

Biohydrogen R&D in the Netherlands

Hans Reith, secretary *Netherlands Biohydrogen Network*, c/o Energy research Centre of the Netherlands, Unit Biomass. P.O. Box 1, 1755 ZG Petten, The Netherlands. Tel. + 31-224-564371; e-mail: reith@ecn.nl



Bio-H₂ and -CH₄ R&D in the Netherlands

Biological H₂ production can make a substantial contribution to future renewable energy demand, e.g. for generating useful energy from biomass residues¹⁾. Current R&D in the Netherlands addresses all basic and applied aspects of biological H₂ production and H₂ end-use in fuel cells²⁾. In addition, there is a large body of expertise and R&D in the related field of CH₄ fermentation of organics, in which H₂ is an intermediate. Co-operation and knowledge exchange between these fields will clearly benefit bio-H₂ development, as well as the further development and improvement of CH₄ fermentation technology due to the close interaction of microbial H₂ and CH₄ metabolism and shared technological challenges. 'Green' CH₄ can be applied in the existing infrastructure, while renewable H₂ will be applied on a longer term due to the required technology adaptations³⁾. Bio- H₂ should remain the primary R&D focus in longer term development because of the advantages of H₂ as a clean, efficient and versatile energy carrier.

The Netherlands Biohydrogen Network: Participants and major fields of expertise and R&D

INSTITUTE	EXPERTISE/R&D
Universiteit van Amsterdam - Swammerdam Institute for Life Sciences Siem Albracht	hydrogenases: catalytic site and reaction mechanism
Delft University of Technology - Dept. of Biotechnology - Enzymology Fred Hagen	biochemistry and biotechnology of hyperthermophiles H ₂ production and storage
University of Nijmegen - Department of Microbiology Jan Keltjens	H ₂ and CH ₄ fermentations physiology + regulation of H ₂ and CH ₄ metabolism
University of Groningen - Biomolecular Sciences & Biotechnology Institute Theo Hansen	physiology of anoxygenic phototrophs
Wageningen University Laboratory of Microbiology Fons Stams, Ed van Niel	H ₂ production by extreme thermophiles biological watergas shift reaction
Wageningen University - Food & Bioprocess Engineering Rene H. Wijffels, Marcel Janssen	phototrophic H ₂ production photobioreactor development
Wageningen University - Environmental technology Grietje Zeeman	anaerobic treatment of waste water and solids effluent post treatment / gas purification
Agrotechnological Research Institute ATO - BU Renewable Resources Pieter Claassen, Truus de Vrije	feedstock pretreatment & hydrolysis thermophilic H ₂ fermentations & process development
TNO Environment, Energy & Process Innovation Johan van Groenestijn	feedstock pretreatment / process & reactor development gas separation and purification / effluent treatment
Lettinga Associates Foundation Jules van Lier	expertise centre for anaerobic treatment of organic wastes and waste water
Energy research Centre of the Netherlands ECN - Unit Biomass Hans Reith, Erik van Zessen	photobioreactor development
Energy research Centre of the Netherlands ECN - Unit Clean fossil fuels Arend de Groot	infrastructural integration of H ₂ production systems stationary and mobile fuel cell systems (SOFC, PEMFC)

The Netherlands Biohydrogen Network

Researchers from 10 universities and R&D institutes participate in the *Netherlands Biohydrogen Network*. The objectives of the *Network* are:

- to promote (inter)national knowledge exchange and R&D co-operation (IEA);
- to provide information and expertise for government & the market sector.

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R&D challenges & opportunities

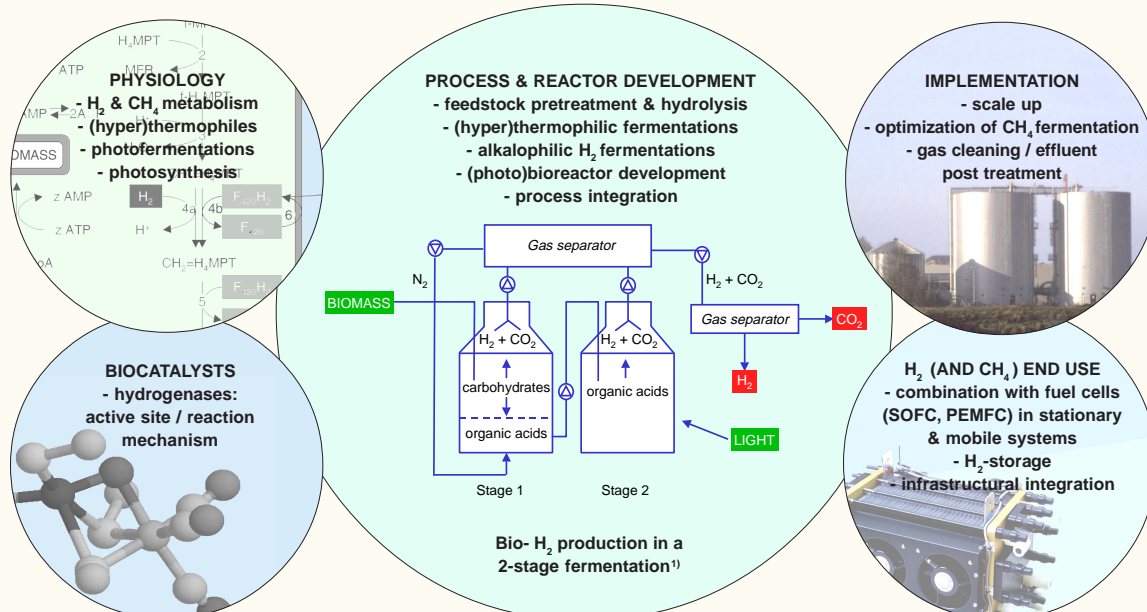
- development of efficient technology for feedstock pretreatment and hydrolysis; sub-optimal hydrolysis currently poses a major bottleneck for high H₂ (and CH₄) production rates and yields
- development of effective H₂-stripping technology from fermentation broths; low H₂ partial pressure strongly enhances the H₂ production rate
- exploration of hyperthermophiles for novel, thermostable enzymes
- alkalophilic H₂ fermentations (favourable thermodynamics)
- hybrid systems: integration of hydrogenases (or biomimetic analogs) as a Pt replacement in fuel cell electrodes
- optimization of CH₄ fermentation technology
- combination of fermentation processes and fuel cell technology

Accelerating factors for development

- increased co-operation of life sciences and bioprocess engineering;
- integration of commercial waste processing and energy production; large amounts of 'bio-energy' remain unused e.g. in composting
- fiscal stimulation of 'green' fuel and electricity production
- programmatic R&D funding

Future activities of the Network

- publication of essays (2002) on the status and perspectives of biological H₂ and CH₄ production and their integration in the energy infrastructure²⁾
- construction of a website on the Internet Bio-H₂ platform www.biohydrogen.nl offering publications, links and other information
- design and co-ordination of bio-H₂ R&D projects and programmes



References

1. P.A.M. Claassen, J.W. van Groenestijn, A.J.H. Janssen, E.W.J. van Niel and R.H. Wijffels. Feasibility of biological hydrogen production from biomass for utilization in fuel cells. In: *Proceedings of the 1st World Conference and Exhibition on Biomass for Energy and Industry, Sevilla Spain, 5-9 June 2000*
2. Survey of R&D and expertise on biological H₂ and -CH₄ production in the Netherlands / Status and perspectives

of biological H₂ and CH₄ production and their integration in the future energy infrastructure' To be published. Novem project no. 249.402-0180

3. *Proceedings of Workshop Biological H₂ Production*, October 4th, 2001. Novem, Utrecht, The Netherlands (in Dutch).