Design of a Dissolution and Filtration System for Fast Dissolution in a Solvent-Based Plastic Recycling System

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Abstract:

The Solvent Targeted Recovery and Precipitation (STRAP) process is an innovative solvent-based recycling technology designed for the selective recovery of polymers from mixed plastic waste. STRAP operates by dissolving a specific polymer in a solvent system where the targeted polymer is soluble while other polymers remain undissolved. The dissolved polymer is then separated from the undissolved materials through mechanical filtration and recovered via precipitation by altering the system temperature. We have developed a 25 kg/hr STRAP Pilot-Scale Unit (PSU) to demonstrate the scalability and efficiency of this process. The PSU comprises several critical components: (i) solid material conveying and dosing systems; (ii) a dissolution vessel; (iii) centrifugal and candle filters; (iv) a precipitator; (v) an outgassing extruder; (vi) a solid material dryer; (vii) a solvent recovery system; (viii) oil heating and water-cooling systems; and (ix) a nitrogen generator. The core functionalities of the PSU are centered around the dissolution vessel and centrifugal filter. Our unique dissolution process implements high-shear mixing using propellers rotating at 1700 rpm, coupled with wall baffles in the vessel to induce high intensity turbulent flow, for enhanced dissolution. The non-dissolved solid is separated from the hot resin solution by a centrifugal sifter, which employs a screw conveyor to transfer the solid-liquid mixture into a steel screen and axial brushes section, rotating at 800–1700 rpm, ensuring efficient filtration and low solvent content in the solid material. The dissolved polymer solution is centrifugally expelled through the screen, while undissolved residues are conveyed axially by

paddles to the outlet. Extensive testing and iterative design improvements have optimized the system's performance, achieving dissolution times of <30 seconds and complete separation of solution and undissolved solids in <3 minutes. These advancements enable high operational efficiency, making the STRAP PSU a critical step toward scaling the technology for industrial applications. The data generated provides essential insights for future upscaling efforts, positioning STRAP as a viable solution for enhancing polymer recycling and supporting a circular economy.