🔥 PCM-Based Thermal Energy Storage and Enhanced Heat Transfer with Elliptical Fins

Domain: Thermal Engineering | **Tools Used:** ANSYS Fluent | **Type:** Simulation & Design | **Application:** Electric Vehicle Thermal Management

📌 Overview

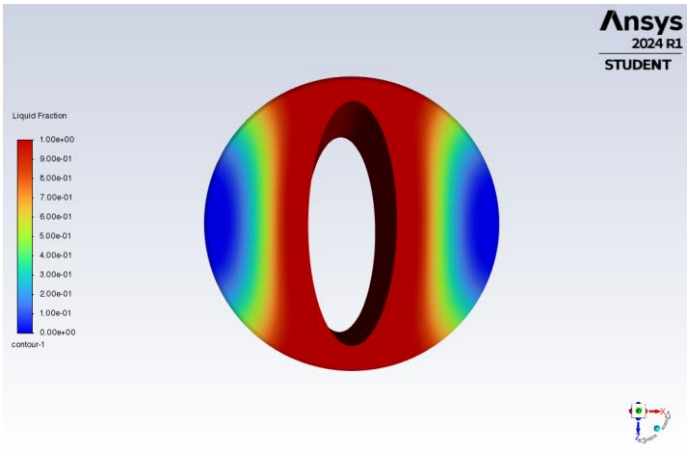
This project investigates the use of elliptical fins in a Phase Change Material (PCM)-based thermal energy storage system to improve heat transfer performance. Through transient CFD simulations in ANSYS Fluent, the study compares the melting behavior, heat distribution, and liquid fraction efficiency of elliptical fins versus conventional circular fins.

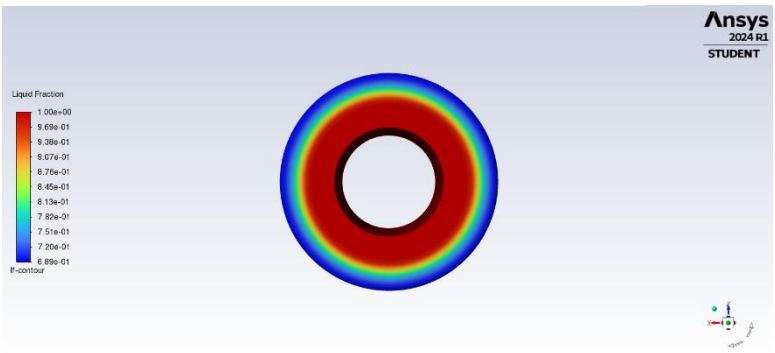
🎯 Objectives

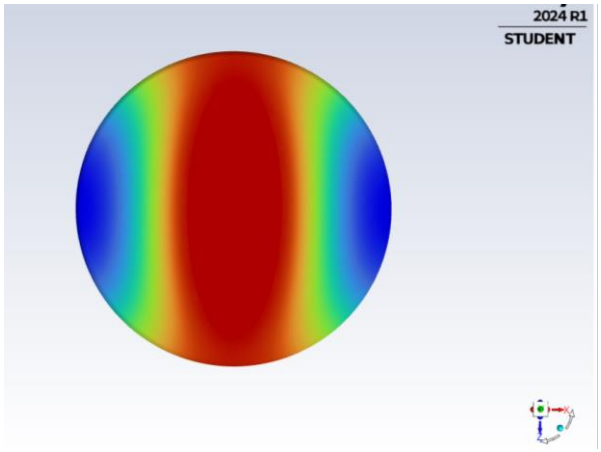
- To design and simulate elliptical and circular fins in PCM environments.
- To analyze liquid fraction and thermal response over a 300-second transient period.
- To optimize fin geometry for better heat transfer in compact energy storage systems.

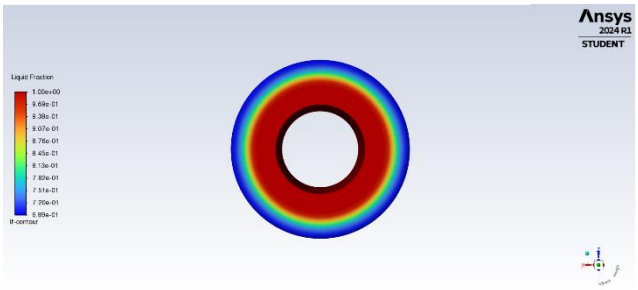
🧪 Methodology

- **Geometry Design:** 3D models of elliptical and circular fins were created with equivalent surface areas.
- **Simulation Setup:** Transient thermal analysis conducted using ANSYS Fluent; PCM melting behavior and temperature fields tracked.
- **Performance Metrics:** Heat transfer rate, liquid fraction, and uniformity of temperature distribution.









📊 Key Findings

- **Elliptical Fins:**
  - Achieved faster PCM melting (higher liquid fraction).
  - Provided more uniform temperature distribution.
  - Demonstrated superior energy flux regulation.
- **Circular Fins:**
  - Slower heat transfer and PCM melting.
  - Less effective in spreading thermal energy evenly.

💡 Impact

Elliptical fins show promising potential in improving PCM-based energy storage, especially in systems where rapid and uniform heat dissipation is essential, such as electric vehicle batteries or electronics cooling.