FERMENTATION OF BIOMASS-DERIVED SYNGAS TO ETHANOL AND ACETATE BY *Clostridium ljungdahlii*

J. ORTIGUEIRA[1], F. PINTO[1], F. GÍRIO[1] and P. MOURA[1,2,*]

[1] LNEG - National Laboratory of Energy and Geology, Bioenergy Unit, Estrada do Paço do Lumiar 22 - 1649-038, Lisbon, Portugal

[2] CiiEM - Center for Interdisciplinary Research Egas Moniz, ISCSEM, Quinta da Granja, Monte de Caparica, 2829 – 511, Caparica, Portugal

*Corresponding author: patricia.moura@lneg.pt, tel:+351 210924600, fax:+351 217163636

Abstract

In the biochemical pathway of lignocellulosics conversion into fuels, a significant portion of biomass cannot be hydrolysed to fermentable sugars and remains as waste substrate that, due to its recalcitrance, is not converted to ethanol by microorganisms. In terms of product yield, this residual biomass represents renewable feedstock that is being wasted, which contradicts the target of 100% feedstock utilisation. The gasification of this biomass constitutes an alternative to circumvent this problem, as the produced synthesis gas (syngas) can be used as substrate for microorganisms that are able to convert CO, CO_2 and H_2 into important bulk chemicals and biofuels, such as ethanol, acetate and butanol [1,2]. Thus, syngas fermentation to ethanol and acetate can be regarded as a possible process to increase the overall product yield from lignocellulosic feedstock.

Some advantages of fuels and chemicals production through syngas fermentation over metal catalyst conversion are the possibility of utilisation of the whole biomass regardless its quality, the independence of a fixed H_2:CO ratio for the bioconversion process, a higher specificity of the microbial biocatalyst over chemical catalysts, and the bioreactor operation at ambient conditions [3]. However, syngas fermentation also presents several limitations, such as low yields and poor solubility of the gaseous substrate in the liquid phase.

The objective of the present study was to evaluate *C. ljungdahlii* as microbial catalyst capable of fermenting syngas produced by gasification of spent solids obtained after lignocellulosic biomass saccharification and fermentation into ethanol. The heterotrophic and autotrophic growth of *C. ljungdahlii* were compared. Parameters such as bacterial growth, acetate and ethanol production, substrate consumption, and bioconversion yields were evaluated. In order to overcome the problem of gas diffusion in the liquid phase, fermentations were conducted at different total pressures.

References

[1] Henstra, A.M., Sipma, J., Rinzema, A., Stams A.J.M.: Microbiology of synthesis gas fermentation for biofuel production. Cur. Opinion Biotechnol. 18, 200-206 (2007)

[2] Köpke, M. *et al*.: *Clostridium ljungdahlii* represents a microbial production platform based on syngas. Proc. Nat. Acad. Sci. USA, 107, 13087-13092 (2010)

[3] Munasinghe, P.C., Khanal, S.K.: Biomass-derived syngas fermentation into biofuels: opportunities and challenges. Bioresource Technol. 101, 5013-5022 (2010)