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A THERMISTOR TELETHERMOMETER FOR SEA SURFACE TEMPERATURE MEASUREMENTS

The standard method of measuring sea surface temperature is to collect a sample of water with a canvas bucket from within the first 15 cm of the sea surface and to measure the temperature of the sample obtained using a sensitive mercury thermometer. The measurement of engine-room intake water temperature is not recommended since it is liable to siting errors and the temperature measured may be at depths varying from 1 to 3 metres depending on the size of the vessel. The bucket method is, however, impracticable from large ships travelling at speeds above 15 knots. Even from smaller ships the technique is laborious and sometimes dangerous.

The bucket method of measuring sea surface temperature is used normally in all selected weather observing ships equipped by the India Meteorological Department and was also employed during the first few scientific cruises of the Indian Oceanographic ship *INS Kistna*. Considering the difficulties of using this method in rough seas, particularly during the monsoon, it was decided to install a thermistor thermometer on the ship for the remote indication of sea surface temperature. The temperature sensor has for the present, been installed in the main inlet pipe of the engine intake, with the indicator in the laboratory on the top deck. The thermistor sealed in its glass capillary is inserted in a thin-walled metallic tube, 15 cm long and 2 cm diameter, built into the engine in-take pipe, and filled with conducting oil to a depth of 10 cm. This ensures good thermal contact between the thermistor and the wall of the tube and prevents direct contact of the thermistor with sea water. The sensor will be shifted to a location on the hull when the ship is next dry-docked. Comparative observations taken between the bucket and telethermometer observations during various scientific cruises have shown very small differences.

Principle—A bead thermistor is used as the temperature sensor. Since thermistors have a very high negative temperature coefficient of resistance, the effect on the temperature measurement, of a change in temperature of the leads from the thermistor to the indicator is negligible and special compensation leads are not required.

The resistance of the thermistor is measured by the out-of-balance Wheatstone bridge method. The circuit is shown in Fig. 1. R_1, R_2 and R_3 are variable resistances and T, the thermistor. R_1, R_2 and R_3 are adjusted to give full scale deflection on the meter for the desired temperature range of the thermistor. The out-of-balance current through the galvanometer is proportional to the resistance of the thermistor and therefore to the temperature for small ranges of temperature values.

Description—The thermistor used is a Stantel thermistor FS 2311/300 having a resistance of 4000 ohms at 0°C and 900 ohms at 50°C. It has a maximum rated power dissipation of 10 mW, a very low thermal capacity and a small lag coefficient. Since the self-heating effect for a given power dissipation is rather large, the power dissipated is kept less than 1 mW. Sealed in a fine glass capillary, it can be directly inserted in the water pocket where temperature is to be measured.

The indicator unit consists of a micro-ammeter having a range 0—60 μA and

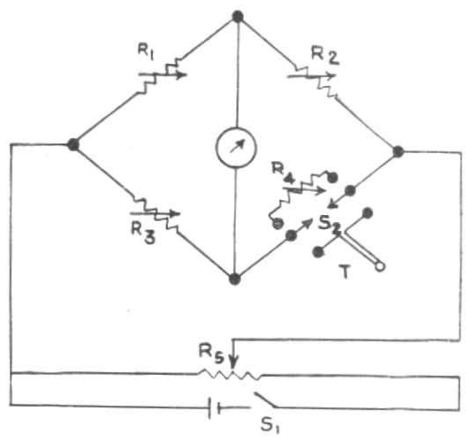

Fig. 1. Circuit diagram of Thermistor Bridge

directly calibrated in degrees Celsius 0—50°C. The power supply is a 1·5 volt dry battery.

Calibration and setting—The thermistor is calibrated in a melting ice bath, R_1, R_2 and R_3 being adjusted till the meter reads zero. The calibration over the range 0—50°C is carried out as usual in a standard water bath, the temperature over the range being checked with a precision standard thermometer.

The reference resistance R_4 enables the circuit to be checked periodically. Switch S_2 introduces R_4 in the circuit in place of the thermistor, when the meter should read 25°C. In case of small errors, the meter can be set to read correctly by adjusting potentiometer R_5. The battery is replaced, if the reading does not come to 25°C.

Performance and accuracy—The measurements of sea surface temperature using the thermistor telethermometer have been found in actual practice to be extremely simple. The accuracy is of the order of 0·05°C and the speed of response of the order of 10 seconds or less. The power requirements are also very small (0·5 mA at 1·5 volt) and an Eveready type 6-G battery lasts for 6—8 months. Lengths of cable upto 2 km can be used, if the resistance is kept within 20—30 ohms. The cable has however, to be carefully shielded to avoid any R.F. pickups.

The main drawback of the out-of-balance bridge method is the variation of the out-of-balance current with the e.m.f. supplied to the bridge and the sensitivity of the galvanometer, which is dependent to a certain extent on the temperature of the galvanometer. The former is corrected by means of the 25°C check observation which is made daily. The latter has been found to be negligible in actual conditions. Since thermistors are not available within very close tolerances, recalibration of the instrument will be necessary whenever the thermistor is replaced.

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