AIP | Review of Scientific Instruments

A Simple, Inexpensive High Power Low Frequency Water Load

F. E. Vermeulen and F. S. Chute

Citation: Review of Scientific Instruments **42**, 544 (1971); doi: 10.1063/1.1685166
View online: http://dx.doi.org/10.1063/1.1685166
View Table of Contents: http://scitation.aip.org/content/aip/journal/rsi/42/4?ver=pdfcov
Published by the AIP Publishing

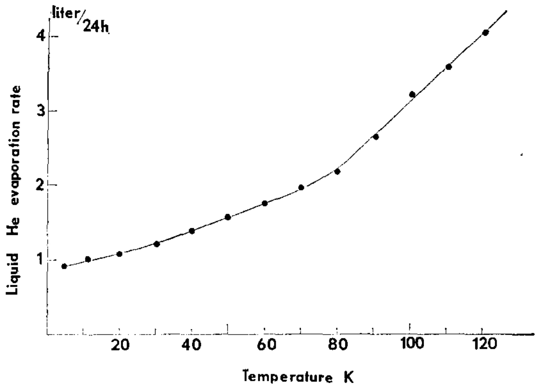

FIG. 1. Liquid helium evaporation rate vs temperature. The measurements were carried out in a standard Hebrew University helium Dewar which when unloaded has an average evaporation rate of 0.75 liter/day and a capacity of 4.8 liters of liquid helium.

one assumes that the conductivity is due entirely to the three 0.012 cm diam copper wires which run from the oven to the helium bath. This is consistent with a value of 10 W/K·cm for electrical grade copper in this temperature range.[2] A fourth constantan wire does not contribute to the thermal conductivity.

From Fig. 1 it is also seen that above 75 K the liquid helium loss rate increases sharply. This is attributed to the deterioration of the vacuum inside the closed container.

The plastic containers are fabricated of Altuglas Perspex.[3] Details of the general configuration for a Mössbauer measurement are shown in Fig. 2. All joints, including wire feedthroughs, are sealed with NHP mounting plastic.[4] Care should be exercised in preparing the mounting plastic using only one drop of hardener in about 10 g of a half-and-half mixture of resin and resin thinner. The heating element is wound from 10 cm of 0.02 cm diam Chromel-P[5] wire which is spot welded in an argon atmosphere to 0.012 cm diam copper wire connections.

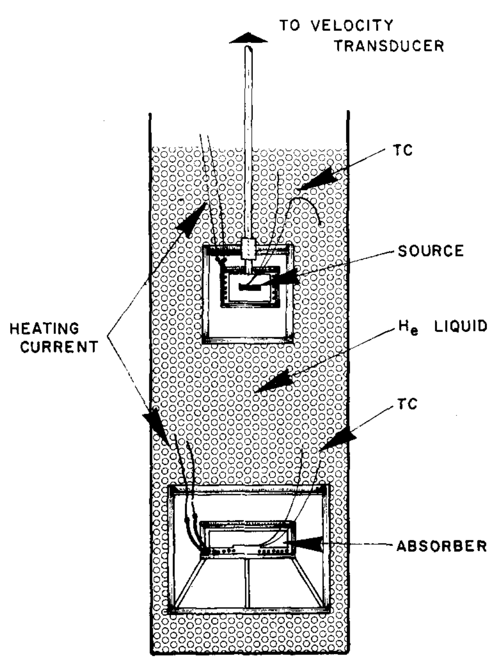

FIG. 2. Construction details of ovens and diagram of experimental configuration.

We wish to acknowledge the help of M. Azoulai in constructing the ovens and in taking measurements, and also helpful discussions with Dr. E. R. Bauminger.

* Nuclear Research Center, Negev, Israel.
[1] Manufactured by Beta Ltd., Bersheva, Israel.
[2] G. K. White, *Experimental Techniques in Low Temperature Physics* (Oxford U. P., 1968), 2nd ed., p. 217.
[3] Manufactured by Altuglas Co., Paris, France.
[4] Manufactured by North Hill Plastics, Ltd., 49 Grayling Rd., London N. 16, England.
[5] Manufactured by Hoskins Mfg. Co., Detroit, Mich.

A Simple, Inexpensive High Power Low Frequency Water Load

F. E. VERMEULEN AND F. S. CHUTE

Department of Electrical Engineering, University of Alberta, Edmonton, Alberta, Canada

(Received 19 October 1970; and in final form, 25 November 1970)

DURING the testing of a high power oscillator as a driving source for a Sloan–Lawrence accelerator structure the need arose for a 50 kHz, 20 kW, 20 kV peak-to-peak variable resistive load. Because a corresponding need may arise in other applications where similar voltage and power levels are present, as for instance in induction heaters and high power low frequency transmitters, the parameters of a simple inexpensive water load are described below. This water load is variable over a wide range of resistance, frequency, and power.

A sketch of the apparatus is shown in Fig. 1. It consists of a long hollow Perspex cylinder which at its midpoint

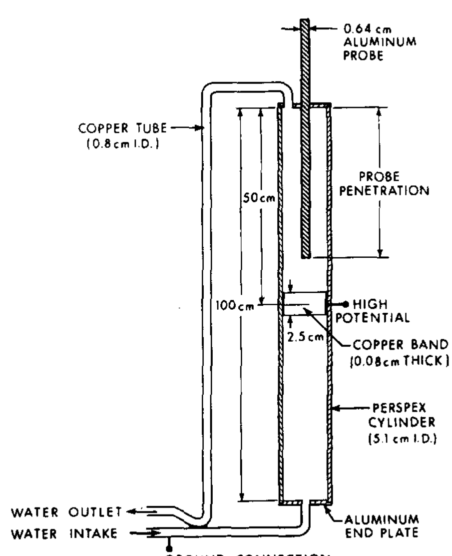

FIG. 1. Sketch of water load.

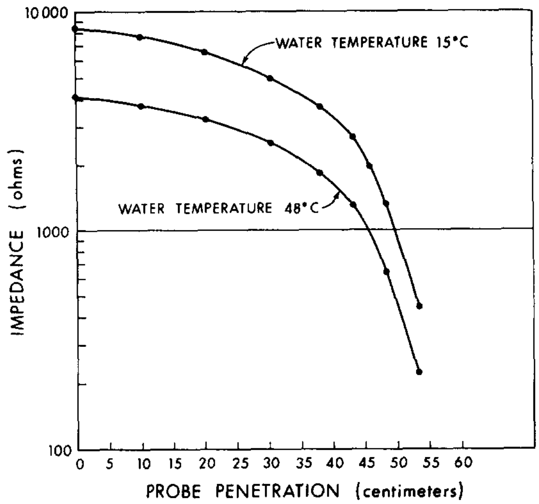

FIG. 2. Impedance as a function of probe penetration and water temperature.

and adjacent to its interior wall contains a circular copper band. An electrical connection is brought through the wall of the Perspex cylinder to the outside and forms the high voltage terminal. The ends of the Perspex cylinder are closed off by aluminum plates with provisions for a water inlet at one end and an outlet at the other. One of the end plates supports an aluminum probe whose penetration into the Perspex cylinder is adjustable. Both end plates are fastened in place by epoxy and are electrically connected through the copper water feed tubes, one of which also serves as the ground terminal. In this way, both the water inlet and outlet are held at ground potential which, in view of the high operating voltage, is a desirable safety factor. Provision is made to measure the water temperature at both inlet and outlet.

The impedance of the water load is variable over a wide range by adjusting the penetration of the aluminum probe. Measurements with a Hewlett–Packard 4800A vector impedance meter showed the impedance to be almost entirely resistive over a frequency range from 1–100 kHz. In this range the impedance phase angle varied between 0° and −3°, and the impedance level, depending upon the aluminum probe penetration and water temperature, could be set anywhere between a few hundred and several thousand ohms. At any particular probe penetration the impedance level remained constant within an interval of 3% throughout the aforementioned frequency range. Exceptions were probe penetrations of more than 48 cm, in which case the impedance level varied within an interval of 11%. The results of the low power impedance measurements are shown in Fig. 2. In obtaining these measurements, care had to be taken to dc decouple the Hewlett–Packard impedance meter from the water load because the latter acted as a galvanic cell with open circuit voltage and short circuit current of 0.5 V and 150 μA. Impedance measurements were also taken between 100 and 500 kHz. Although the impedance level remained constant, the load became increasingly capacitive. At 500 kHz the load phase angle approached −6° at a water temperature of 48°C and −9° at a water temperature of 15°C. All the foregoing measurements were carried out at several different water flow rates with no discernible differences in the results obtained.

Besides the water load shown in Fig. 1 several other prototypes were tested. All of these had the same basic geometry as that shown in Fig. 1, but employed different lengths and diameters of Perspex cylinders. It was generally found that the impedance level with no probe penetration varied as the ratio of length/cross-sectional area of the Perspex cylinder. The impedance level will also be a function of the mineral content of the cooling water.

The power absorbed by the water load is computed from

$$P = 0.07 \times \Delta T \times w,$$

where P is the power absorbed (kW), ΔT the temperature rise of water (°C), and w the water flow rate (liters/min). The impedance of the water load when operated at full power and computed from measurements of absorbed power and applied voltage agreed closely with the impedance measured at low power. For example, with a probe penetration of 38 cm at a power absorption of 23.8 kW at 44 kHz and an outlet water temperature of 44°C, the measured load resistance was 2100 Ω. Interpolating the low power measurements displayed in Fig. 2 to 44°C yields a value of about 2000 Ω. Owing to the strong temperature dependence some difference between the low and high power resistance measurements is to be expected. In the former case the water temperature is uniform, whereas in the latter case the water temperature increases gradually between water inlet and outlet.

The writers would like to thank the National Research Council of Canada for financial support of this work.

In Situ Preparation of Specimens in the Philips EM300 Electron Microscope

A. E. CURZON

Physics Department, Simon Fraser University, Burnaby 2, British Columbia, Canada

(Received 30 November 1970; and in final form, 21 December 1970)

EVAPORATORS have been designed for use in various electron microscopes.[1–6] These devices enable the processes of nucleation and growth to be studied as they occur when a vapor condenses on a substrate. In view of the importance of such studies the author has developed an evaporator for use with the Philips instrument.

A simplified perspective drawing of the evaporator is shown in Fig. 1. The two metal–ceramic feedthrough