DESIGN AND FABRICATION OF BATTERY COOLING SYSTEM

A PROJECT REPORT

Submitted by

GOKUL KRISHNAN G (927622BME019)
GOKUL RAM B (927622BME020)

in partial fulfillment for the award of the

degree of

BACHELOR OF ENGINEERING

in

MECHANICAL ENGINEERING

M.KUMARASAMY COLLEGE OF ENGINEERING, KARUR

ANNA UNIVERSITY:: CHENNAI 600 025

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BONAFIDE CERTIFICATE

Certified that this project report **"DESIGN AND FABRICATION OF BATTERY COOLING SYSTEM"** is the bonafide work of **"GOKUL KRISHNAN G (927622BME019), GOKUL RAM B (927622BME020)"** who carried out the project work during the academic year 2023 – 2024 under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project reportor dissertation on the basis of which a degree or award was conferred on an earlier occasion on thisor any other candidate.

Signature

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Signature

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This project report has been submitted for the end semester project viva voce Examination held on _____________

INTERNAL EXAMINER

EXTERNAL EXAMINER

DECLARATION

We affirm that the Project titled "**DESIGN AND FABRICATION OF BATTERY COOLING SYSTEM"** being submitted in partial fulfillment of for the award of Bachelor of Engineering in Mechanical Engineering, is the original work carried out by us. It has not formed the part of any other project or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

Student name	Signature
1. GOKUL KRISHNAN G	---------------------------
2. GOKUL RAM B	----------------------------

Name and signature of the supervisor with date

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We offer our whole hearted thanks to our project coordinator **Mr.S.Nandha Kumar M.E.,Ph.D,** Department of Mechanical Engineering**,** for his constant encouragement, kind co-operation, valuable suggestions and support rendered in making our project a success.

We glad to thank all the Teaching and Non Teaching Faculty Members of Department of Mechanical Engineering for extending a warm helping hand and valuable suggestions throughout the project.

Words are boundless to thank Our Parents and Friends for their constant encouragement to complete this project successfully.

INSTITUTION VISION & MISSION

Vision

- To emerge as a leader among the top institutions in the field of technical education.

Mission

- Produce smart technocrats with empirical knowledge who can surmount the global challenges.
- Create a diverse, fully-engaged, learner-centric campus environment to provide quality education to the students.
- Maintain mutually beneficial partnerships with our alumni, industry and professional associations.

DEPARTMENT VISION, MISSION, PEO, PO & PSO

Vision

- To create globally recognized competent Mechanical engineers to work in multicultural environment.

Mission

- To impart quality education in the field of mechanical engineering and to enhance their skills, to pursue careers or enter into higher education in their area of interest.
- To establish a learner-centric atmosphere along with state-of-the-art research facility.
- To make collaboration with industries, distinguished research institution and to become a centre of excellence

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

The graduates of Mechanical Engineering will be able to

- PEO1: Graduates of the program will accommodate insightful information of engineering principles necessary for the applications of engineering.
- PEO2: Graduates of the program will acquire knowledge of recent trends in technology and solve problem in industry.
- PEO3: Graduates of the program will have practical experience and interpersonal skills to work both in local and international environments.
- PEO4: Graduates of the program will possess creative professionalism, understand their ethical responsibility and committed towards society.

PROGRAM OUTCOMES

The following are the Program Outcomes of Engineering Graduates:
Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

The following are the Program Specific Outcomes of Engineering Graduates:
The students will demonstrate the abilities

1. **Real world application:** To comprehend, analyze, design and develop innovative products and provide solutions for the real-life problems.
2. **Multi-disciplinary areas:** To work collaboratively on multi-disciplinary areas and make quality projects.
3. **Research oriented innovative ideas and methods:** To adopt modern tools, mathematical, scientific and engineering fundamentals required to solve industrial and societal problems.

Course Outcomes	At the end of this course, learners will be able to:	**Knowledge Level**
CO-1	Identify the issues and challenges related to industry, society and environment.	Apply
CO-2	Describe the identified problem and formulate the possible solutions	Apply
CO-3	Design / Fabricate new experimental set up/devices to provide solutions for the identified problems	Analyse
CO-4	Prepare a detailed report describing the project outcome	Apply
CO-5	Communicate outcome of the project and defend by making an effective oral presentation.	Apply

MAPPING OF PO & PSO WITH THE PROJECT OUTCOME

Course Outcomes	**ProgramOutcomes**												**Program Specific Outcomes**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO - 1	3	3	3	3	2	2	2	2	3	3	2	2	3	2	3
CO - 2	3	3	3	3	2	2	2	2	3	3	2	2	3	2	3
CO - 3	3	3	3	3	2	2	2	2	3	3	2	2	3	2	3
CO - 4	3	3	3	3	2	2	2	2	3	3	2	2	3	2	3
CO - 5	3	3	3	3	2	2	2	2	3	3	2	2	3	2	3

ABSTRACT

The rising adoption of electric vehicles (EVs) has emphasized the need for efficient thermal management strategies to optimize battery performance and extend its lifespan. This abstract explores the implementation of liquid cooling systems as an innovative solution to address the challenges associated with battery overheating during charging and discharging cycles. The proposed system utilizes a liquid coolant circulation mechanism to absorb and dissipate heat generated within the battery pack. The study investigates the thermal conductivity and heat transfer capabilities of various coolant formulations to identify an optimal solution for enhancing the overall efficiency of the battery cooling system. Additionally, the design considerations for integrating liquid cooling channels within the battery pack are explored to ensure uniform temperature distribution and mitigate hotspots. By employing liquid cooling, this research aims to not only maintain the battery's operating temperature within a safe range but also improve energy efficiency and charging speed. The findings of this study contribute valuable insights into the potential of liquid cooling systems as a robust and scalable solution for addressing thermal challenges in EV batteries, paving the way for advancements in electric vehicle technology and sustainable transportation.

SCOPE OF PROJECT

The scope of a battery cooling system project extends across various domains, reflecting its critical role in advancing electric vehicle (EV) technology. Firstly, the project involves in-depth research and development to design an efficient and reliable cooling system that caters to the specific needs of high-capacity lithium-ion batteries commonly used in EVs. This encompasses exploring various cooling techniques, such as liquid cooling, air cooling, or hybrid systems, and evaluating their effectiveness in maintaining optimal battery temperatures.

Implementation of the project extends to collaboration with battery manufacturers and EV companies to integrate the cooling system seamlessly into existing or upcoming vehicle models. Compatibility, scalability, and adaptability become crucial factors in ensuring widespread adoption.

Furthermore, the project involves the incorporation of intelligent control systems, employing sensors and feedback mechanisms to continuously monitor and regulate battery temperatures in real-time. This not only enhances performance but also contributes to the overall safety of EVs.

Considering the dynamic nature of the EV industry, the project scope extends to addressing future challenges and innovations. This includes anticipating advancements in battery technology, exploring novel cooling methods, and adapting the system to support fast-charging technologies.

In addition, the scope encompasses considerations for sustainability and environmental impact. Designing energy-efficient cooling systems and exploring eco-friendly cooling fluids align with the broader goals of creating sustainable transportation solutions.

The project's impact goes beyond individual vehicles; it influences the entire EV ecosystem. Successful implementation improves the competitiveness of EVs in the market by addressing key concerns such as range anxiety, charging times, and battery longevity. It also contributes to the global push towards reducing reliance on traditional combustion engines, promoting a cleaner and greener transportation landscape.

In conclusion, the scope of a battery cooling system project spans research, development, collaboration, adaptability, sustainability, and the overarching goal of enhancing the efficiency, performance, and safety of electric vehicles, thereby contributing significantly to the ongoing evolution of the automotive industry.

CHAPTER 1
INTRODUCTION

The battery cooling system in electric vehicles (EVs) plays a pivotal role in ensuring optimal performance, efficiency, and longevity of the battery pack. As EVs rely heavily on high-capacity lithium-ion batteries, managing the temperature within a specific range is crucial for safety and overall functionality.

These cooling systems typically employ a combination of liquid and air cooling techniques to dissipate heat generated during charging and discharging cycles. Liquid cooling, involving a coolant circulating through channels within the battery pack, is effective in maintaining uniform temperature distribution. This prevents hotspots that could lead to thermal degradation and premature aging of the battery cells.

Moreover, active thermal management systems use fans or liquid pumps to enhance heat dissipation. Intelligent control systems monitor the battery temperature in realtime, adjusting the cooling mechanism as needed to optimize performance. Thermal sensors strategically placed within the battery pack ensure precise temperature regulation.

In extreme conditions, such as rapid charging or high ambient temperatures, the cooling system becomes particularly crucial. Overheating can not only degrade battery performance but also pose safety risks. Therefore, many EV manufacturers incorporate advanced thermal management solutions to enhance the overall efficiency and safety of their vehicles.

Efficient cooling systems contribute to faster charging times, increased energy retention, and prolonged battery life, addressing key concerns in EV adoption. As technology advances, research continues to explore innovative cooling methods, including phase-change materials and more intricate thermal management strategies, to push the boundaries of electric vehicle performance and reliability

CHAPTER 2

WORKING

A battery liquid cooling system powered by solar energy typically involves solar panels generating electricity to operate a pump or fans for cooling. The solar power generated is used to circulate a cooling liquid, such as water or a specialized coolant, through the battery system. This helps maintain optimal operating
temperatures, improving battery efficiency and lifespan. It's a sustainable approach to managing battery heat, often used in renewable energy setups or off-grid applications.Electric vehicle batteries are cooled through a combination of active and passive thermal management systems. The cooling process involves Overall, the combination of liquid cooling, heat exchangers, fans, and thermal management systems ensures that the temperature of EV batteries remains within an optimal range for performance, efficiency, and longevity.

CHAPTER 3

MATERIALS

- Liquid coolant
- Copper tube
- Water pump
- Temperature sensor
- Battery

WORKING PROCEDURE

In a battery cooling system using liquid cooling, a fluid circulates through a closedloop system to manage the temperature of the battery pack. Here's a simplified overview of the working procedure

Coolant Circulation:

The liquid coolant flows through a network of channels or pipes that are in close contact with the battery cells or modules

Thermal Sensors:

Thermal sensors are strategically placed within the battery pack to monitor temperature variations. These sensors provide real-time data to the control system.

Control System:

A control system processes the data from thermal sensors and determines whether the battery temperature is within the optimal range. If the temperature exceeds predefined limits, the cooling system is activated

Heat Exchanger:

The coolant absorbs heat from the battery cells as it circulates. A heat exchanger, often located between the battery and the coolant loop, facilitates the transfer of heat from the cool ant to the external environment.

Pump:

A pump ensures the continuous circulation of the coolant. It pushes the heated coolant away from the battery cells towards the heat exchanger, and then returns the cooled fluid back to the battery

Radiator or Cooling System:

In electric vehicles, a radiator or another cooling mechanism dissipates the absorbed heat into the surrounding air.

Temperature Regulation:

The cooling system regulates the temperature by adjusting the flow rate of the coolant based on the input from thermal sensors. This helps maintain the battery within the optimal temperature range for efficient operation and longevity.

PROJECT SNAP SHOT

DESIGN AND FABRICATION OF BATTERY COOLING SYSTEM

Fig :3.1 Project snap shot

CHAPTRER 4

BLOCK DIAGRAM

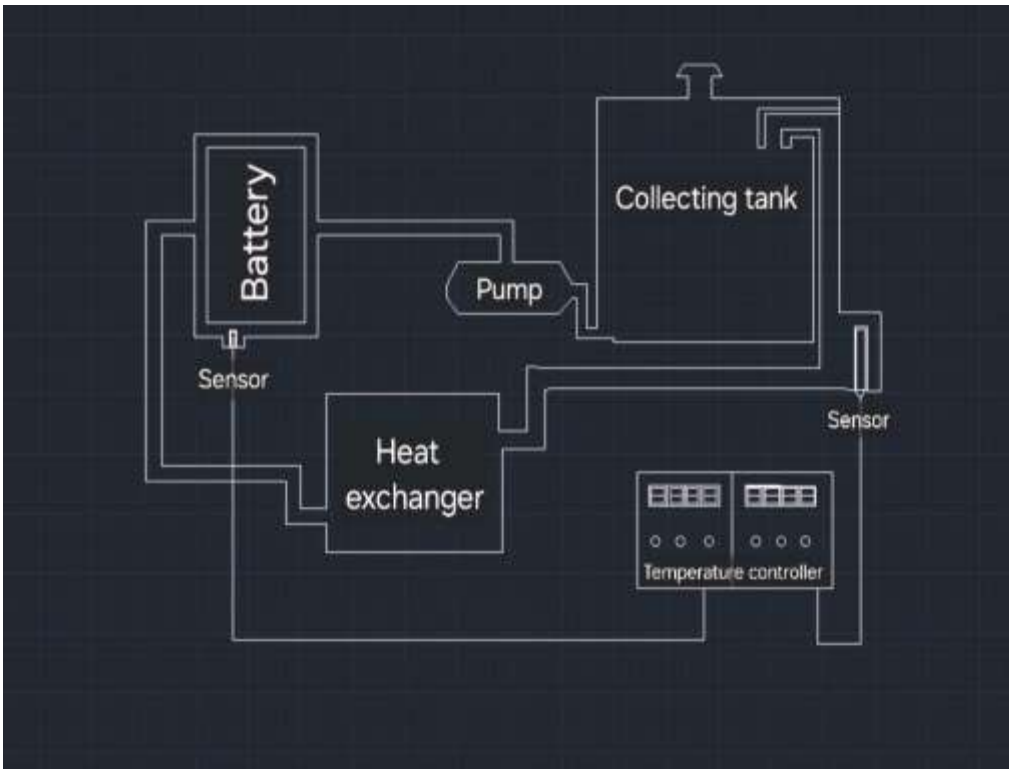

Fig : 4.1 Block Diagram

CHAPTER 5
ADVANTAGES

The use of a liquid cooling system for batteries offers several advantages:

- Temperature control
- Uniform cooling
- Efficient heat dissipation
- Thermal stability
- Extended battery life
- Fast charging capability
- Enhance performance

CHAPTER 6

CONCLUSION

The liquid battery cooling system is a critical component in electric vehicles that significantly impacts their performance, efficiency, and longevity. By utilizing a combination of liquid cooling techniques, this system effectively dissipates heat generated during charging and discharging cycles, preventing thermal issues that could compromise battery health.

The implementation of a liquid cooling system enhances the uniform distribution of temperature within the battery pack, mitigating the risk of hotspots and ensuring optimal conditions for the lithium-ion cells. The active thermal management, often incorporating pumps and fans, further improves heat dissipation and responsiveness to dynamic temperature changes.

The real-time monitoring and control mechanisms integrated into liquid cooling systems contribute to the overall safety of EVs. These systems can adapt to various operating conditions, preventing overheating and maintaining the battery within an optimal temperature range. This adaptability is crucial for addressing challenges posed by rapid charging, high ambient temperatures, and diverse driving scenarios.

Moreover, the liquid cooling approach supports faster charging times, increased energy retention, and extended battery life, addressing key concerns in EV adoption. As technology continues to advance, ongoing research in this field aims to refine liquid cooling systems, exploring innovative materials and strategies to further improve their efficiency.

In the broader context, the adoption of liquid battery cooling systems aligns with the global push towards sustainable transportation. By optimizing the thermal management of EVs, these systems contribute to reducing reliance on traditional combustion engines, promoting a cleaner and more environmentally friendly future.

In essence, the liquid battery cooling system stands as a crucial enabler for the widespread acceptance of electric vehicles, ensuring they not only meet but exceed performance expectations while addressing safety and sustainability concerns in the evolving landscape of automotive technology.

CHAPTER 7

COST ESTIMATION

S.NO	COMPONENTS	PRICE
1	BATTERY	1600
2	COPPER TUBE	300
3	WATER PUMP	900
4	HEAT EXCHANGER	900
5	THERMOSTAT	900
6	ALUMINUM TUBE	100
7	VOLTAGE REGULATOR	50
	TOTAL	4750

CHAPTER 8

REFERENCE 1

We have the study of the journal of energy storage, volume 2 , part D
Published on 30 November 2023

Performance analysis of liquid cooling battery thermal management system in different cooling cases

Author links open overlay panel

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REFERENCE 2

Research on Electric Vehicle Cooling System Based on Active and Passive Liquid Cooling

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REFERENCE 3

A novel direct liquid cooling strategy for electric vehicles focused on pouch type battery cells

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