A Bucket for the measurement of Sea Surface Temperature

ANNA MANI

Meteorological Office, Poona

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ABSTRACT. The note describes a rubber bucket and thermometer supplied to "selected" ships in the Indian Ocean for the measurement of sea surface temperature. It is shown that the equipment is capable of measuring the sea surface temperature correct to $\pm 0^{\circ}.1$ F.

1. Introduction

The chief sources of error in the bucket method of measuring sea surface temperature have been discussed by Ashford[1]. He has shown from a comparative study of different buckets that these errors can be reduced to a minimum by the use of a suitably insulated receptacle for collecting the sample and an accurate thermometer of quick response and small heat capacity to measure the temperature. The present note describes experiments carried out at the Meteorological Office, Poona, to develop a suitable marine bucket and sea thermometer for supply to "selected" ships in the Indian Ocean.

2. The Bucket

Four different models were constructed and tested for their suitability. The first model was double-walled, consisting of an inner brass vessel and an outer canvas container, with a wooden base and top. Water enters the inner chamber through a spring lid while the bucket is towed at sea and passing through holes at the bottom of the inner chamber escapes from the outer canvas container through eyelets at the top. This reduces the pull on the rope and the strain on the inner walls of the bucket while being towed, thus avoiding the risk of its tearing or even actual loss at sea ; it also ensures good circulation enabling the bucket to reach the true sea water temperature fairly rapidly. The insulating properties of the single water jacket were, however, found to be poor (Fig. 1).

The second model had an additional air jacket, provided by a second water-proofed canvas vessel, the space between the two canvas vessels being filled with sponge rubber (Fig. 2). The rope handle extended down the sides of the bucket and round the base, so that there was no pull on the rim of the canvas container during towing. The insulation was found to be good and nearly fifty such buckets were supplied to "selected" ships during 1949-1952. Its main defect, however, was the short life of the canvas containers. It was also felt that the size of the bucket could be reduced without increasing the errors of observation.

In the third model the two canvas vessels were replaced by a single moulded latex rubber container of quarter inch thickness. While tests showed that the insulating properties of the rubber vessel were good, the bucket was very heavy and the rubber tended to deteriorate rapidly if left in the sun and in contact with sea water. These drawbacks have been overcome in the final model which consists of two vessels of vulcanised rubber, reinforced with a single canvas insertion (Fig. 3). The canvas insertion is replaced by a brass sheet one inch wide at the rim and the two vessels are directly screwed to the metal top. The bucket is light and robust and easy to handle. The whole vessel is encased in a protecting network of rope (Fig. 4).

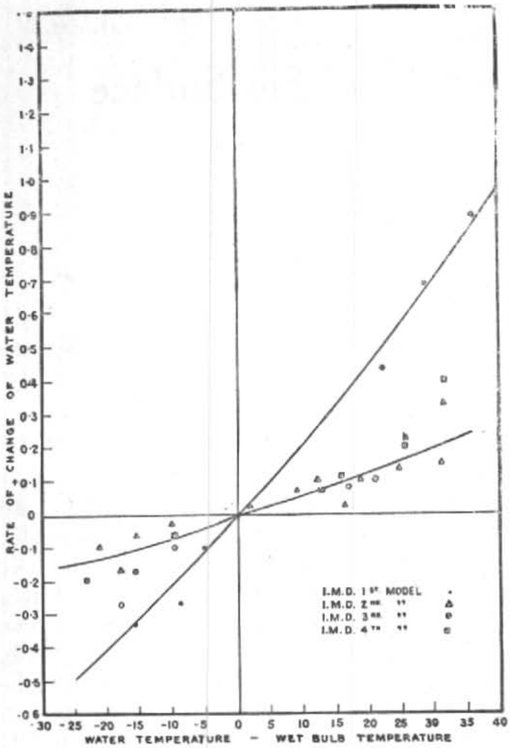

Fig. 1

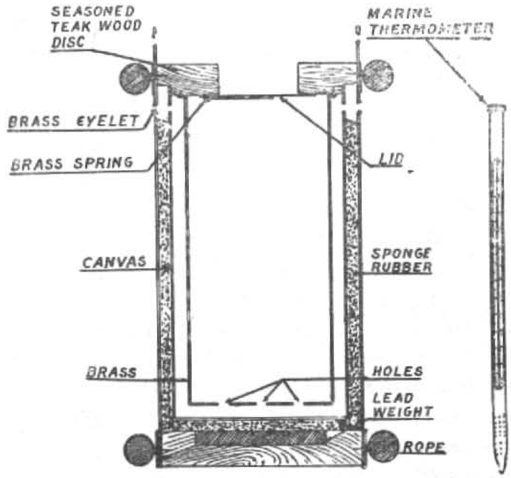

Fig. 2

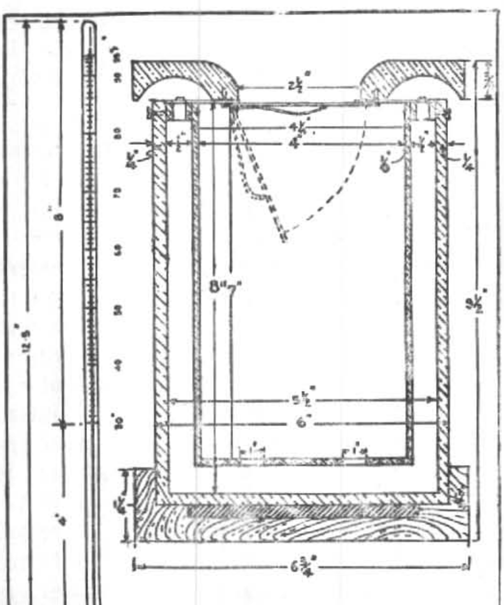

Fig. 3

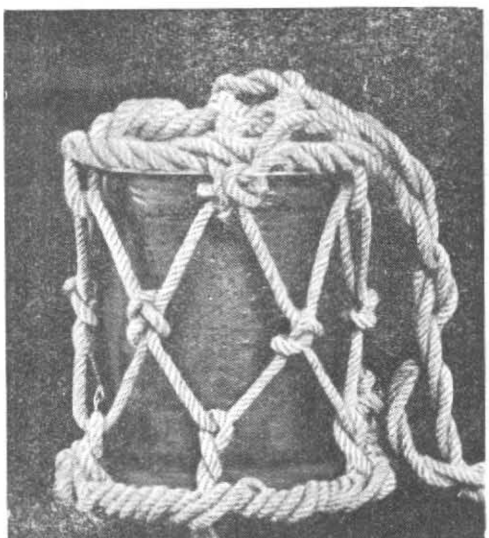

Fig. 4

The chief errors in the bucket method of measuring sea temperature are—

(1) The initial temperatures of the bucket and sea are usually different. This error is avoided by towing the bucket in the sea for some time while the water circulates freely through the bucket. Actual trials on the Moola river at Kirkee and on the Khadakwasla lake showed that a towing time of one minute was sufficient to bring the collected sample to the true water temperature.

(2) Between the collection of the sample and the actual reading of the thermometer, the temperature of the collected sample may change as a result of evaporation and heat exchange, unless the bucket is properly insulated. Measurements of the rate of change of water temperature for all the four models were carried out in a wind tunnel, two buckets being compared simultaneously to avoid variations with time of air speed, humidity etc. Observations were taken of the rate of change of temperature for water temperatures varying from 40° to 120° F, the average air speed inside the tunnel being of the order of 15 mph. The results obtained for the four models are given in Fig. 1, where the rate of change of temperature in °F min^{-1} is plotted against the difference between water temperature and wet bulb temperature. It will be seen that for the last three models the rate of change of temperature is of the order of 0°·1 F min^{-1} for a wide range of temperatures.

Measurements were also made from a " stormboat " on the Moola river of the rate of cooling of the water collected. After towing the bucket for two minutes the temperature of the collected sample was read every half minute for three minutes. The rate of cooling was found to be 0°·03 F min^{-1}. The conditions at the time were: clear sky, wet bulb temperature 77° F, air temperature 84° F, surface water temperature 80°·5 F, wind speed 11 mph.

3. The Thermometer

The sea thermometer supplied to the selected ships with the second model was an ordinary solid-stem mercury-in-glass thermometer with a cylindrical bulb, mounted between springs in a light chromium-plated brass case. It had a range of +10° to + 145° F, was graduated in whole degrees Fahrenheit and could be read to 0°·1 F. Its heat capacity was small (water equivalent —4·7 gm) so that even if the temperature of the thermometer differed from that of the water sample (4000 gm) by 10° F, the resultant change in the temperature of the water when the thermometer was immersed in it was only 0°·01 F. The thermometer, however, was not easy to read and for low values of sea surface temperature it had to be lifted slightly from the bucket to be read. These defects have been overcome in the new thermometer illustrated in Fig. 3. The scale is more open and the 4″ long ungraduated portion near the bulb enables the temperature to be read without the thermometer having to be lifted out of the bucket.

REFERENCE

1. Ashford, O. M., *Quart. J. R. met. Soc.*, **74**, p. 99 (1948).