The salient features of the portable incubator are its use of a fatty acid phase-change material for temperature regulation, and its exceptional insulating properties derived from rigid insulation. Computer simulations, cost analyses, and prototype and material testing all provided input which was used to iteratively improve the portable incubator prototype. Analysis of testing results led to the selection appropriate insulation and phase change materials, as well as the identification of the most cost-effective combination of materials. The final working prototype meets the design specifications, demonstrating its ability to accurately incubate water samples.

**ABSTRACT**

The portable incubator repeatedly ran successful tests. Tests included: outside ambient temperature (22±5°C), outside cold temperature (< 20°C), outside hot temperature (>39°C), drop test. Final price per portable incubator $141.70

**DESIGN DEVELOPMENT**

Energy Requirement: Testing and Results
Through the use of a resistive heater, a thermostat and a relay, the energy requirement to keep a small cooler 34°C for 24 hours was determined to be 162 kJ.

Heat Source for Incubation: Phase Change Material (PCM)
Used for thermal energy storage and temperature regulation. High latent heat of fusion allows for a large storage of heat energy upon melting.

Solidification releases this energy at a relatively constant temperature.

PCM Selection: Fatty Acids (Lauric and Myristic)
Basic components of vegetable oils and animal fats. 60% of Palm kernel oil.

General chemical formula is CnH2nO2

PCM Binary Mixture: Testing and Results
The highest-performing PCM was a binary mixture of Myristic Acid (n=14) at 66% and Lauric Acid (n=12) at 33%.

**MATERIAL SELECTION**

**INSULATION**

Igloo 14 Can Cooler Shell ($30.90)
Incubator shell and casing. Allows for portability and robustness. Purchase at local sports stores.

Rigid Insulation ($6.24)
Improves Igloo’s insulation. Low thermal conductivity (k=0.023W/mK) and cheaper than Styrofoam. Purchase at local construction stores.

Foam Filler ($6.78)
Fills in air gaps and increases insulation. Improves insulation by eliminating convection. Purchase at local hardware stores.

**HEAT SOURCE & TEMPERATURE REGULATION**

Phase Change Material: Myristic Acid & Lauric Acid ($32.54)
Heat to and regulate at incubation temperature. Have high latent heat of fusions (189 & 180 kJ/kg) and melting temperatures (55 & 44°C) near desired incubation temperature.

Purchase online.

**VALIDATION**

Max/Min Temperature ($22.95)
Records maximum and minimum incubator temperatures. Insures accurate incubation. Purchase online.

**RESULTS**

The portable incubator repeatedly ran successful tests. Tests included: outside ambient temperature (22+5°C), outside cold temperature (< 20°C), outside hot temperature (>39°C), drop test.

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