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An Investigation Of
SCALING OF ZIRCONIUM AT ELEVATED TEMPERATURES

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Current Work

During this period data were obtained on the scaling behavior of graphite-melted and arc-melted zirconium in oxygen, and a comparison made with air studies of the same materials.

The variation of breakaway time, time for scale color change, and metal growth with temperature for arc melted and graphite melted zirconium are shown in Figs. 1 and 2, respectively. These data are for specimens scaled in air and were originally reported in Quarterly Status Report No. 16. Figs. 3 and 4 show similar plots for the two grades of zirconium scaled in oxygen. Although growth of specimens scaled in oxygen has been observed, these data are not complete and are therefore omitted from Figs. 3 and 4.

A comparison of these four figures reveals the following features:

1. Generally, the curves are shifted to shorter times by decreasing purity of metal in both air and oxygen.
2. At the higher temperatures the beginning of the scale color change takes place very rapidly in oxygen for both materials and takes place at times considerably shorter than those required for breakaway in the scaling rate.
3. The time for the beginning of the scale color change is approximately the same in air and oxygen for both materials between 800 and 1000°C. Below 800°C the first white scale on graphite melted material appears sooner in oxygen than in air, while for arc melted zirconium the appearance of the first white scale is retarded by oxygen.
4. In graphite melted zirconium scaled in oxygen both the beginning and the end of the color change reaction occur at shorter times as the scaling temperature is dropped below 800°C. No such reversal was observed in air.
5. For both materials, the breakaway persisted to higher temperatures in oxygen than in air.
6. For graphite melted zirconium at 1000°C in both air and oxygen the scale color change is complete before the breakaway is observed.

7. The breakaway and beginning of scale color change take place at approximately equal times in arc melted zirconium scaled in air; however, when this material is scaled in oxygen the breakaway precedes the appearance of the first white scale below 900°C .
8. The completion of the scale color change in graphite melted zirconium is retarded in oxygen above approximately 650°C ; below this temperature the color change reaction was completed in shorter times in oxygen than in air.
9. Completion of scale color change in arc melted zirconium takes place at equal times in air and oxygen at 1000°C . At temperatures both above and below 1000°C the completion of the color change is retarded in oxygen.

Future Work

Growth data for arc melted and graphite melted zirconium will be completed in oxygen. An effort will be made to explain the differences in scaling behavior of these two grades of zirconium in air and oxygen.

FIG. 1 : TIME-TEMPERATURE RELATIONSHIPS FOR BREAKAWAY, SCALE COLOR CHANGE, AND 1%, 10% AND 100% GROWTH FOR ARC MELTED ZIRCONIUM, SCALED IN AIR.

FIG.2 : TIME-TEMPERATURE RELATIONSHIPS FOR BREAKAWAY, SCALE COLOR CHANGE, AND 1%, 10% AND 100% GROWTH FOR GRAPHITE MELTED ZIRCONIUM, SCALED IN AIR.

FIG. 3: TIME-TEMPERATURE RELATIONSHIPS FOR BREAKAWAY AND SCALE COLOR CHANGE FOR ARC MELTED ZIRCONIUM, SCALED IN OXYGEN.

FIG. 4 : TIME-TEMPERATURE RELATIONSHIPS FOR BREAKAWAY AND SCALE COLOR CHANGE FOR GRAPHITE MELTED ZIRCONIUM, SCALED IN OXYGEN.