

Biomass for biological hydrogen production

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Introduction

Hydrogen production from biomass offers the advantage of providing a renewable energy carrier for extensive reduction of the CO_2 emission. At Wageningen UR a process for biological hydrogen production consisting of 2 consecutive fermentations has been developed (Fig. 1). The specific merits of this bioprocess are production of pure hydrogen from wet biomass at small scale.

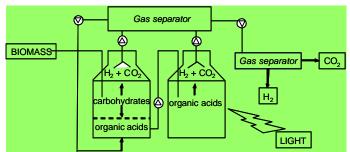


Fig. 1 Bioprocess for hydrogen production from biomass.

The first fermentation is done by thermophilic bacteria at 70 °C, the second by photoheterotrophic bacteria. Typical hydrogen concentrations in the dry off gases are 50% and >85%, respectively. The hydrogen in the off gas can be directly fed into a PEM fuel cell.

Application of biomass

Wageningen UR is coordinator of EU and Dutch projects in which several samples of biomass have been, successfully, tested (Fig. 2, <u>www.biohydrogen.nl</u>). Hydrogen production by thermophilic bacteria occurs freely on glucose, xylose, mixtures hereof, oligosaccharides and starch. Cellulose can be fermented to hydrogen with low conversion rates. For employing lignocellulosic biomass, research has also addressed pretreatment and hydrolysis. Extrusion and enzymatic hydrolysis have been employed to provide fermentable feedstock for the first fermentation. During fermentation by thermophilic bacteria, e.g. Caldicellulosiruptor saccharolyticus or Thermotoga spp., acetic acid and, to a much smaller extent, lactic acid are the by-products. Both acids are readily converted to hydrogen and CO_2 by photoheterotrophic bacteria such as Rhodobacter capsulatus, at ambient temperature in the light.



Fig. 2 Application of biomass for biological H₂ production.

H₂ production cost from potato steam peels

A conceptual design has been made for a H_2 production plant where potato steam peels at 800 kg/h are fermented to 57 kg H_2 /h. The required volume for a thermoreactor is 450 m³ and 12 ha for a tubular photoreactor.

Table 1. Estimation of hydrogen production cost using potato steam peels as biomass

	EURO/kg H_2
Equipment, maintenance, insurance,	2.01
overhead	
Personnel	0.17
Potato steam peels	0.68
Amylase, caustic etc.	0.11
Electricity kW	0.13
Total cost	3.10 ¹⁾

¹⁾ equivalent to 22 EURO/GJ H_2 .

Further research

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