Ats-132B

NASA TECH BRIEF

Nickel-Base Superalloys Developed for High-Temperature Applications

The problem:

To develop nickel-base alloys for use at elevated temperatures (1500° F to 2200° F). The alloys are required to have good workability and greater strength at higher temperatures than commercially available nickel-base alloys.

The solution:

A class of nickel-base superalloys containing varying percentages of alloying elements.

How it's done:

The nominal composition in weight percent of a nickel-base alloy used as a starting material for systematic alloying studies consisted of 8 molybdenum, 6 chromium, 6 aluminum, 1 zirconium, and a balance of nickel. This composition, selected for high-temperature strength and ductility from various experimental compositions subjected to stress–rupture and tensile tests, was systematically modified using carbon, titanium, vanadium, tungsten, and tantalum as alloying elements. All of the experimental alloys investigated were induction-melted under an inert gas cover. It is significant to note that vacuum casting techniques are not required for these alloys.

The most promising of the nickel-base alloy modifications, designated NASA TaZ-8, has the following composition in weight percent: 6 chromium, 6 aluminum, 4 molybdenum, 8 tantalum, 4 tungsten, 2.5 vanadium, 1 zirconium, 0.125 carbon, and a balance of nickel. The average stress–rupture test life, use temperature, and ultimate tensile strength at high temperatures of the alloy exceed or compare favorably with commercially available nickel-base alloys. The alloy has a considerable degree of workability potential. For example, 0.100-inch-thick cast slabs of the alloy can be rolled into 0.015-inch-thick superstrength sheets. Oxidation-resistance of the alloy is somewhat less than that of a representative fully workable nickel-base alloy. Some spalling of the oxide scales was observed in tests at 1900° F, but the depth of the depletion layer between the surface oxide and the unaffected layer was quite small, indicating that the alloy would tend to preserve its structural integrity as a result of depletion of alloying constituents upon exposure to high-temperature oxidizing conditions.

Notes:

1. Further information concerning these alloys is given in NASA Memorandum 4-13-59E and in NASA Technical Notes TN D-260, TN D-1531, and TN D-2495, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 22151.
2. Inquiries may also be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio, 44135
   Reference: B66-10222

Patent status:

This is the invention of a NASA employee, and U.S. Patent Nos. 2971837, 2971838, and 3167426 have been issued to him. Inquiries about obtaining license rights for its commercial development should be addressed to the inventor, Mr. John C. Freche at Lewis Research Center.

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