Abstract

Process Economics Program Report 115D

BIODEGRADABLE POLYMER LIFE CYCLE ASSESSMENT

(December 2001)

SRI's Process Economics Program (PEP) was commissioned by its clients in 2000 to undertake a life cycle assessment (LCA) for the purpose of comparing a biodegradable polymer with a conventional commodity polymer in packaging applications. Biodegradable polymers offer the potential of addressing a range of environmental concerns associated with conventional polymers such as greenhouse gas emissions and sustainability. LCA is a tool specifically developed for assessing the overall environmental burden of a product and the system employed for manufacturing it. This report provides a cradle to grave LCA comparison of two polymers that may be used in food packaging applications:

- Polylactide (PLA) is a biodegradable polymer derived from corn. Fertilizer and herbicide production and corn farming serve as the initial subsystems. Corn is wet milled to obtain dextrose, the fermentation substrate for lactic acid. PLA is made from lactic acid with a solventless polymerization process. PLA may be thermoformed into food packaging that is compostable, but is more likely to be disposed by landfill in the United States.
- Polypropylene (PP) is derived primarily from natural gas in the United States. Natural gas liquids are recovered from above ground natural gas facilities and serve as the feedstock to steam cracking to make ethylene and propylene. The monomers are gas phase polymerized into PP. The polymer may be thermoformed into food packaging that is typically landfilled or incinerated after use.

In this report, PEP presents an inventory analysis of the PLA and PP systems including fuel use for processing and transportation. We also provide an impact assessment focused on global warming, the most important global environmental issue today. The following important conclusions are reached:

- PLA is a more energy efficient polymer than PP for a food packaging application such as a thermoformed yoghurt cup. However, the difference between the two systems becomes marginalized when the uncertainties of the estimates are considered.
- PLA and PP greenhouse gas emissions are equivalent when the effects of carbon sequestration in a landfill are taken into consideration. Uncertainties regarding PLA biodegradation in a landfill can greatly impact estimates of greenhouse gas emissions.
- While measured field or facility data are preferred for a rigorous LCA, PEP data can provide a reasonable basis when measured data is unavailable. Energy inventories and greenhouse gas emissions are readily derived from PEP data, but other potentially relevant impact indicators are not.

This report is useful as a transparent analysis of many of the energy and environmental issues associated both with biodegradable and conventional polymers. It also provides a detailed description of LCA methodologies and of the industry status of biodegradable polymers. The Appendix contains flow diagrams and material balances from the six PEP Reports that serve as the basis of the process data used in this study.

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