

Advanced Recycling Pathways for Composite Multilayer Packaging Waste: Implications for Resource Recovery and Circular Economy

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ABSTRACT

Composite multilayer packaging waste is difficult to recycle due to its complex combination of polymer and barrier layers. This study investigates advanced recycling pathways, focusing on solvent-based separation technologies that enable recovery of high-purity polymers from multilayer structures. These approaches offer promising opportunities to improve resource recovery, reduce landfill dependence, and support circular economy strategies for plastic packaging waste management.

INTRODUCTION

- Multilayer packaging provides excellent barrier properties but is difficult to recycle.
- Conventional recycling methods cannot separate bonded polymer layers.
- Increasing consumption of flexible packaging creates growing waste challenges.
- Advanced recycling technologies may enable recovery of valuable materials.

METHODOLOGY

- Review of experimental and pilot-scale studies on multilayer packaging recycling
- Analysis of solvent-based selective dissolution and precipitation processes
- Evaluation of polymer recovery efficiency and recyclate quality
- Assessment of operational parameters, including solvent selection and feedstock variability

DISCUSSION

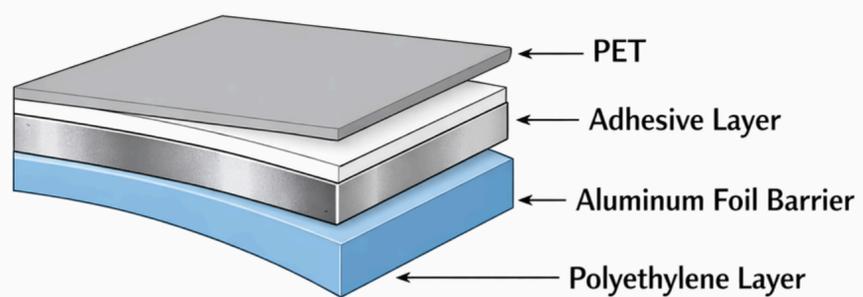
Solvent-based recycling technologies demonstrate strong potential for separating multilayer polymer structures while preserving material quality. However, their performance depends on several operational factors including feedstock contamination, solvent recovery efficiency, and energy demand. Integration with effective collection and pre-sorting systems is essential for ensuring stable process performance.

RESULT

- High-purity polymer recovery achievable through selective dissolution processes
- Near-complete separation of multilayer structures demonstrated in experimental studies
- Improved resource efficiency compared with landfill disposal or incineration
- Recovered polymers suitable for reuse in value-added applications

CONCLUSION

Solvent-based recycling provides an effective pathway for recovering polymers from complex multilayer packaging waste that cannot be processed through conventional recycling. When integrated with proper waste collection and sorting systems, these technologies can significantly enhance resource recovery and support circular economy strategies.



Cross-section of multilayer plastic packaging

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INTRODUCTION

Biodegradable waste forms a large share of municipal solid waste. When disposed of in landfills, it contributes to greenhouse gas emissions and loss of valuable nutrients. Composting offers a sustainable treatment option by converting organic waste into useful soil amendments.

Assessing the performance of municipal composting systems is essential for improving waste diversion and supporting circular economy strategies in emerging urban waste-management systems.

METHODOLOGY

Research Approach

Assessment of centralized municipal composting systems and their operational performance.

Data Collection :

Observations from composting facilities combined with literature analysis.

Data Analysis

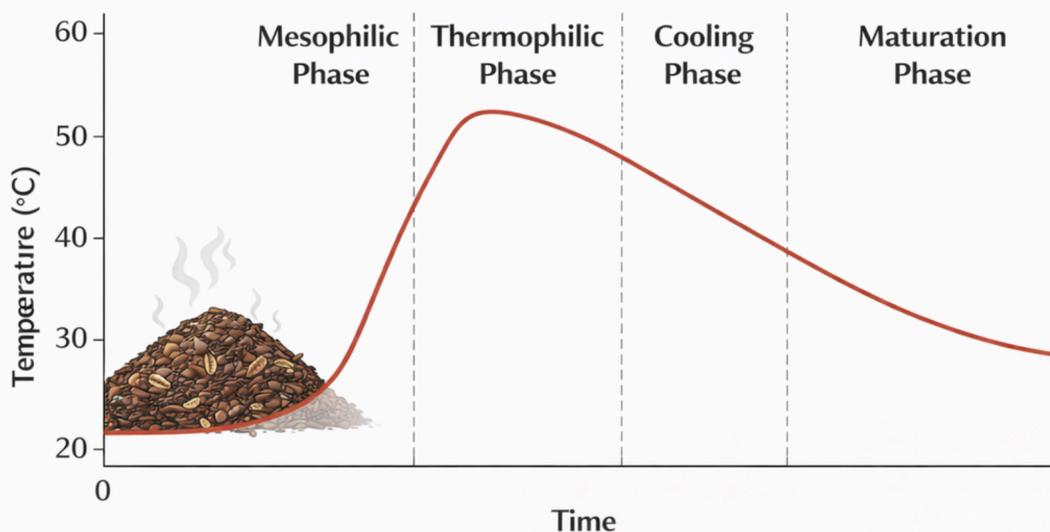
Evaluation of key process indicators including temperature evolution, stabilization dynamics, and compost maturity.

RESULT

- Thermophilic temperatures enable effective biodegradation and sanitation.
- Proper aeration and moisture control support microbial activity and process stability.
- Feedstock variability and contamination affect compost quality.
- Stabilized compost can be produced when proper process control is applied.

CONCLUSION

Municipal composting provides a low-carbon alternative to landfill disposal for biodegradable waste. When supported by effective source separation and process control, composting can produce valuable soil amendments while contributing to waste diversion and circular resource use.



Temperature Phases in Composting Process