Green chemistry
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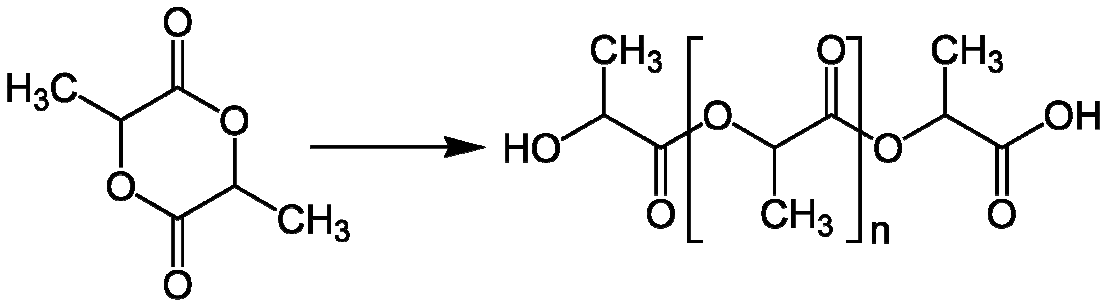
Polymerization of lactide to polylactide

Name of the chemical process in industry:

Polymerization of lactide to polylactide



Catalytic and thermolytic ring-opening polymerization of lactide (left) to polylactide (right)

Applications:

Tea bags are made of polylactide (PLA). polylactic acid
Peppermint tea is enclosed.

Mulch film made of

Biodegradable plastic cups in use at an eatery

There are 12 principle in green chemistry:

1. Prevention
2. Atom economy
3. Less hazardous synthesis
4. Deigning safer chemical
5. Safer auxiliary substance
6. Energy efficiency
7. Use of renewable resource
8. Reducing derivatives
9. Catalysis
10. Design for degradation
11. Use of real time analysis for pollution prevention
12. Accident prevention

1.Prevention

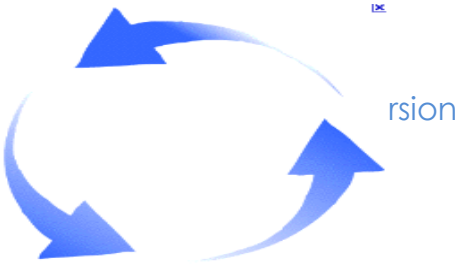
No waste generation.
It prevents the use of traditional method to produce plastic from fossil fuels and hence reduces the greenhouse gas generated during the production processs.

Lowering the use of petroleum generated

Reducing the greenhouse gas

2.Atom economy

Typical conditions for polymerization are 180 °C to 210 °C, tin octoate (catalyst)concentrations of 100-1000 ppm, and 2-5 hour to reach 95%



Now, through the use of a metabolically engineered strain of E.coli, the team , have developed a one-stage process which produces polylactic acid and its copolymers through direct fermentation. This makes the renewable production of PLA
and lactate-containing copolymers cheaper and more commercially viable.

3. Less hazardous synthesis

Using renewable resources for the polymerization, such as corn starch, tapioca products (roots, chips or starch) or sugarcanes. Less or even no hazardous produc

4. Deigning safer chemical

Poly(lactic acid) or **polylactide** (**PLA**) is a thermoplastic aliphatic polyester derived from renewable resources, such as corn starch, tapioca products (roots, chips or starch) or sugarcanes.

corn starch

tapioca products

sugarcanes

5. Safer auxiliary substance

The NatureWorks PLA process substitutes renewable materials for petroleum feedstocks, doesn't require the use of hazardous organic solvents typical in other PLA processes, and results in a high-quality polymer that is recyclable and compostable.

No hazardous organic solvents

6.Energy efficiency

Typical conditions for polymerization are 180 °C to 210 °C, tin octoate (catalyst)concentrations of 100-1000 ppm, and 2-5 hour to reach 95% conversion.

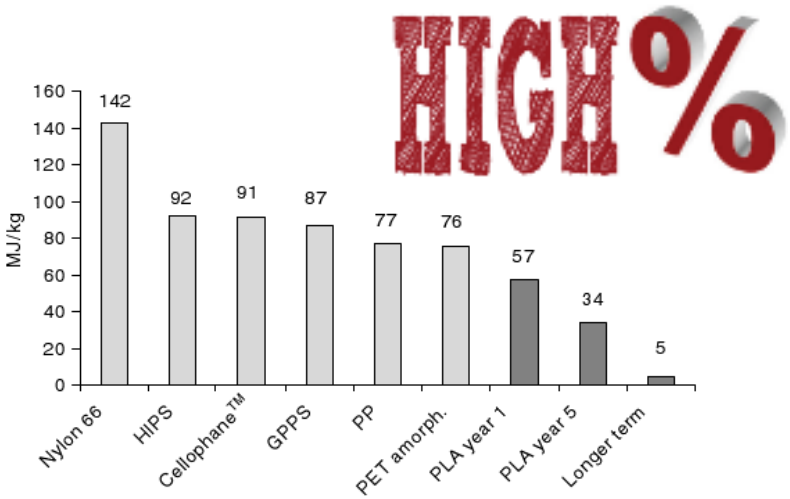


FIGURE 16.4
MJ/kg of energy required to produce various polymers (From Gruber, P., Keynote address, Massachusetts Green Chemistry Symposium, Amherst, MA, 2001. With permission.)

7. Use of renewable resource

Poly(lactic acid) or **polylactide** (**PLA**) is a thermoplastic aliphatic polyester derived from renewable resources, such as corn starch, tapioca products (roots, chips or starch) or sugarcanes.

corn starch

tapioca product

sugarcanes

8. Reducing derivatives

PLA of high molecular weight is produced from the dilactate ester by ring-opening polymerization using most commonly a stannous octoate catalyst, but for laboratory demonstrations tin(II) chloride is often employed. This mechanism does not generate additional water, and olecular weights is accessible.

No generation of water

9. Catalysis

Lactic acid is produced by fermenting corn and converted to lactide, the cyclic dimer ester of lactic acid using an efficient, tin-catalyzed cyclization.

Ring-opening polymerization catalyst: stannous octoate

Laboratory demonstrations catalyst: tin(II) chloride

10. Design for degradation

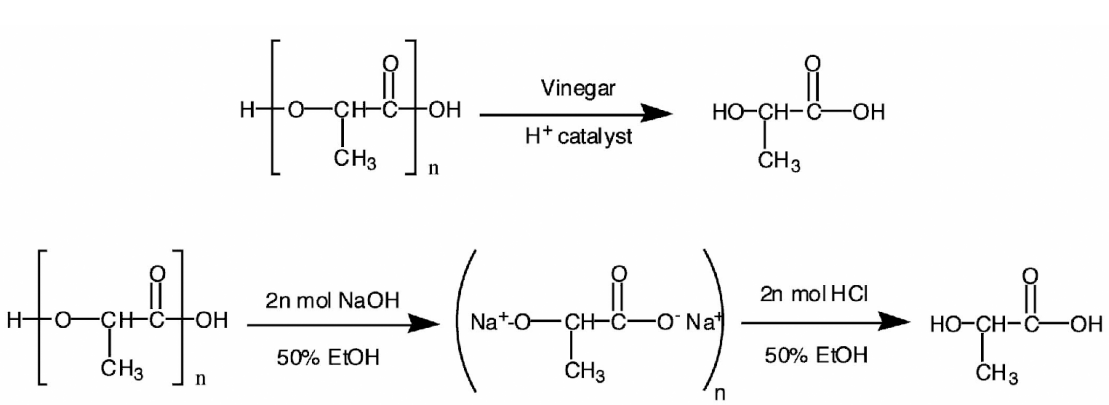
It can biodegrade under certain conditions, such as the presence of oxygen.

Through thermal depolymerization, a highly purified lactic acid is extracted and can be considered as raw material for the manufacturing of virgin PLA with no loss of original properties..

Because it is biodegradable, it can also be employed in the preparation of bioplastic, useful for producing loose-fill packaging, compost bags, food packaging, and disposable tableware.

PLA also has many potential uses, for example as upholstery, disposable garments, awnings, feminine hygiene products, and diapers.

PLA shares a similar molecular bonding structure to that of lipids or fats, which are routinely broken via acidic or basic hydrolysis



11. Use of real time analysis for pollution prevention

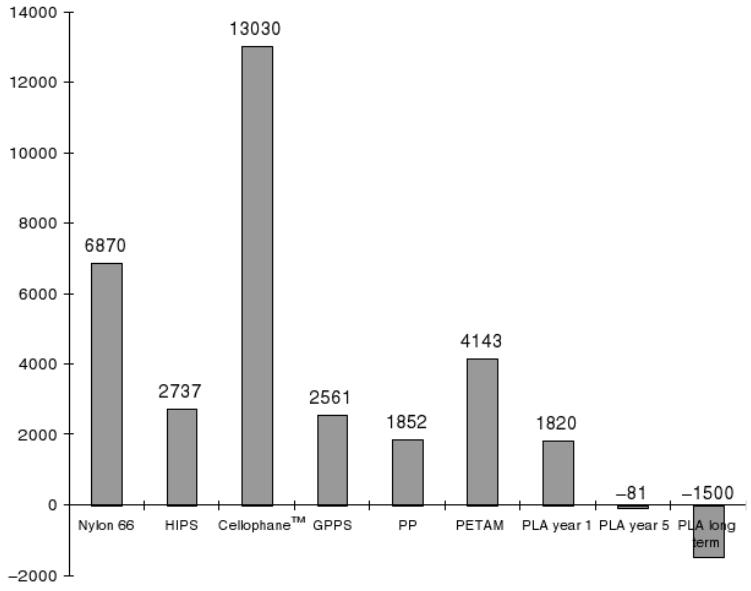


FIGURE 16.5
Greenhouse gas emissions (kg/ton) for production of various polymers. Long-term emissions for PLA are based on utilization of biomass for the production of lactic acid.

Th er
be balanced by an equal amount taken from the atmosphere during the growth of plant feedstock.
Longer term, as PLA is produced from field wastes or other biomass, PLA can become a CO_2 sink and actually contribute to a net reduction in greenhouse gases.

12. Accident prevention

Aliphatic polyesters can be assembled from lactones under very mild conditions, catalyzed anionically, cationically or metallorganically.

Source:

Google + Wikipedia

useful website:

Google: <<Polylactic acid technology>>
http://docs.google.com/viewer?a=v&q=cache:n_k_SyTXtQoJ:www.jimluntllc.com/pdfs/polylactic_acid_technology.pdf+Polymerization+of+lactide+to+polylactide+less+hazard+synthesis&hl=zh-TW&gl=hk&pid=bl&srcid=ADGEEShhpnEYr_9LU3yESezJVIv5F2Dah3Lj_HzSIu2Z1E43I9564xspkQvKeVDrs9SDdJOdR69SAxKbHij_5O-yqnjoR-HFHEbqsXOWTA-sY_iqj44Pd7w_cZ3QIKDB3rS8f-ccbcZn&sig=AHIEtbQXB4nMrkC27WhZwj3LP7pCjNGTUQ

Wikipedia: <<polylactic acid>>
http://en.wikipedia.org/wiki/Polylactic_acid#See_also

Wikipedia: <<Green chemistry>>
http://en.wikipedia.org/wiki/Green_chemistry