

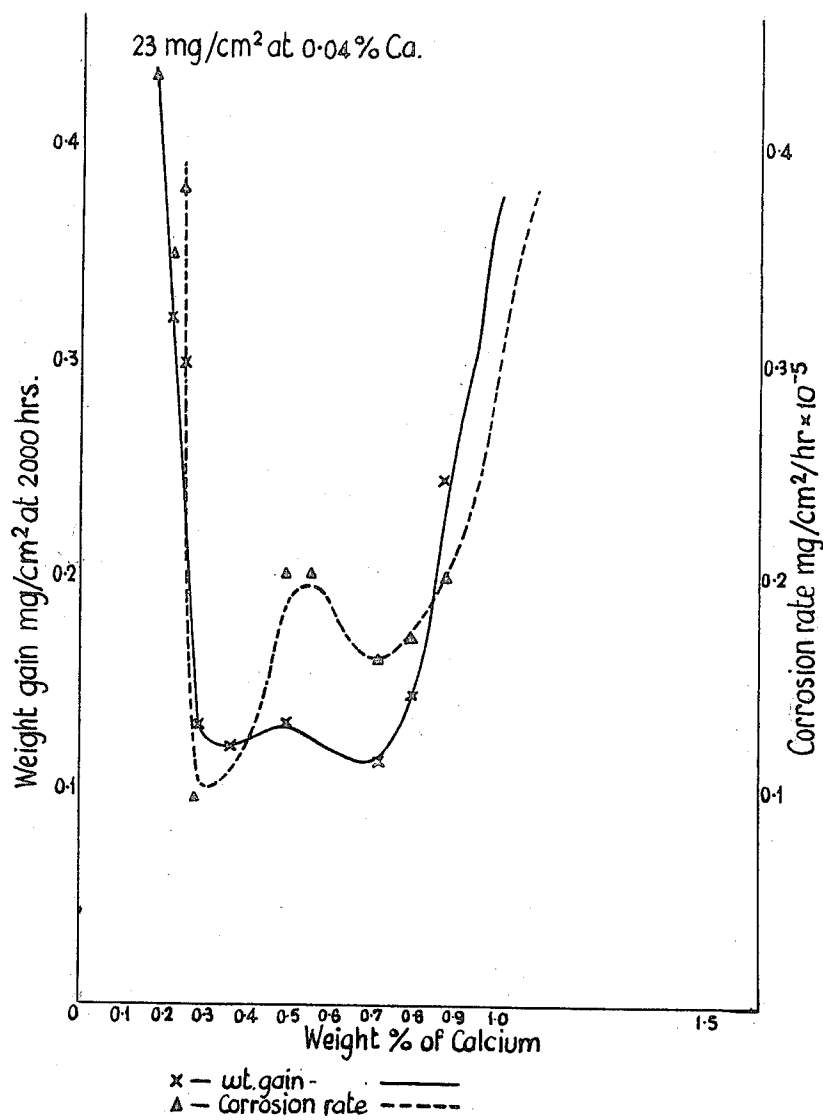
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T. RAINE ET AL

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BERYLLIUM ALLOYS

Filed July 22, 1963



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BERYLLIUM ALLOYS

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2 Claims. (Cl. 75—150)

The present application is a continuation-in-part of application Serial No. 144,312, filed on October 11, 1961, now abandoned, by us and assigned to the assignee of the present application.

This invention relates to alloys suitable for use at high temperatures in an atmosphere of carbon dioxide. Such conditions arise in the core of graphite-moderated advanced gas cooled nuclear reactors in which carbon dioxide is used for cooling and heat extraction and where metallic parts are in contact with the hot gas. Because of its extremely low neutron cross-section consideration has been given to the use of beryllium as a fuel containment material to protect the fuel from oxidation by the cooling gas and to promote efficient heat exchange between the fuel and the gas.

The oxidation resistance of commercially produced "reactor grade" beryllium is very good at elevated temperatures in air, but is pressured carbon dioxide the corrosion resistance in the temperature range 650° C. to 700° C. is very poor. Assessment of the degree of corrosion is difficult because oxidation occurs at randomly distributed areas on the surface due to local unavoidable impurities; these areas resemble blisters. For example, six discs cut from a length of hot-pressed, hot-extruded bar were subjected to a temperature of 700° C. in carbon dioxide at 300 lbs. per inch squared (p.s.i.g.) containing 300 parts per million (p.p.m.) water. The weight gains after 350 hours varied between 13.7 mg./cm.² and 53.2 mg./cm.². The corrosion resistance of this type of beryllium is deleteriously affected by increasing the water content of the gas.

Investigations have been made as to the possibility of alloying Ca with Be in small percentages of Ca with a view to increasing the strength of the resulting Be. It was found by the prior experimentation that Ca did not, in any extent, form a solid solution in Be, so that the small amount (below 1.0%) of Ca which did enter into solid

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solution was not enough to improve the strength of the alloy; the remaining part of the added Ca merely formed a phase which has little effect on the mechanical strength.

Applicants have now found that, provided the amount of Ca alloyed with Be is restricted to between 0.25 and 0.95%, by weight, a surprising increase in the corrosion resistance of the Be is produced.

According to the present invention, an alloy of calcium and beryllium having good corrosion resistance in carbon dioxide atmosphere at high temperatures, consists of 0.25 to 0.95% calcium and the remainder beryllium except for unavoidable impurities.

The corrosion of this alloy is very low and consistent. For example, two samples of an alloy of 0.5% calcium and 99.5% beryllium, when subjected to carbon dioxide gas at 700° C. and 300 p.s.i.g. and containing 300 p.p.m. water showed a weight gain of 0.199 mg./cm.² and 0.218 mg./cm.², respectively, after 2,800 hours' exposure. The weight gains of these samples had increased to only 0.211 mg./cm.² and 0.240 mg./cm.² respectively after a further exposure of 3,800 hours, i.e., a total exposure of 6,600 hours. Samples of the same alloy when exposed to steam under a pressure of 1 atmosphere at 500° C. gave weight gains of only 0.131 mg./cm.² and 0.122 mg./cm.² respectively after 1,000 hours' exposure.

The accompanying drawing shows how the resistance to corrosion of the subject alloy increases within the range 0.5% to 0.95% Ca. The full line curve shows the corrosion expressed as weight gain in mg. per cm.² after 2000 hours. The interrupted line curve shows the corrosion expressed as weight gain in mg. per cm.² × 10⁻⁵ per hour.

These alloys can be made by any of the conventional powder metallurgical techniques. However, a preferred process comprises consumable-electrode arc melting followed by direct fabrication, i.e., extrusion of ingot to tube, or rod, or the like, or by forging and rolling of the ingot to sheet.

What we claim is:

1. An alloy of calcium and beryllium consisting of 0.25% to .95%, of calcium, by weight, and the remainder beryllium except for unavoidable impurities.

2. An alloy of 0.5% calcium and 99.5% beryllium, by weight, the percentage of beryllium including such unavoidable impurities as may be present.

No references cited.

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