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Construction of an Inexpensive Low-Temperature Incubator

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Abstract.—A simple and inexpensive procedure is described for the modification of standard compact refrigerators for use as incubators at temperatures between 0°C and room temperature.

Many studies in fish biology, including, for example, studies on the storage of gametes (Rosenberg 1983) or the effects of reduced temperature on embryos (Cloud et al. 1988), require the use of refrigerated incubators. Commercially available laboratory refrigerators are expensive and typically have a limited effective range (about 0–10°C). Small refrigerators designed for home use, while cheaper, also have a limited range and do not offer accurate control, especially outside the temperatures used to store food. To overcome these problems we modified small home refrigerators for use as low-temperature incubators by installing an external thermostatic controller to regulate temperatures from 0 to about 25°C.

Three 0.07-m^3 compact refrigerators (model ARO31M, Absocold Corp., Richmond, Indiana)[2] were each equipped with an external hydraulic-action thermostatic controller (model 1609-101, White-Rodgers Division, Emerson Electric Co., St. Louis, Missouri). Installation of thermostats involved exposing and separating the wires in the power cord. The 110-V-line wire (black) was cut, the insulation stripped from the ends, and the wire ends fitted with crimp-style terminals. The exposed portion of the cord was passed through the duplex connector at the bottom of the controller unit, and the line wire was connected in series with the controller. The exposed portions of the common wire (white) and ground wire (green) were not modified and were tucked inside the controller. The controller unit was mounted on the back of the refrigerator with sheet-metal screws (Figure 1).

The controller monitors temperature by expansion and contraction of fluid within a copper sensing bulb. Pressure changes within the bulb are transferred through copper capillary tubing and

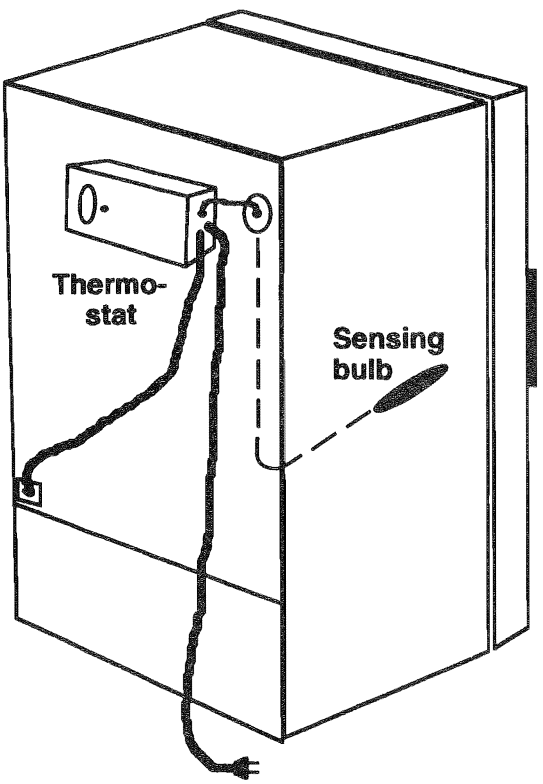

FIGURE 1.—Rear-side view of refrigerator equipped with external thermostatic controller and modified power cord. Sensing bulb and capillary tubing were inserted into refrigerator through a hole in the back and attached below the center shelf.

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[2] Reference to trade names or manufacturers does not imply endorsement of commercial products by the U.S. Government.

cause movement of a diaphragm within the thermostat. During installation, the capillary tube was passed through a hole in the back of the refrigerator. The hole was sealed with duct putty, and the sensing bulb was fastened under the center shelf with plastic tie straps. The original thermostat was not disabled but was placed at a setting that would not interfere with the operation of the external controller.

The modified refrigerators were tested at three temperatures (10, 15, and 20°C). The desired temperature was set using factory-calibrated dial settings on the controller, and refrigerators were allowed to equilibrate for 24 h. After equilibration, temperature inside the refrigerators was recorded for 5 h with a type-T thermocouple and chart recorder. Average temperature was calculated from values collected at 3-min intervals ($N > 85$ at each temperature).

The original thermostat in the refrigerators was not calibrated and was useful over a range of only about 0–10°C. The external thermostat we installed was calibrated in °C and designed to control temperatures from −34 to 32°C. In actual use, at nonfreezing temperatures in an air-conditioned laboratory, the external thermostat was effective from 0 to about 25°C, a range useful, for instance, in studies of warmwater fishes. Factory-calibrated dial settings were accurate: a setting of 10°C yielded an actual temperature (mean ± SD) of 9.9 ± 1.6°C; a setting of 15°C yielded 14.9 ± 2.4°C, and a setting of 20°C yielded 19.2 ± 2.1°C. The controllers were set to the minimum differential range (2°C); thermostats with a smaller differential are available and would presumably offer tighter control of temperature.

Installation of controllers on three refrigerators required about 2 h. When purchased in 1991, each refrigerator cost US$90, and each thermostat cost $20. The cost of the modified refrigerators was below that of standard laboratory refrigerators (usually $400 or more) and that of commercially available low-temperature incubators, which offer a broader temperature range (typically −10 to 55°C) but cost thousands of dollars.

References

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