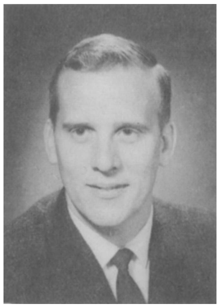
AUTHORS AND PAPERS

The highly condensed summaries of papers and technical notes (below) are intended to assist the busy reader in determining the order in which to read the technical material. Biographical comments are for human interest.



ADVANCED RANKINE SYSTEM MATERIALS

Materials required for the development of advanced Rankine systems for space applications include materials for nuclear fuels for the reactor, refractory metals for alkali-metal containment, electrical materials for the alternator, and stainless steels for the radiator. Uranium carbide and uranium dioxide are presently being considered as reactor fuels for the system. Of the numerous refractory metals available, three tubing alloys have survived the welding, thermal aging, and mechanical property screening tests. This paper also presents data on the potential turbine materials, electrical materials, and cermets for alkali-metal lubricated bearings.

Thomas A. Moss (BS and MS, Metallurgical Engineering, University of Arizona), Assistant Chief, Brayton Cycle Branch, Space Power Systems Division, joined the staff of the NASA-Lewis Research Center in 1962 as a metallurgical engineer. He is currently working on solar- and isotope-powered Brayton-cycle space power systems. Earlier, he directed work in support of advanced alkali-metal Rankine systems as Head of the Materials Section.

SPACE RADIATOR MATERIALS AND GEOMETRY

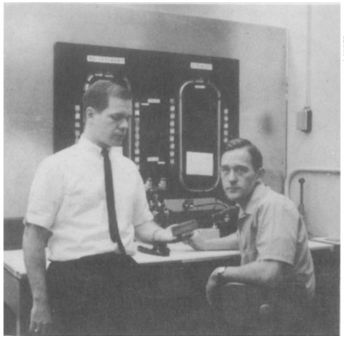
Materials and fin-tube geometry have a large influence on the ultimate size and mass of a waste-heat radiator for use in space. In turn, many factors, such as meteoroid damage protection, structural integrity, vehicle integration, and fluid compatibility, influence the requirements for materials and geometry. A wide variety of materials and geometries is considered in this work.

S. Lieblein (shown on left) was appointed Chief of the Flow Analysis Branch of the NASA-Lewis Research Center in 1960. In this position he is responsible for direction of in-house and contract research on space radiators. James H. Diedrich is engaged in research on space radiators in the same Branch. His principal fields of interest include the use of beryllium as radiator armor, radiator fabrication, and surface coatings for high emittance.

BRAZED GRAPHITE-METAL COMPOSITES

Cb-1%Zr and 316 Stainless were each brazed with developmental alloys to Graphite-G and an expanded form of pyrolytic graphite as part of a program to develop brazing techniques for joining dissimilar metals considered for tube-to-armor joints of high-temperature graphite space radiators. Brazing and thermal stability tests indicated that compatible braze bonds can be made between the graphites and potential tube materials.

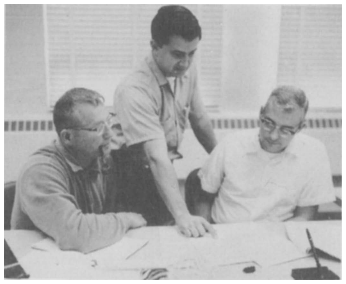
A. DelGrosso is a senior engineer in the Missiles and Space Systems Division of Douglas Aircraft Corp. Since he joined the Nuclear Department in 1962, he has been responsible for materials research and development studies associated with the fabrication of space radiators and reactor designs. Previously, he was associated with Aerojet General Nucleonics, Allis Chalmers, and Atomic Development Associates. His BS (1951) in Metallurgical Engineering is from the University of Pittsburgh.



MASS TRANSFER OF NIOBIUM ALLOYS IN LITHIUM

Mass transfer rates of Nb-1%Zr and D-43 (Nb-10%W-1%Zr-0.1%C) in high-temperature lithium were determined in the research reported here. The oxygen content of both alloys decreased during test. Zirconium and Nitrogen were transferred by the lithium from the higher-temperature to the lower-temperature loop surfaces. The extent of this mass transfer was greater in the Nb-1%Zr test and resulted in a light zirconium-nitride mass-transfer deposit on the cold-leg surfaces of this alloy.

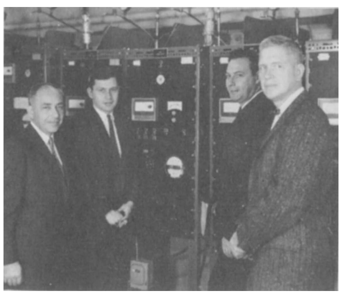
J. H. DeVan and C. E. Sessions are both Metallurgical Engineers working in the Materials Compatibility Laboratory of Oak Ridge National Laboratory. They are involved in alkali-metal corrosion studies, mostly with those involving refractory metal alloys, with their primary efforts devoted to lithium and potassium.



ALKALI METALS IN Nb-1%Zr

By maintaining low oxygen levels in the systems, no corrosion was detected in Nb-1%Zr capsules containing the alkali metals Li, Na, K, Rb, and Cs at 1150°C for 6000 h at $< 5 \times 10^{-8}$ torr. This work tends to reinforce interest in Nb-1%Zr as a suitable container material for alkali metals as coolants and working fluids in high-temperature, compact, space power plants utilizing the Rankine cycle.

The authors are all members of the staff of Brookhaven National Laboratory's Metallurgy and Materials Science Division. Shown l to r are A. H. Fleitman, A. J. Romano, and C. J. Klamut, Section Leader. They have written numerous papers in the past ten years in the field of liquid-metal corrosion including work with Bi and Hg as well as the alkali metals.



CARBON AND NITROGEN TRANSFER IN LIQUID K

Carbon and nitrogen transfer by potassium in stainless-steel thermal convection loops containing Cb-1%Zr and stainless-steel tabs were studied in work reported here. Typical test conditions were 5000 h at 1600°F maximum, 1200°F minimum. The Cb-1%Zr formed thin carbide and nitride surface films at a rate limited by diffusion through the films. Cold bend tests showed good ductility in the alloy after 5000 h under test conditions. Transfer of carbon and nitrogen from hot to cold stainless steel was unaffected by the Cb-1%Zr and had less effect on tensile properties than microstructural changes associated with the thermal history.

K. Goldmann, S. Kostman, N. Hyman, and J. McKee (shown from l to r) are all staff members of the Research and Engineering Center of United Nuclear Corporation. Goldmann (BS, Penn State; MS, MIT) is Manager of the Liquid-Metal Systems Department, and has broad experience in the development of power plants with recent emphasis on liquid-metal cooled reactors. Kostman is a metallurgist specializing in reactor materials problems. As a Senior Materials Engineer, Hyman has responsibility for the project supervision of liquid-metal corrosion programs. McKee, a Materials Consulting Engineer, has been a long-time contributor to the state-of-the-art of liquid-metal technology and nuclear fuel development.

CORROSION OF W, Mo, AND Re IN Li

This work on the compatibility of various tungsten alloys, TZM (Mo-0.5%Ti-0.08% Zr), Mo-50%Re, and rhenium in static lithium at high temperatures, discloses that the molybdenum alloys were resistant to attack by lithium at up to 3000°F for up to 1000 h of exposure in TZM containers. The tungsten-base materials exhibited varying degrees of surface dissolution and grain-boundary penetration at 2800°F, while the unalloyed rhenium underwent dissimilar metal interaction when immersed in lithium for 1000 h at 2500°F, or for 100 h at 3000°F.

John A. De Mastry has been active in materials research for nuclear applications for ten years. He presently directs a group conducting research on cladding materials. This work encompasses liquid-metal corrosion, irradiation damage effects, mechanical properties studies, and alloy development. His BS (1953) and graduate work are both in Metallurgy from Ohio State.