Polyhydroxyalkanoates in the Circular Economy

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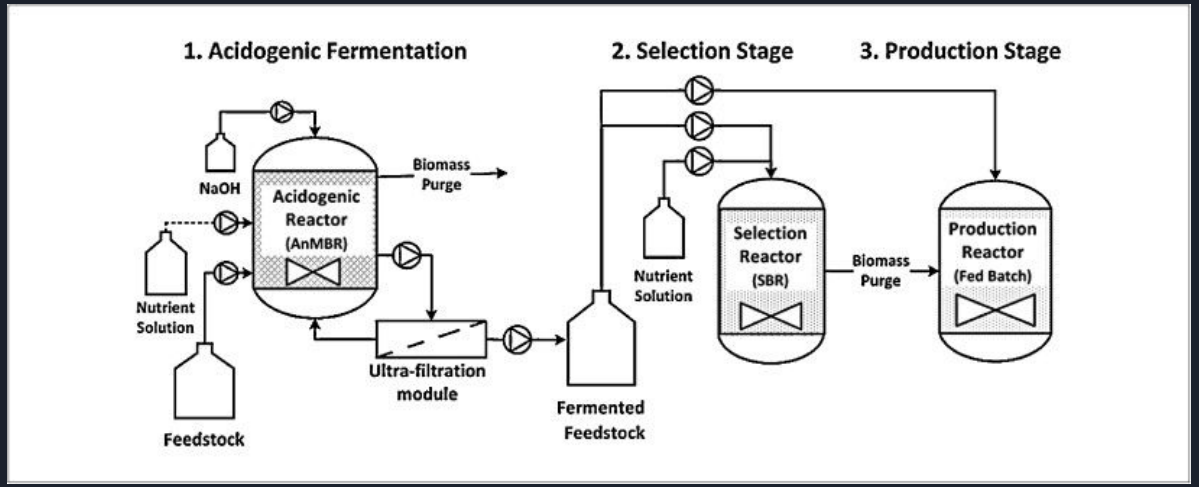
Brief History of Biopolymers

- 1800s- The first plastics were actually made from natural polymers or biopolymers
  - Natural Polymers
    - Rubber gum, Rayon
  - Biopolymers
    - Celluloid, Shellac, Casein
- Early 1900s - The first completely synthetic resin, Bakelite, was invented, launching the world of plastics into what we know now
- Recently - The goal of biopolymers is to create a polymer that is comparable to synthetic materials, 100% non-toxic biodegradation, inexpensive, renewable, and doesn't require additives or has non-toxic, biodegradable additives.
  - Polyhydroxyalkanoates (PHA), Polylactic acid (PLA), starches, Collagen

PHA Production

Production

- Production is more environmentally friendly than polymers made from crude oil
- Produced from many different types of bacteria, so there may be certain bacterial strains that work better for various circumstances
- Since PHA is produced from sugars or fats, waste oils or waste sugars can be used



PHA Disposal

Disposal

- PHA can decompose on its own through the work of other bacteria and fungi when in right temperature and humidity conditions
- Can decompose through aerobic conditions or anaerobic condition
    - Aerobic conditions will breakdown PHA into water, carbon dioxide, and biomass
    - Anaerobic conditions will breakdown PHA into carbon dioxide and methane
- Can be composted in industrial composting, home composting, environmental (littering) composting, or even landfills
- Can be recycled but this isn't the main focus for PHA

PHA Uses

- Physical properties of PHA are very similar to those of petroleum based polymers
- Since it can biodegrade, the best uses would be for single use plastics, things that are typically found as litter, things you use in the environment, additives or filler in cosmetics, etc.

Issues with PHA

- There is a high cost with PHA production
  - Downstream processing is one of the bigger costs
  - Carbon sources for the bacteria can be expensive
  - Maintaining the fermentation processes can lead to high costs

- PHA has a very narrow thermal processing window
  - Conventional polymer processing equipment cannot be used with PHA
  - May be issues with excessively fast biodegradation of PHA that has had thermal degradation during processing

- PHA needs to be used with biodegradable additives
  - If environmentally toxic additives are used, then the product can't be composted

PHA in the Future

PHA holds incredible potential as a biodegradable alternative to conventional plastics, but high production costs stand in the way of their widespread use. With dedicated research into more efficient production methods and innovative technologies, we can unlock PHA's full potential for single use plastics or plastics typically found as litter. Governments have a powerful role to play by funding cutting-edge research and offering incentives that encourage companies to embrace this sustainable material. By investing in PHA, we take a bold step toward a cleaner, greener future—one where eco-friendly materials lead the charge in reshaping our world for the better.

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