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Brief 71-10050

AEC-NASA TECH BRIEF

AEC Headquarters

Concentric Tubes Cold-Bonded by Drawing and Internal Expansion

The problem:

To form a strong mechanical bond between concentric metal tubes without the application of heat or brazing materials. The bond must retain strength at elevated temperatures and when subjected to constant or cyclic temperature gradients.

The solution:

A combination drawing and expansion process that produces a residual tangential tensile stress in the outer tube and a tangential compressive stress in the inner tube.

How it's done:

The assembled tubes, with about 0.8 cm (0.03 in.) radial clearance, are first drawn through a die at room temperature to reduce their diameters. The assembly is then expanded at room temperature by drawing an oversized plug of commercial die steel through the inner tube of the assembly. This expansion strains both tubes beyond their elastic limits. No restraint is placed on the outer surface of the large tube during the expansion step. After the plug has moved through the entire assembly, the residual stresses produced cause the outer tube to clamp inward on the smaller tube and form a strong mechanical bond at the interface between the tubes.

Notes:

1. A duplex (cold-bonded) steel tube, containing 2.25% chromium, 1% molybdenum, 0.13% carbon, 0.50% manganese, and 0.40% silicon, exhibited an interface shear of 12.4 MN/m^2 (1800 psi) at room temperature and 6.9 MN/m^2 (1000 psi) at 756°K (900°F). The outer tube had an initial and final o.d. of 3.97 cm and 3.65 cm, respectively (1.563 in. and 1.438 in., respectively). A smaller duplex tube of the same material, with an initial and final o.d. of 1.74 cm and 1.51 cm, respectively (0.684 in. and 0.594 in., respectively), exhibited an interface shear strength of 31 MN/m^2 (4500 psi) at room temperature.
2. Tubes of different materials may be joined if the strain required to produce yielding of the outer tube is at least 75% of that required for yielding of the inner tube.
3. Tubes of this type are used in condensers and heat exchangers.
4. Requests for further information may be directed to:

   Technology Utilization Officer
   Division of Technical Information
   AEC Headquarters
   Washington, D.C. 20545
   Reference: B71-10050

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Technology Utilization Officer
Division of Technical Information
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Category 08