AEC-NASA TECH BRIEF

Niobium-Uranium Alloys with Voids of Predetermined Size and Total Volume

The problem:

To produce a niobium-uranium alloy having voids predetermined as to size and total volume. Niobium, with a melting point above 2400°C and a comparatively low neutron cross section, is an attractive metal when combined with a fissionable material for use as nuclear fuel. In some instances, void-free fuel is important; in some situations, fuels containing voids substantially uniform in size and uniformly distributed throughout the fuel body are important. For all fuel applications, uniform distribution of fissionable material is necessary.

The solution:

A novel method of producing niobium-uranium alloys having voids predetermined as to size and total volume. A mixture of uranium oxide, a niobium oxide, and graphite of various carbon-to-oxygen ratios is heated to a temperature below the melting point of the resultant alloy.

How it's done:

In all experiments the oxides were mixed with graphitic carbon in a ball mill and pressed into right-circular tubes having outside and inside diameters of 12 and about 4 mm, respectively. All samples were heated in crucibles within an induction furnace. As the sample was heated and partial vacuum was applied to the furnace, the sample temperature was recorded as well as the pressure within the furnace and the amount of gas evolved. After cooling of the sample at the end of each run, several sections perpendicular to the tube's major axis were taken and examined for porosity by standard metallographic techniques.

While any niobium-uranium alloy might have been used, the eutectic that occurs at about 20% uranium (by weight) was preferred. The stoichiometric gram quantities (28.57 g Nb_2O_5, 5.72 g $UO_{2.14}$, and 7.01 g C) were mixed, pressed, put into tantalum crucibles, and heated to between 1950° and 2100°C. Since the sintering was conducted below the melting point of the alloy, no segregation occurred and the resultant product was a homogeneous niobium-uranium (20% by weight) alloy containing many voids distributed throughout the sample. Experiments used 6.91, 6.81, 6.71, 6.61, or 6.51 g of carbon, as well as greater-than-stoichiometric amounts.

To a certain point, decrease in the carbon content from the stoichiometric value or increase in the oxygen content reduced the number and size of voids in the sample. One can control not only the total volume of voids but also their character—their size. The number and size of voids were affected by variation in the particle size of the graphite but not of the oxides. Each of various crucible materials used produced different results.

Note:

Inquiries concerning this innovation may be directed to:

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(continued overleaf)

Patent status:

Inquiries concerning rights for commercial use of this innovation may be made to:

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