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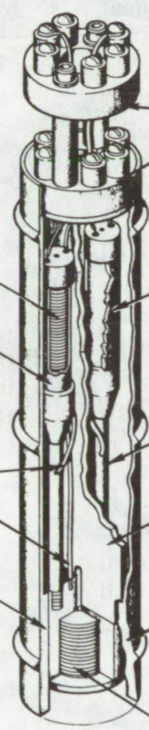
Steady-State Differential Calorimeter Measures Gamma Heating in Reactor



The problem:

To devise a method for measuring the gamma heat deposited in different samples in a research reactor. Information on the amount of heat generated in materials being irradiated in a reactor is of importance in the design of in-pile experiments.

The solution:

A steady-state differential calorimeter, which displays good accuracy and reproducibility of results, is used to measure gamma heating in a reactor environment. The instrument has demonstrated the ability to reproduce results with an accuracy of 2%. Such instruments have been constructed with measuring ranges of from 3 to 500 mW/g of sample using copper samples of approximately 4 g. The calorimeter has a long life expectancy since it is virtually unharmed by the reactor environment.

How it's done:

The calorimeter shown is 3.1 cm in diameter and 15.8 cm long. The instrument consists essentially of

(continued overleaf)

two aluminum sample cells with internal heaters mounted on aluminum pedestals. One cell is empty; the other holds a sample material. The pedestals are arranged symmetrically on a controlled-temperature heat sink, which is also made of aluminum and contains an internal heater. All the heaters are nichrome wire wound on cores made of an insulating material called lava A.

Thermocouples are attached to each pedestal and to the heat sink. The pedestal thermocouples are connected in electrical opposition, across a null detector, to indicate the temperature difference between the pedestals. The null meter has a sensitivity of 0.2 μV or 0.005°C per minor division. The heat sink thermocouple is used to indicate temperature.

The two pedestal units, insulated from each other by lava A, are placed in a lava A container. The container is designed so that only the bottom of the heat sink is left uninsulated. This allows a path for the internally generated heat to escape to the environment. Two terminal rings on the top of the container allow cable leads to be connected from the associated instrumentation. All connections from the calorimeter to the instrumentation are made with cable composed of copper conductors insulated with polyvinyl.

Specific quantities of electrical power are supplied to each cell to obtain a zero temperature difference between the pedestals in the absence of radiation. After this balance is obtained, the calorimeter is placed in a radiation field. The presence of the radiation causes heat to be deposited in the sample. This additional heat source in the sample cell disturbs the calorimeter balance. To compensate, the electrical power delivered to the sample-containing cell is reduced to reestablish balance. The gamma heating value is then obtained by using the measured electrical power delivered to each cell, in an equation derived from the analysis of a theoretical model of the calorimeter.

It is possible to calibrate the instrument so that it will operate in a horizontal position. Thus, it can be used to measure gamma heating in reactor beam holes as well as vertical facilities.

Notes:

1. Additional details are contained in *A Steady-State Differential Calorimeter Used to Measure Gamma Heating in a Reactor Environment*, by Dale A. Herbst and James H. Talboy, ANL-7178, March 1966, Argonne National Laboratory, Argonne, Illinois 60439. This report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151; price $3.00 (microfiche copies, $0.65).
2. This information may be of interest to manufacturers of differential calorimeters and research laboratories using such equipment.
3. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B68-10182

Source: D. Herbst and J. H. Talboy
Reactor Operations Division
(ARG-10120)

Patent status:

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

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