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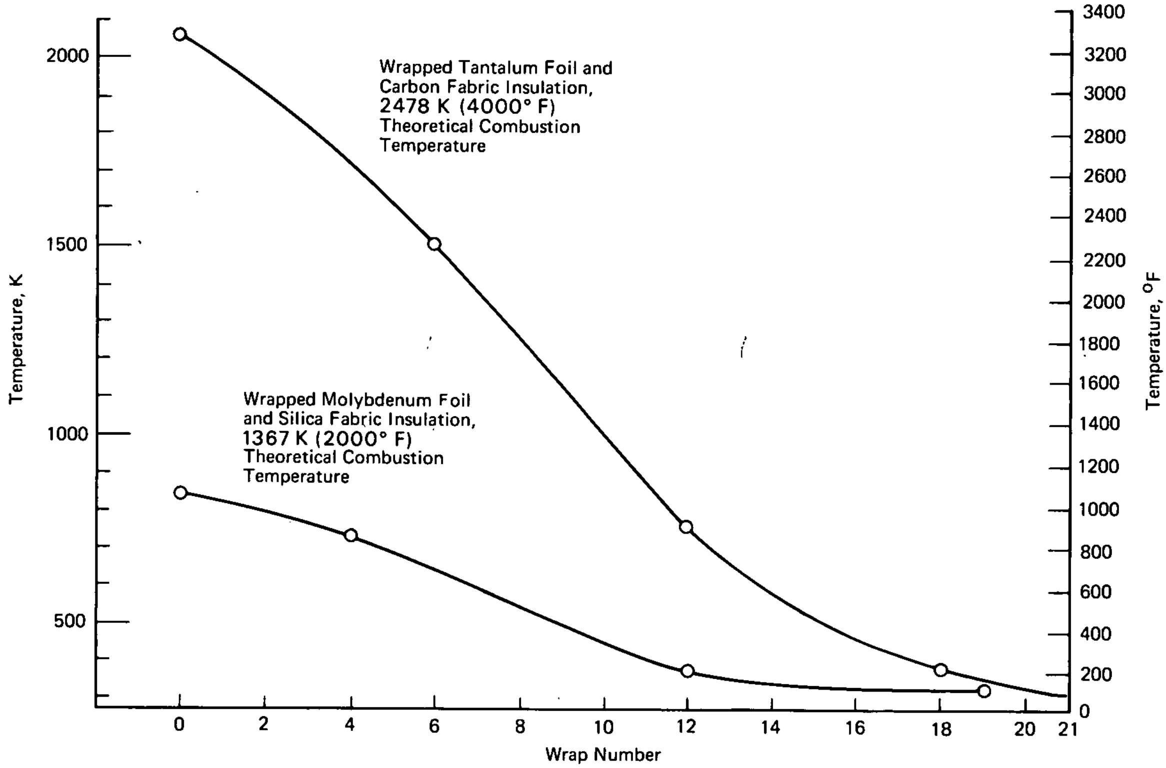
# NASA TECH BRIEF

*NASA Pasadena Office*



## Improved Insulating Materials Effective at Extremely High Temperatures

Two multilayer foil and fabric insulators, usable to 1367 K (2000° F) and up to 2478 K (4000° F), respectively, offer marked space saving and efficiency




Typical Temperature Profiles at End of Firing Period

in nuclear power, plasmas, magnetohydrodynamics, and other high-temperature operations.

The lower-temperature configuration consists of molybdenum foil, 0.0254 mm (0.001 in.) thick, wrapped with an interleaved layer of silica cloth around the object to be insulated. In developmental tests, the foil and fabric were wrapped to a radial thickness of 1.47 cm (0.58 in.) around the combustion chamber of a graphite rocket engine. The assembly was installed in a vacuum chamber which was taken down to an initial vacuum of $1.3 \times 10^{-2}$ $N/m^2$ ($10^{-4}$ torr). The engine was fired at a theoretical combustion temperature of 1367 K for a period of 1000 sec. A maximum heat load of 46 W of thermal energy was detected by the

(continued overleaf)

calorimeter which surrounded the insulation. Typical temperatures at various points in the wrapped insulation, as indicated at the end of the firing period, are shown in the figure.

The foil maintained its integrity during firing, although the surface near the combustion chamber was rough and discolored. The silica fabric was only slightly sintered in the layers closest to the chamber. The low effective thermal conductivity of this molybdenum-silica insulator at relatively low temperatures favors its use up to 1367 K.

A similar configuration of tantalum foil, 0.0254 mm thick, and carbon cloth is usable at even higher temperatures. During testing, the tantalum-carbon insulation materials were wrapped to a radial thickness of 2.54 cm (1.0 in.) around the combustion chamber. Despite an initial vacuum similar to that obtained in the molybdenum-silica tests, the pressure rose to between $2.66 \times 10^2$ to $1.64 \times 10^3 N/m^2$ due to extreme out-gassing during firing at a theoretical temperature of 2478 K. The maximum heat load was 113 W of thermal energy. Typical temperatures at the end of the firing period, as detected at various levels within the tantalum-carbon insulation package, are also shown in the figure.

The inner layers of tantalum foil combined chemically with the carbon cloth during firing, forming brittle tantalum carbide. This carbide, however, is itself an effective part of the insulator because of its reflective surface. The strength of the carbon cloth was not significantly affected, although the cloth was somewhat changed in appearance in the hotter regions. The tantalum-carbon insulation essentially retained its integrity throughout the firing and soakback period.

Above 1367 K, the effective thermal conductivity of the tantalum-carbon insulator is lower than that of the molybdenum-silica one. The tantalum-carbon insulator is therefore recommended for use at temperatures above 1367 K up to 2478 K.

## Note:

Requests for further information may be directed to:

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Reference: TSP71-10289

## Patent status:

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

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Source: L. W. Carlson of
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