Electrolyte Formulation Process

APPLICATION PAPER

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Introduction

The Electric Vehicle (EV) market is undergoing a revolution, transforming the transportation landscape through the use of Lithium-Ion battery (LiB) technology.

The demand for electric vehicles is projected to reach 44% of global passenger vehicle sales by 2030 and 75% by 2040. To meet this challenge, the quality of LiB construction materials including cathode active material, anode active material, electrolyte, separator, and others, must adhere to established specifications.

Electrolyte

The electrolyte in lithium-ion batteries is fundamental to enabling the flow of current between the cathode and anode, facilitating the electrochemical reactions that store and release energy. This paper explores the critical role of filtration in the electrolyte formulation process, emphasizing its importance in achieving high ionic conductivity, chemical and electrochemical stability, and overall battery performance.

The electrolyte typically comprises lithium salts (e.g., LiPF6) in organic solvents, such as ethylene carbonate (EC), dimethyl carbonate (DMC), diethyl carbonate (DEC), or ethyl methyl carbonate (EMC), along with additives (e.g., vinylene carbonate (VC)). The percentage distribution of lithium salts, organic solvents, and additives is generally around 10%, approximately 85-90%, and the balance, respectively.

These salts may not completely dissolve in the solvents. To maximize the performance of the electrolyte—i.e., achieve high ionic conductivity and high chemical/electrochemical stability—solid particles must be minimized. Since the composition of electrolytes varies considerably among battery cell manufacturers, the appropriate filter needs to be determined in each case.

Electrolyte Formulation Process & Importance of Filtration

The electrolyte formulation process involves several key steps, each requiring precise control to maintain the purity and stability of the final product. The electrolyte processing diagram is shown in Figure 1.

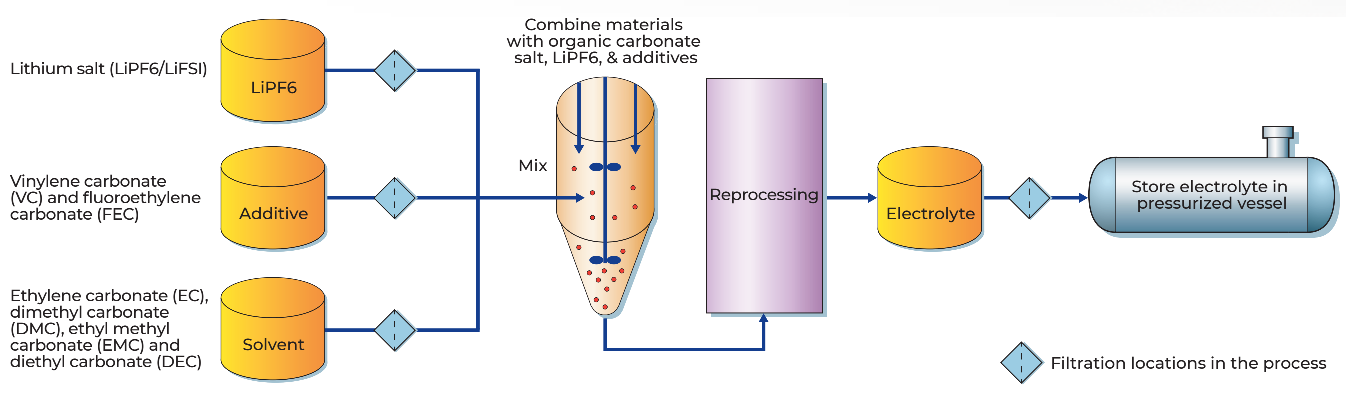

Figure 1: *Electrolyte Formulation process diagram*

Removal of Particles from Raw Materials

The primary components of the electrolyte include lithium salts, such as lithium hexafluorophosphate ($LiPF_6$), dissolved in organic carbonate solvents like ethylene carbonate (EC) or dimethyl carbonate (DMC).

Filtration is necessary to remove particles from each ingredient before the mixing process to maintain the purity of raw materials. Lithium salts and organic carbonate solutions, such as ethylene carbonate or dimethyl carbonate, must be pure to enable ionic conductivity, chemical and electrochemical stability, and thermal stability.

Maintaining Electrolyte Cleanliness

The cleanliness of the electrolyte is vital for efficient ion transfer between the anode and cathode. Any particulate matter in the electrolyte can impede ion flow, reducing the battery's performance and efficiency. Filtration before storage ensures that the electrolyte remains free from particles that could interfere with its function.

Ensuring Chemical Stability

Filtration helps remove contaminants that could react with electrolyte components. For example, moisture can lead to the formation of hydrofluoric acid (HF) from fluoride lithium salts, which is highly corrosive and can damage internal battery components. Preventing moisture contamination is thus critical.

Filtration Materials and Technologies

Given the electrolyte's high acidity, filtration materials must be chemically resistant. Fluoropolymer-coated stainless steel filter vessels are recommended to withstand the corrosive nature of the electrolyte. Achieving high cleanliness levels requires very fine particulate removal filters, with ratings ranging from 0.45µm to 2µm.

Different filtration technologies and configurations are employed depending on processing line requirements. Advanced filtration solutions, such as those offered by Pall Corporation, are designed to minimize the total cost of ownership while ensuring the highest levels of purity and stability.

Conclusion

Filtration is a vital component of the electrolyte formulation process for lithium-ion batteries. By removing solid particles and impurities, filtration enhances the electrolyte's ionic conductivity, chemical stability, and overall performance. The use of chemically resistant materials and advanced filtration technologies underscores the importance of maintaining high cleanliness and purity standards. As the demand for high-performance lithium-ion batteries grows, the role of filtration in electrolyte processing becomes increasingly significant, highlighting its critical contribution to advancing battery technology.

EV Battery Value Chain

The various stages in the electric vehicle (EV) battery value chain, shown in Figure 2, highlight the crucial roles of filtration and separation in achieving yield, purity, and reliability goals. This includes lithium refining, battery cell manufacturing, recycling, and the production of battery active materials. Active materials require the treatment of chemicals and polymers to create essential components like the separator, electrolyte, and anode/cathode.

Pall Corporation, with over 400 experienced engineers and scientists, is your partner for filtration and separation needs throughout the EV battery value chain. Services include prototype testing, on-site pilot testing, best practice training, process optimization, audits, contaminant analysis, application troubleshooting, validation services, and presentations at scientific forums.

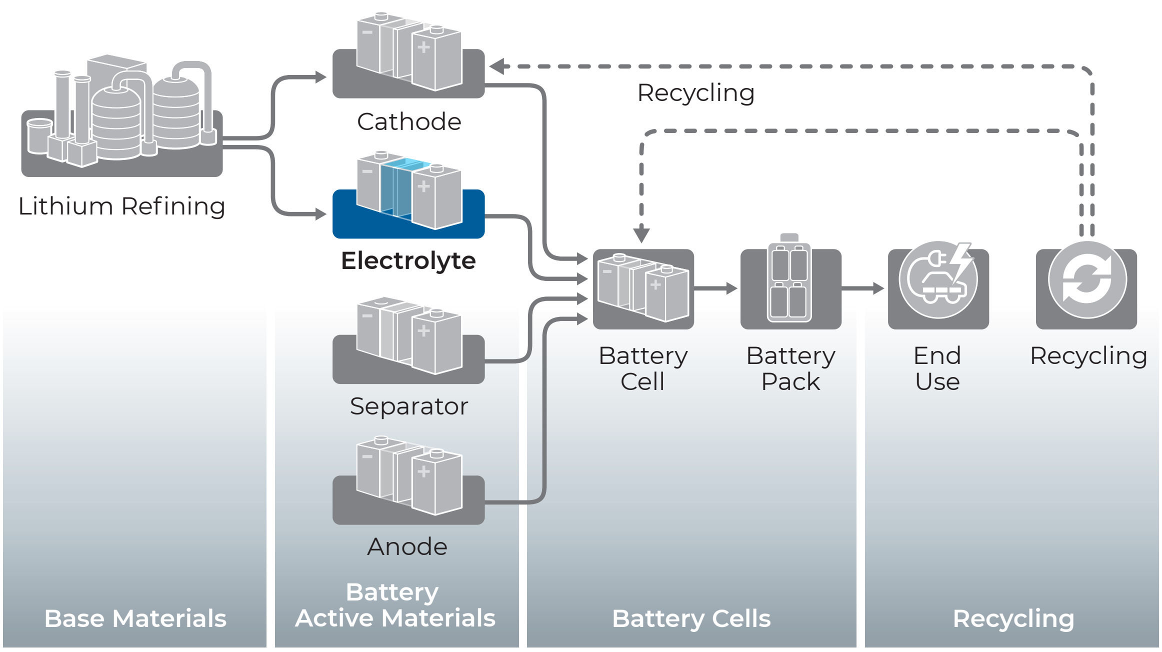

Figure 2: Applications in the EV Battery Value Chain

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References

1. *Bloomberg New Energy Finance, "Electric Vehicle Outlook 2023", Bloomberg NEF, New York, 2023 https://about.bnef.com https://about.bnef.com electric-vehicles-outlook/*

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