BIOHYDROGEN PRODUCTION VIA STEAM REFORMING OF PYROLYSIS BIO-OIL

E. Mulu Fetene*, M. Troiano*, R. Solimene, P. Salatino***
elshadaymulu.fetene@unina.it
*Dipartimento di Ingegneria Chimica, dei Materiali e della Produzione Industriale, Università degli Studi di Napoli Federico II, P.le Tecchio 80, 80125 Napoli (Italy)
**Istituto di Scienze e Tecnologie per l'Energia e la Mobilità Sostenibili, Consiglio Nazionale delle Ricerche, P.le Tecchio 80, 80125 Napoli (Italy)

Abstract
Biohydrogen production from fast pyrolysis of biomass is becoming increasingly attractive as a convenient path to produce green hydrogen at affordable costs. Bio-oil can be converted to hydrogen via reforming or gasification processes. Catalytic steam reforming is the best alternative to produce high quality biohydrogen at lower reaction temperature. The combined fast-pyrolysis/steam reforming process for biohydrogen production is analyzed from a variety of perspectives.
Process layout. Two basic options may be considered, based on in-line or off-line combination of the pyrolytic and reforming stages. The in-line setup avoids using condensation and volatilization sections, a feature that makes this scheme cost-effective. Possible drawbacks are operational problems at the reforming stage due to contaminats associated with bio-oil. The off-line setup is characterized by remarkable flexibility as to the operational parameters of either conversion stages, and is better suited to hybrid delocalized/centralized biomass exploitation schemes. One further degree-of-freedom regards the choice of processing bio-oil as a whole, or selected fractions of it resulting from simple fractionation stages.
Design and operation of the steam reformer. Gas-solid fluidization is the reference technology for the design and operation of the steam reformer, due to the excellent thermal performance and multiphase contacting patterns of fluidized bed converters. However there are still some key issues to be addressed. Dispersion/mixing pattern of highly viscous and unstable bio-oil upon upon feeding to a fluidized bed may be problematic, and deserves better characterization and control. Moreover, effective contact between bio-oil vapours and the catalyst may be jeopardized by the aggregative behaviour of fluidized beds, especially in the bubbling fluidization regime. Careful reactor design and control of fluidization patterns is required to prevent gas phase segregation and inefficient vapour/catalyst contact.
Catalyst formulation. Bio-oils are characterized by complex and widely variable nature. Bio-oil components and specific contaminants may cause catalysts deactivation, hence loss of conversion and/or selectivity to biohydrogen. Catalyst formulation must be optimized with reference to the specific feedstock and process layout to ensure maximum productivity and stability.