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Thermal Management in Electronics and Battery Systems in Vehicles

Ms. Dhyaneshwar S Phapale, Prof. B. M. Randhavan, Prof. P. B. Dengale

Department of Mechanical Engineering Sahyadri Valley College of Engineering, Rajuri, Pune, India

Abstract: The rapid evolution of electronic systems and battery technologies in vehicles necessitates advanced thermal management strategies to ensure optimal performance and safety. This paper presents a comprehensive review of thermal management systems (TMS), comparing conventional methods such as air and liquid cooling with emerging techniques like phase change materials (PCMs), heat pipes, and advanced liquid cooling systems. While traditional methods offer simplicity and cost- effectiveness, they often struggle with limited heat dissipation capacity and inefficiencies under high thermal loads. In contrast, modern TMS provide enhanced thermal regulation, faster heat absorption, and better adaptability to varying conditions. The study identifies key limitations, including high implementation costs and system complexity, while highlighting the scope for integrating nonmaterial's and smart cooling technologies. Methodologies, tools, and simulation techniques used in TMS development are outlined. Expected outcomes include improved battery lifespan, enhanced energy efficiency, and vehicle safety. The paper concludes by emphasizing the critical role of innovative TMS in advancing automotive technology..

Keywords: TMS, PCMs, thermal regulation, heat absorption, adaptability etc.

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