RADIOISOTOPE MICROCALORIMETERS

CR-100 7” Thermoelectric Enclosure

The series CR-100 Microcalorimeters provide an accurate measurement of radioisotope heat release rates.

iTi INTERNATIONAL THERMAL INSTRUMENT COMPANY

PRINCIPLE

The thermal gradient calorimeter transfers all the heat developed in a reaction to its surrounding heat sink at a constant temperature. The calorimeter walls thermoelectrically transduce sample heat release into an electrical signal which is directly proportional to the energy release of the source. Transient as well as steady state energy releases may be measured.

FEATURES

- Whole body heat release measurements
- Microwatt to kilowatt sample output
- High sensitivities and repeatability
- Linear output
- Transient and steady state response
- Wide temperature range
- Simple "In-situ" recalibration
- No excitation required

SPECIFICATIONS

Sample chamber volume range:
1 in^3 to any required volume

Sensitivities:
To 15 milliwatts per millivolt

Temperature range:
Cryogenic to 500°F

Response Time:
10 sec. to 10 min.

Vacuum:
to 10^{-6} torr.

Output impedance range:
10 Ohm to 7500 Ohm

Accuracies:
To 0.5%

Repeatability:
0.01%

Power Supply:
not required

Materials:
Aluminum, stainless steels, copper, composites

CONSTRUCTION

The calorimeter walls are composed of a thin high temperature thermopile structure containing thousands of junctions. One set of junctions is in thermal contact with one wall surface, and the other set is in contact with the opposite surface. As heat flows through the walls (Fig. 1) a temperature difference is established between both sets of thermopile junctions, thus generating a voltage which is directly proportional to the heat flow. The large number of thermopiles develop extreme sensitivity to minute heat flows. Calorimeters are constructed in a range of designs incorporating large sample chambers for high heat fluxes (cover) or small sample chambers capable of measuring low heat releases (Fig. 2).

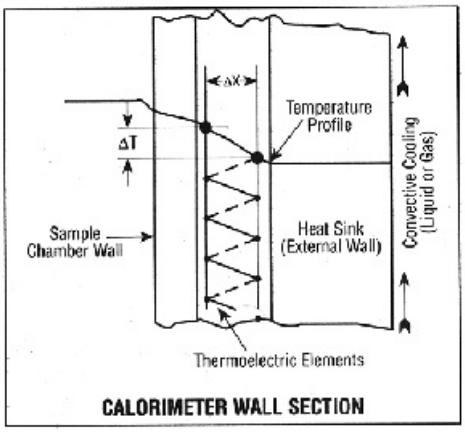

Figure 1

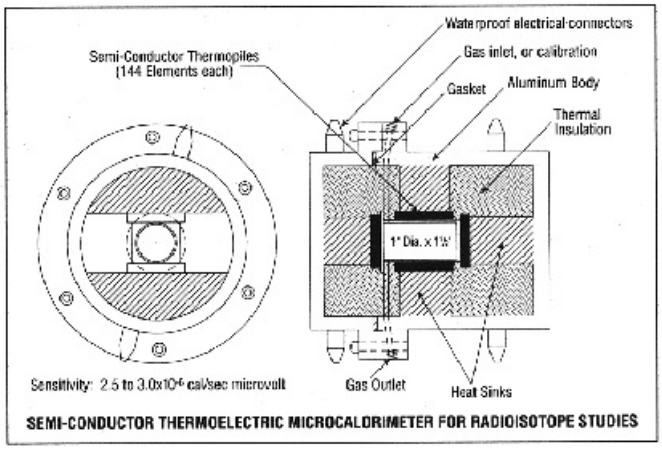

Figure 2

CALIBRATION

Each calorimeter is calibrated at a base temperature of 70°F by a known, electrical heat source in thermal equilibrium with the system.

The calibration constant is expressed in terms of wattage input versus millivolt output. A temperature correction curve is also supplied for use at elevated temperatures.

APPLICATIONS

The CR-100 Series calorimeters are designed to measure both microcaloric and megaocaloric heat release from pure or mixed radioisotopes. The magnitude of the generated signal is linearily proportional to the mean intensities of the sample.

Other applications include: physical, chemical and biological thermogenesis, specific heats, heats of fusion and reaction.

EXAMPLE OF OPERATION

Reactive materials are placed in a suitable container within the calorimeter chamber and permitted to reach equilibrium. To decrease the equilibrium time, it is desirable to heat sink the container to the sample chamber wall. The calorimeter should be situated in a constant temperature environment cooled either by gas or liquids. The time required for the calorimeter assembly to attain thermal equilibrium is a function of the conductivity and size of the sample, the thermal contact at the sample chamber well, calorimeter wall characteristics, and the external cooling rate. At thermal equilibrium, the output signal will reach a mean steady state value which is proportional to the total heat release from the sample. With the known calibration constant (milliwatts/millivolt), the total heat liberation is accurately determined. For radioisotopes with mean decay rates greater than calorimeter response time, the signal is proportional to radioisotope sample decay (Fig. 3).

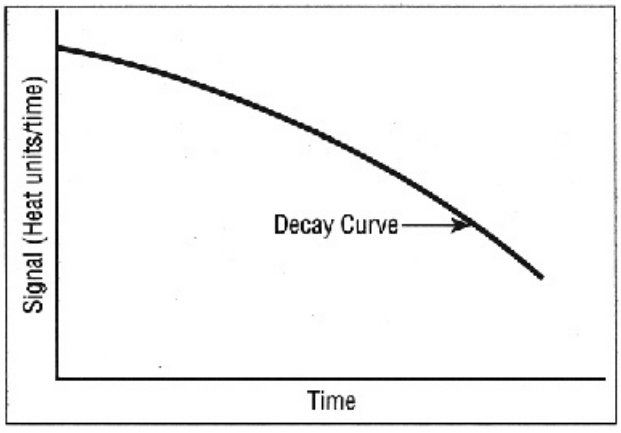

Figure 3

MICROWATT DETERMINATIONS

To measure microwatt heat flow accurately, it is necessary to provide a stable, cooling environment. However, most constant temperature cooling baths exhibit small fluctuations which may generate signals the same order of magnitude as those produced by the sample. To avoid this large noise to signal ratio, a temperature compensated enclosure has been developed (Fig. 4). This double cup system contains both an active and passive chamber having matched sensitivities in opposition. Thus, spurious, external temperature fluctuations are compensated for, and only the heat release from the sample source is detected.

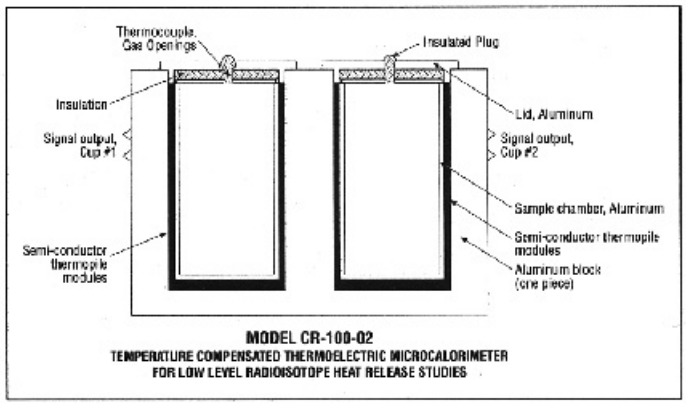

Figure 4

COMPENSATED MICROCALORIMETER SPECIFICATIONS

Sample chamber series:
1" - 6" Dia. x 1" - 12"

Sensitivity:
to 5 milliwats per millivolt

Materials:
Aluminum, composites, semi-conductor elements

Calibration:
1% Acc.

Sample chamber matching:
Within ½%

Internal resistance:
10 to 7500 Ohm

Readout required:
Millivolt potentiometer/Recorder

Environmental requirements:
Ambient temperature operation/Constant temperature bath

STANDARD MODELS, SINGLE CHAMBER

Model Number	Internal Dimensions		External Dimensions		Accuracy %	Sensitivity, Milliwatts per Millivolt	Nominal Output Resistane	Temperature F° (Note1)	63% Response Time, Mn.
	Diameter, In.	Depth, In.	Diameters, In.	Length, In.					
CA-100-1	1	1	3	3	1%	15	4	250*	1
CA-100-2	2	4	4	6	1%	15	10	250*	1
CA-100-4	4	8	5	12	1%	250	2000	600	3
CA-100-8	8	16, 32	9	21	1%	250	4000	600	3
CA-100-C	Custom	Custom	Custom	Custom	1%	250	Varies	600	Varies

* Models CR-100-1 and CR-100-2 are also available for 600°F operating temperature at reduced sensitivities.

READOUT INSTRUMENTATION

Suitable readouts for all CR-100 models include: millivolt potentiometers/recorders, data loggers, or conventional D.C. Millivolt meters.

ORDERING INFORMATION

Delivery.....6-8 weeks, ARO
Shipping weight.....5 to 200 lbs
Terms.....net 30 days to established customers
FOB.....Del Mar, California

OTHER ITI THERMAL INSTRUMENTS

Thermal Conductivity Apparatus, Heat Flux Meters, HEAT-PROBE™, Accelerator target Calorimeters, Radiometers, Thermal Flux Standards.