COMPETITIVE HYDROGEN FROM AGRO-FORESTRY RESIDUES

New four step process, dealing with the tar problem

Project Description

The original process comprises four steps to arrive from humid biomass to nearly pure hydrogen. The proposed reduction will still give good added value. It is limited to the most innovative of the steps, skipping the first (drying and pelletising fresh biomass) and the last (steam shift of syngas to hydrogen), which are the steps with least technological risk.

It is expected that the development of the second step (carbonisation of the pellets) and the third step (steam reforming of the cabonised pellets) gives maximum added value, also because we intend to integrate them with each other. It will lead to results that can easily be combined with the first and last step (because to a good measure independent) to yield a process that can be implemented commercially.

The second and third step require the most research in order to define the best process parameters and to obtain an optimal energetic efficiency and the best composition of the syngas, with the least possible amount of impurities (resolving also the known tar problem for gasification).

The role of fund raising to implement the objectives of this reduced proposal within a complete (including first and last step) becomes important in order to guarantee a concrete impact of this project on the NIS countries and their relation to the EU. It is expected that investors will be found that are interested to realise a complete line, as the partners have been networking in the last years to obtain this

Scientific basis

In this project,

1. The process of converting a defined quality of pellets to syngas will be optimised;
2. A working prototype for about 5 kg/h syngas will be constructed (corresponding to 0.5 kg/hour of H2);
3. The technical (not executive) design for a ton bio-hydrogen/hour will be obtained;
4. Promotion will be made for a complete 4-step demonstration plant with external (non-INTAS) resources.

Objectives

The proposed process can compete with conventional hydrogen production (with natural gas or electrolysis). It is an alternative method of direct gasification because the process temperatures and the investments are lower, so that a reasonable efficiency and competitive technology is obtained.
A very important advantage over normal gasification, where tar is one of the biggest problems for a stable reaction, is that in this process, the contaminants remain in the carbonisation reactor, separated from the gasification. There they are a trivial problem (they disappear with the carbonisation exhaust and reused for heating the process), while the steam reforming receives a clean feedstock (charcoal).

The whole process includes the following steps (this reduced proposal skips steps 1 and 4):

1. (Biomass pelletisation with a new pelletiser process where no drying heat is needed);
2. Carbonization of the pellets by air at 280-550oC to increase concentration of carbon content in the solid stock;
3. Steam (H2O) gasification of the carbonized biomass is performed in the presence of gasification catalysts at 850-950oC in order to produce maximal yields of the wanted products such as CO and H2. This step will be integrated with step 2 into one reactor, in order to use the heat of that step;
4. (Shift-Conversion Process of bio-syngas to generate additional hydrogen. In this step we intend to apply new approaches to the Shift-process performance, namely, the catalytic reaction will be performed in a reactor with a controlled temperature profile and integrated with a reactor with regulated temperature).

The gaps to be filled in by this project:

- Optimisation of the carbonisation temperature, so that the temperature is high enough that the impurities disappear, but not so high that too much carbon disappears;
- The temperature and other conditions of the steam reforming so that an optimal composition of the syngas is obtained (leading to less costs for further hydrogen yield).

The integration between these two steps (in separate reactors), which will lead to higher efficiency.

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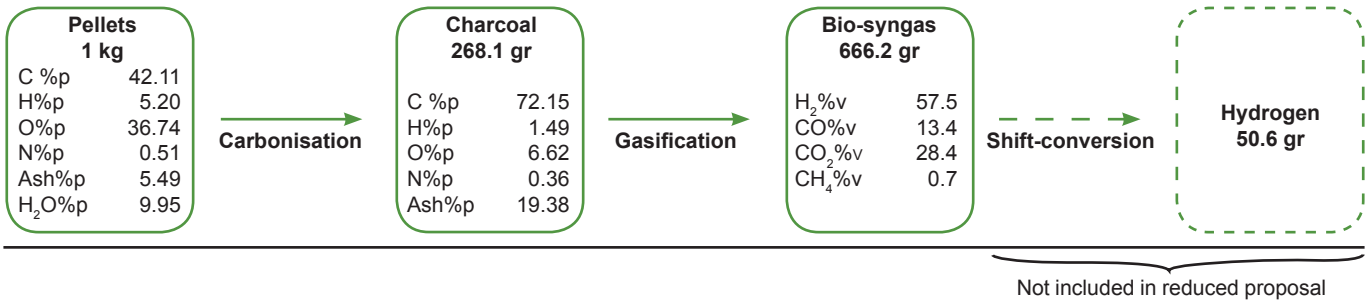
Expected results

Expected results can be deduced from preliminary trials carried out by the University of Sassari in a small laboratory apparatus that demonstrate the feasibility of the process to produce good bio-syngas from pellets obtained from a typical agricultural residuum (corn stocks). The results are summarised with the following experimental data:



On the basis of the results obtained in the bench-scale plant a preliminary design of a pilot plant for the treatment of 3 t/day of pellets will be elaborated. This is expected to be taken up by the partners and investers, to realise a complete plant (fresh biomass to hydrogen) where also step 1 and 4 are included.

Project Title

competitive hydrogen from agro-forestry residues

Contract Number

INTAS Ref. Nr 05-1000005-7745

Duration

1st January 2007 – 1st January 2009

Global Project Cost

80 000,00 Euro

European Commission Contribution

80 000,00 Euro

EUBIA Contribution

EUBIA is the general coordinator of the project from the administrative, legal and financial side and in charge to ensure the correct organization and cooperation between the partners and with the European Commission.

Bio SynGas Composition and H.H.V.

S.S. Bagasse Charcoal Steam Reforming (950°C - 1 BAR)

H_2	CO	CO_2	CH_4
52%	45%	2.7%	0.4%

H.H.V. = 12.47 MJ/Nm^3

Participants

1 European Biomass Industry Association (EUBIA), Belgium
2 Energia, Trasporti, Agricoltura S.r.l., ETA, Italy,
3 Luikov's Heat and Mass Transfer Institute, National Academy of Sciences of Belarus,
4 Boreskov Institute of Catalysis, Russia
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