitrogen and ozone. In the presence of moisture, nitrous and nitric acids would, therefore, be formed in small amounts and it is thought that these would be sufficient to account for the attack observed.

The nature of the corrosion deposits was not determined but probably consisted largely of amorphous aluminum hydroxide.

In neither of the samples was the attack serious enough to cause failure of the part or impairment of its usefulness.

WAP/gm

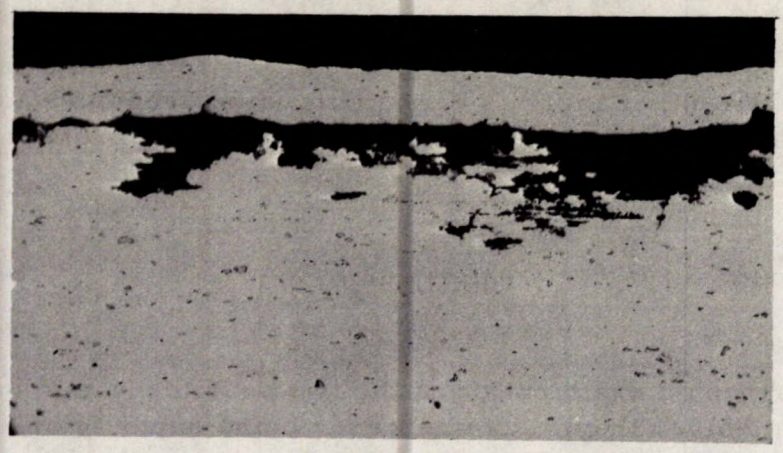

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Figure 1. Pitting attack in Sample Wall Chamber (inner surface) showing intergranular nature of corrosion. (Unetched)

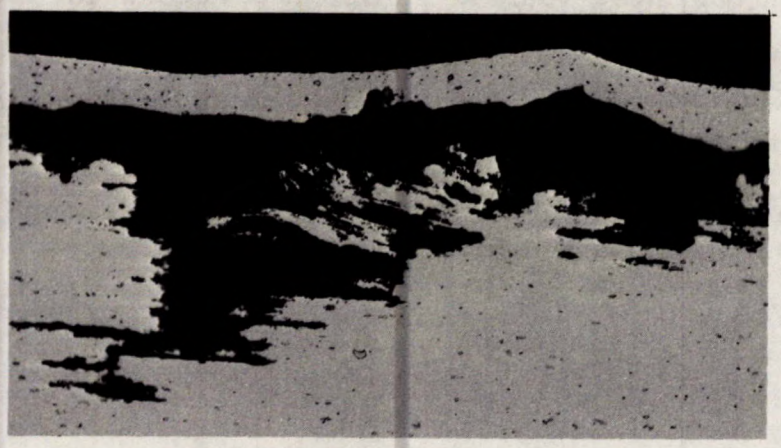

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Figure 2. As Figure 1, showing deepest pit found in sections examined. (Unetched). (The thin section at the top of each of the figures is of the aluminum foil used to protect the surface of the specimen during mounting and polishing).