PRESTONE PRODUCTS CORPORATION
6250 N River Rd, Suite 6000
Rosemont, IL 60018
www.prestone.com

White Paper: Development of Thermal Management Fluids for Electric Vehicles

by Colin Dilley, PhD

1. Executive Summary

This white paper explores the critical role of thermal management fluids in electric vehicles (EVs) and the ongoing developments in this field. As EV adoption continues to rise, effective thermal management is crucial to ensure optimal performance, battery longevity, and safety. This paper discusses the challenges associated with thermal management in EVs, highlights the characteristics of ideal thermal management fluids, examines the current state of these fluids, and delves into recent innovations. The goal is to provide a comprehensive understanding of the importance of thermal management fluids and the evolving landscape of this technology.

2. Introduction

Electric vehicles are revolutionizing the automotive industry, offering eco-friendly alternatives to traditional internal combustion engine vehicles. However, the efficient operation of EVs relies heavily on maintaining the right temperature conditions. Overheating or undercooling can lead to reduced battery life, performance degradation, and even safety risks. Thus, effective thermal management is essential for the continued success of EVs.

3. Importance of Thermal Management in Electric Vehicles

Thermal management in EVs serves several critical purposes:

Battery Health: Maintaining the battery at an optimal temperature range (typically between 20°C to 40°C) ensures longevity and prevents thermal degradation.

Performance: Proper thermal management enhances the efficiency of powertrain components, including motors and inverters, resulting in improved performance.

Safety: Overheating can lead to thermal runaway, a dangerous condition where the battery's temperature increases uncontrollably, potentially causing fires or explosions.

Range Optimization: Efficient thermal management can extend an EV's driving range by reducing energy consumption during extreme temperature conditions.

4. Challenges in Thermal Management

Developing effective thermal management systems for EVs is not without its challenges:

Temperature Extremes: EVs must operate in diverse climates, from freezing cold to scorching heat, making it challenging to maintain a stable temperature.

Energy Efficiency: Cooling or heating systems can consume a significant amount of energy, impacting the vehicle's overall efficiency.

Weight and Space Constraints: Space and weight limitations in EVs require compact and lightweight thermal management solutions.

5. Characteristics of Ideal Thermal Management Fluids

Ideal thermal management fluids for EVs should possess the following characteristics:

- High Thermal Conductivity: Efficiently transfer heat to and from critical components.
- Wide Temperature Range: Perform reliably in extreme temperature conditions.
- Chemical Compatibility: Be compatible with materials used in the cooling system.
- Non-Corrosive: Avoid damaging components over time.
- Low viscosity to minimize energy consumption of circulation
- Low Environmental Impact: Minimize environmental harm throughout their lifecycle.

6. Current State of Thermal Management Fluids

Currently, thermal management fluids for EVs typically use glycol-based coolants and in a very limited amodevelopment challengesunt dielectric oils. These fluids have been effective but have

limitations in terms of thermal conductivity, compatibility, and environmental impact. Prestone is exploring alternatives to address these shortcomings.

7. Recent Innovations in Thermal Management Fluids

Recent innovations in thermal management fluids include:

Nanofluids: The addition of nanoparticles to traditional fluids can significantly enhance thermal conductivity.

Phase Change Materials (PCMs): These materials can absorb and release heat as they change from solid to liquid and vice versa, providing efficient temperature control.

Ionic Liquids: Non-volatile, non-flammable, and non-toxic, ionic liquids offer a safer alternative to traditional fluids.

Graphene-Based Fluids: Graphene's exceptional thermal conductivity properties make it a promising candidate for thermal management applications.

8. Conclusion

Effective thermal management is pivotal for the success and sustainability of electric vehicles. As the EV industry continues to grow, the demand for improved thermal management fluids will persist. Innovations such as nanofluids, PCMs, ionic liquids, and graphene-based fluids are reshaping the landscape of thermal management technology. These developments hold the promise of enhancing battery life, improving performance, and ensuring the safety of EVs in a wide range of environmental conditions.

To fully realize the potential of these innovations, further research, testing, and standardization are required. As the field of thermal management fluids evolves, it will play a crucial role in shaping the future of electric vehicle technology.

9. References

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