PRECISE TEMPERATURE CONTROLLED PORTABLE STORAGE MODULE FOR PHARMACEUTICAL FLUIDS

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Keywords:

Peltier, precise, portable module, esp8266, temperature sensor.

Introduction:

The temperature-controlled module is a compact, portable unit used in the medical field for pharmaceutical fluids, especially in vaccine programs to maintain the cold chain. Vaccines require temperatures between 2°C and 8°C, while insulin must stay between 2°C and 30°C. This module addresses the transportation challenges of sensitive medical fluids like vaccines, insulin, polio vaccines, and more, by maintaining precise temperatures with an accuracy of ±0.5ºC. It surpasses old methods like ice packs, ensuring safe, effective transport.

Modern fridges use bulky hydrofluorocarbon chemicals, but this module employs thermoelectric cooling via the Peltier module, making it compact and transport-friendly. Critical for COVID-19 vaccines, maintaining cold chain integrity is vital for vaccine efficacy and safety. The proposed real-time temperature monitoring system follows WHO guidelines, aiming to enhance vaccine distribution reliability. This integration of advanced technologies supports global COVID-19 vaccination efforts by ensuring vaccines remain within recommended temperature ranges.

Objectives:

- Uniform-cooling throughout the cold-chamber.
- Rapid Temperature stabilization.
- Portability and power optimization.
- Security of the device

Methodology:

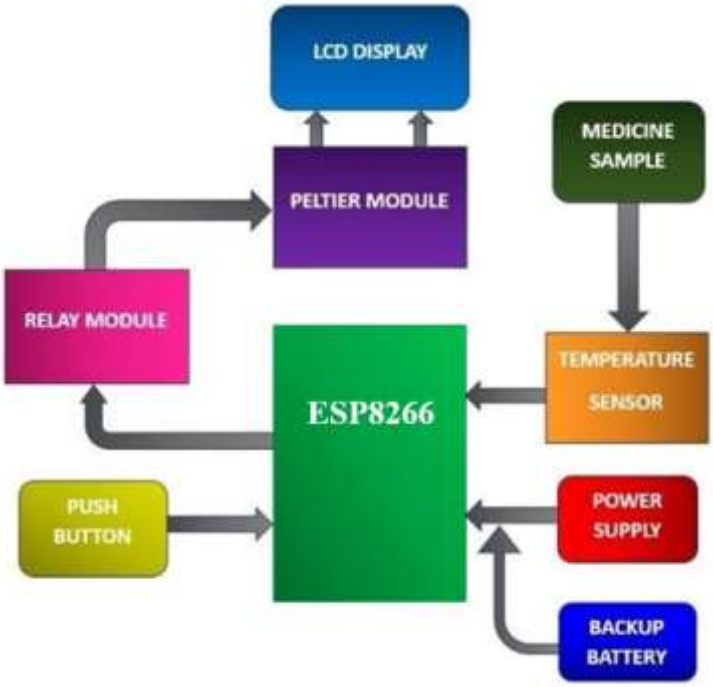

FIG 1: Block diagram

The portable module is equipped with a DHT22 temperature and humidity sensor, which has a precision of ±0.5ºC over a range of -40ºC to +80ºC. The sensor connects to an ESP8266 microcontroller using a single-bus protocol, converting analog outputs to digital. The chamber is insulated with medium-density fibreboard (MDF) and polystyrene to resist temperature fluctuations. Medications like vaccines, antibiotics, and insulin require specific temperature ranges, and the module ensures these are maintained.

The ESP8266 microcontroller, operating at 3.3V, retrieves data from the DHT22 sensor, processes it, and uses control logic to maintain a constant temperature by activating a relay to control heating or cooling elements. The module uses the Peltier thermoelectric cooling technique with TEC1-12704 and TEC1-12706 modules, providing efficient cooling. These modules operate on 12V and 10A DC, with the TEC1-12704 being more efficient for cooling.

A water block and DC fan are used to dissipate heat and circulate cold air within the chamber. The system employs a submersible DC motor for continuous water circulation in the cooling system. The Peltier module is controlled by a single-channel relay with a transistor and freewheeling diode for protection. Users set the desired temperature via push buttons, displayed on a 20x4 LCD unit. The system maintains the target temperature, activating the Peltier module only when necessary, with the LCD displaying current and desired temperatures.

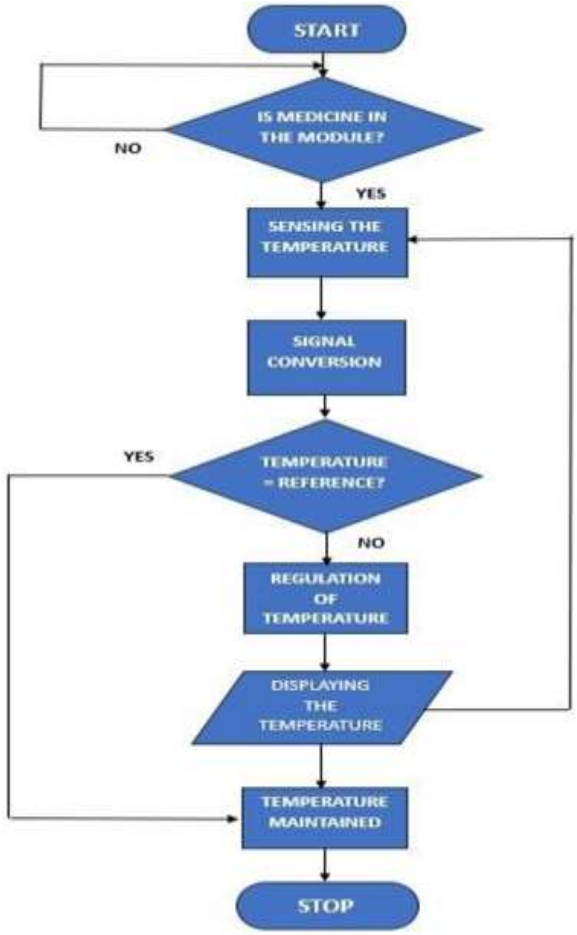

Fig 2: Flow chart

Conclusion:

Larger chambers are cool yet cumbersome, while portable chambers struggle to maintain temperature. While a huge chamber cools quickly, it uses a lot of energy. Compact chambers that have efficient cooling are beneficial for productivity and portability.

It is possible to add more security features, such locks and alarms. A GPS module can be used to track the device's current location, and software can be used to regulate the temperature.

Scope for future work:

Prospective investigations may concentrate on creating temperature control systems that are more energy-efficient, discovering novel materials for insulation, and using Internet of Things technology for data analytics and remote monitoring.

Further research into more economical and ecologically friendly solutions could be beneficial for the continuous creation of more complex and intuitive temperature-controlled pharmaceutical fluid storage modules.