INTRA-LABORATORY CORRESPONDENCE
OAK RIDGE NATIONAL LABORATORY
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MSR 69-17

To: J. R. McWherter
From: H. E. McCoy

Subject: Status of Development of Heat Exchanger Tubing

Our present design studies include tubing with enhanced heat transfer surfaces (fluted tubing). The purpose of the present memo is not to declare doom, but simply to describe the status of development of this product.

We have fabricated six 3 ft lengths of fluted tubing of various configurations (Fig. 1). We can control the depth and pitch of the spiral and have made tubes with spiral depths of 10 to 20 mils and pitches of 2.6 to 7.6 revolutions per linear inch. The tube collapses when the depth exceeds 20 mils.

Metallographic examination (Fig. 2) shows that the cross section of the tubing is not circular. A longitudinal view (Fig. 2) shows that heavy cold working occurs throughout. A closer look (Fig. 3) reveals that the carbide particles characteristic of Hastelloy N actually fracture during fluting. Post fabrication anneals up to 2150°F are inadequate to repair these fractures. The obvious question is whether these fractures propagate under the service conditions that will be encountered. The modified Hastelloy N presently under development does not have as many carbides, but there are enough to provide numerous crack sources during fabrication. Thus, the performance of fluted tubing under service conditions remains a valid question.

The following areas need further study to insure that we have tubing with enhanced heat transfer (Listed in order of priority):

1. Heat transfer measurements to demonstrate that we actually have the degree of enhancement presently being assumed [H. W. Hoffman, et al.].

2. Perform fatigue tests to determine whether the cracks associated with carbide fractures will propagate under realistic service conditions.

3. Obtain more fabrication experience. Numerous other variations in techniques are readily available that may be less destructive to the tubing.

H. E. McCoy

Attachment - Three (3) Figures
cc: C. E. Bettis
    E. S. Bettis
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Fig. 1. (Y-89562) Fluted Hastelloy N tubing for enhanced heat transfer. Original dimensions 3/8 in. OD x 0.035 in. wall.
Fig. 2. (Y-91564) Fluted Hastelloy N tubing having a spiral depth of 15 mils and pitch of 7.6 revolutions per linear inch of tubing. The center portion is a cross section and shows non-circular geometry. The outer pieces are longitudinal cross sections. Magnification: 6X
Fig. 3. (Y-89338) Photomicrograph showing the fractured carbides that result from the fluting operation.