IZTECH ME401 Project Proposal

Advisor(s): Kasım Toprak

Project title: Experimental investigation on the thermal performance of a heat sink

Number of groups: 1

Number of students in each group: 2-3

Is the project within the scope of Co-Op Extended? No

Project Background:

As electronic devices and computer technology advance, chips with high processing power are being used in smaller packages, necessitating more effective thermal solutions. Inadequate cooling can lead to poor performance, reduced lifespan, and rapid failure of electronic devices. Heat sink blocks made of highly thermally conductive materials with thin fins are used to dissipate heat. However, for next-generation devices, these blocks alone are insufficient, requiring additional heat pipes and cooling fans. While fans improve cooling, they also increase power consumption, vibrations, and noise. If the actual thermal performance of heat sink blocks can be accurately determined, the need for additional cooling components can be eliminated. Therefore, the goal is to set up an experimental apparatus to simulate an electronic device's cooling system, examine the effects of temperature and air conditions on heat sink performance, and improve the design to maximize cooling efficiency based on experimental results.

Project Objective:

- Design and Construction of Experimental Setup: Plan, design, and construct an experimental test rig that includes a wind tunnel and necessary electronic components to evaluate the thermal performance of cooling blocks.
- Instrumentation and Calibration: Integrate precise measurement instruments into the setup and perform accurate calibration to ensure reliable data collection on the thermal performance of heat sink blocks.
- Simulation of Real-World Conditions: Establish and control a range of operating conditions, such as varying temperatures and airflow rates, to realistically simulate the environment in which heat sink blocks operate.
- Automated Data Acquisition: Develop and implement an automated data acquisition system capable of continuously monitoring and recording thermal performance metrics during the experiments.
- Validation and Optimization of Experimental Setup: Design validation tests to ensure the accuracy and repeatability of the experimental setup and make necessary adjustments to optimize the setup for reliable results.
- Analysis and Improvement of Cooling Block Designs: Analyze the experimental data to identify the thermal performance of existing cooling block designs and suggest design improvements to enhance cooling efficiency without additional components.

Project Design Criteria:

- Temperature sensors must measure with an accuracy of ±0.1°C, and at least 6 temperature points must be measured in the setup.
- The experimental setup's wind tunnel must be sized appropriately for a heat sink typically used on a computer CPU.
- Heat source capable of delivering power in the range of 50W to 300W to mimic various CPU power outputs.

- Wind tunnel equipped with fans capable of producing variable airflow rates, with an airflow measurement accuracy of ±0.1 m/s.
- Ability to simulate and manipulate ambient conditions.
- Automated data acquisition system capable of storing logged data for at least 5 hours without interruption. It should also be capable of real-time data visualization and analysis.

Expected Outcomes:

The expected outcomes of the thermal performance test rig project for CPU cooling heat sinks include a fully operational rig that can accurately simulate CPU operating conditions and measure thermal performance with high precision. The project aims to provide validated performance data on various heat sinks, analyze their efficiency, and offer optimization recommendations. Additionally, the project is expected to result in the development of a comprehensive report summarizing the findings, which could be used as an educational resource for future research and development in electronic thermal management.

Sustainable Development Goals: (https://sdgs.un.org/goals)

Optimizing thermal management in electronic devices has significant implications across multiple domains, including technology, environment, society, and economy. These advancements support the achievement of several UN SDGs by promoting energy efficiency, reducing waste, fostering innovation, and improving the quality of life. Through responsible and sustainable engineering practices, the electronics industry can contribute meaningfully to a more sustainable and equitable future.

Literature Survey Subjects:

- Natural Convection
- Computational Thermal Modeling
- Extended Heat Transfer Surface
- Data acquisition and analysis

Please write your notes below, which you find useful for students to know about the project.

- This project not only advances the field of electronics by improving thermal management but also aligns with multiple UN SDGs, promoting sustainability, efficiency, and innovation.
- Understanding and applying these principles can lead to significant technological, environmental, and societal benefits, preparing students for impactful careers in engineering and technology.