Biodegradable Plastics Production from Palm Oil Mill Effluent (POME)

PhD-student: Mohd Fadhil, M.D, M.Eng (Environ.)
phone +31 15 278 1551, e-mail: fadhil@tnw.tudelft.nl
Promotors: Prof.dr.ir. Zaini Ujang (UTM - Malaysia)
Prof.dr.ir. Mark C.M. van Loosdrecht (TU Delft –The Netherlands)
Institutes: Delft University of Technology, Department of Biotechnology, Environmental Biotechnology group
University Technology of Malaysia, Department of Environmental Engineering

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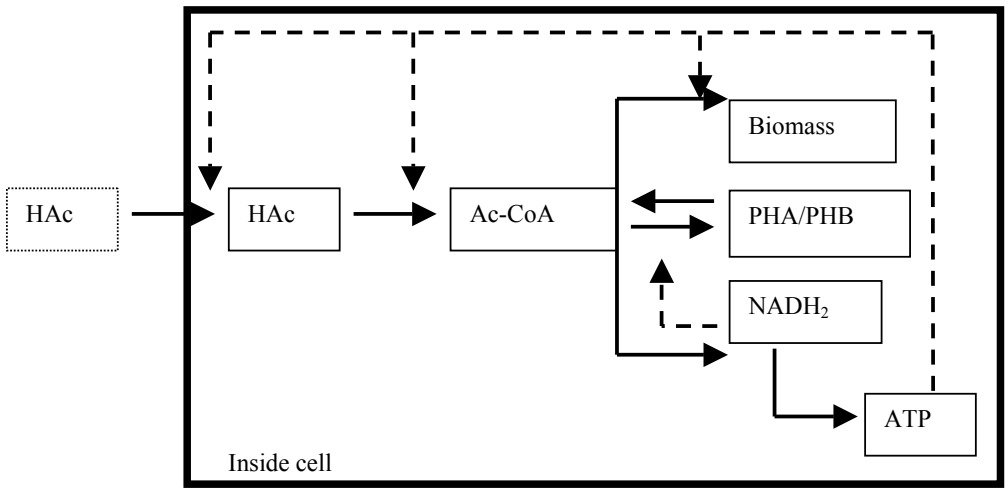
Description

Industrial producers are currently working towards decreasing the cost price of biopolymers by increasing the volumetric production capacity of fermentor systems and improving process technology. The major costs in the production of bioplastics (Polyhydroxyalkanoates, PHA) are determined by the cost of substrate (molasses, glucose and propionate) and extraction of the polymer from the cells (Purushothaman *et al.,* 2001). Therefore, the cost of production can be reduced if lower quality substrates are used. In most activated sludge processes, the biomass grows under transient (unsteady, dynamic) conditions, even when the overall process can be considered to be in steady-state conditions (Van Loosdrecht et al., 1997). Based on the literature, there is the general belief that, under conditions in which microbial growth is limited by some factor (e.g. low nutrient essentials) other than carbon and energy sources, accumulation of reserve material (e.g. PHA) is most likely to occur. The whole mechanism of feast (external carbon present) and famine (all external carbon consumed) regime, enables the bacteria to maintain their growth at a more or less constant, or balanced, rate and efficiently compete for substrate under dynamic substrate supply (Van Loosdrecht et al., 1997, Beun *et al*., 2000). A metabolic model (describing the conversion and reaction), which has been proposed by Van-Aalst-van Leeuwen et al. (1997), is shown in the figure below.



Schematic representation of the metabolism of an organism producing and consuming PHB (adapted from Beun et al., 2000)

To reduce the cost price significantly, we choose palm oil mill effluent (POME) as main substrates (renewable sources). POME is an organic wastewater from palm oil industry and has a high carbon content (BOD higher than 20 g/L) with low nitrogen content (less than 0.2 g/L ammoniacal-nitrogen and less than 0.5 g/L total nitrogen) (Ma *et al*., 2001). Moreover, because it contains high organic content and almost being non-toxic, POME could be suitable for PHA production. Besides, the production of effluent from mill always contributes an environmental problem (e.g. biogas) and produces 25 million tonnes per year of COD (Ma *et al*., 2001). To further reduce the costs we are using mixed cultures for production of bioplastics from POME as a cheap renewable carbon.

On the left side brunches of palm fruit ready for the processing (oil manufacturing), on the right side the effluent pond of a Palm Oil Mill.

References

Beun J.J., F. Paletta, M.C.M. van Loosdrecht and J.J. Heijnen (2000). Stoichiometry and kinetics of poly-beta-hydroxybutyrate metabolism in aerobic, slow growing, activated sludge cultures. In: Biotechnology and Bioengineering, 67, p. 379-389

Ma A.N., C.S. Chow, C.K. John, A. Ibrahim and Z. Isa (2001). Palm oil mill effluent – a survey. In: Proceeding PORIM regional workshop on palm oil mill technology and effluent treatment, p. 233-269. Palm Oil Research Institute of Malaysia (PORIM) Serdang, Malaysia

Purushothaman M., R.K.I. Anderson, S. Narayana and V.K. Jayaraman (2001). Industrial byproducts as cheaper medium components influencing the production of Polyhydroxyalkanoates (PHA) – Biodegradable Plastics. In: Bioprocess Biosystems Engineering, 24 (3), p. 131-136

Van Aalst-van Leeuwen M.A., M.A. Pot, M.C.M. van Loosdrecht and J.J. Heijnen (1997). Kinetic modeling of poly(beta-)hydroxybutyrate production and consumption by *Paraccus pantotrophus* under dynamic substrate supply. In: Biotechnology and Bioengineering, 55, p. 773-782

Van Loosdrecht, M.C.M., M.A. Pot and J.J. Heijnen (1997). Importance of microbial storage polymers in bioprocesses. In: Water Science and Technology 35, p. 41-47