Hydrogen generation from sugarcane bagasse by dry syngas reforming and downstream storage in fuel precursors

Motivation and Main Objective

Brazil is the biggest sugarcane producer in the world and each ton of sugar cane is accompanied by 0,28 t of bagasse and a similar amount of sugarcane straw. Sugarcane bagasse is usually burnt for the production of bioelectricity and steam, but its energetic potential is higher that the energy needed in the industrial process of sugar and ethanol production. In this project an alternative valorization of the sugarcane by-products is targeted. Furthermore, the feedstock can be increased, if for gasification and pyrolysis sugarcane straw is added which actually remains unused in the field. By realization of the process chain, the bunch of end products of sugarcane residues is increased by hydrogen and liquid fuel. Besides the biomass feedstock, which is highly relevant for Brazil, also the choice of catalysts for hydrodeoxygenation is proper to Brazil, as Nb_2O_5 is known to be a potential support for related catalytic reactions, and Brazil is the country with the worldwide highest niobium deposits. Though niobium is a rare element its costs is comparable to nickel, and the element is available for new applications. The use of hydrocarbon-based fossil fuels in the individual transport sector will be reduced significantly in the near future and partly be replace by electric mobility solutions. However, the importance of renewable hydrocarbons will remain in the area of aviation fuels and marine diesel.

Methodology and Planned Activities

The project partners IPT (Sao Paulo, Brazil) and KIT (Karlsruhe, Germany) are major public research institutes in their home countries and have long-term experience in energy research. Their expertise in gasification (IPT) and flash pyrolysis incl. hydrotreating of pyrolysis oil (KIT) are bundled in a new process chain: sugarcane residues are separated into 2 streams. As shown in Figure 1, one part is gasified in a fluidized bed reactor at IPT and then thermally reformed by the water–gas–shift and CO_2 reaction to increase the hydrogen yield. The second part of the sugarcane residue is first pyrolysed at KIT into pyrolysis oil which is then upgraded to fuel precursors with a higher energy content than the original pyrolysis oil. The products are 100 % renewably and suitable for further refining in commercial plants. The project is designed as an exchange project, in which young researchers from IPT work together with KIT specialists in the field of flash pyrolysis and hydrogenation / upgrading. On the other hand, a young researcher of KIT works together with specialists at IPT on the gasification of sugarcane bagasse and hydrogen generation by thermal reforming.

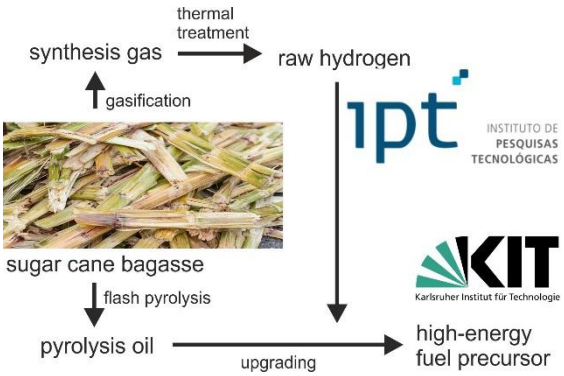

Figure 1. Design scheme for generating hydrogen and pyrolysis oil from sugarcane bagasse and downstream storage into fuel precursors

Intended Outcome

The project will extend the cooperation of Brazilian and German research institutions by working on a process chain which is linked to agriculture, hydrogen technology and fuel production. The parameters of

sugarcane bagasse thermal reforming into a hydrogen rich synthesis gas will be optimized by simplifications which make the process more economic. The application possibilities of this raw hydrogen quality will be proven for the use in the hydrodeoxygenation of sugarcane bagasse based pyrolysis oil. The reaction balance will be evaluated (feedstock and product composition, energy content) which is a necessary prerequisite for estimating the potential process economy. The process chain will be proven but will still need further investigation for implementation into agro-industrial applications.

Information	
Name of the project	Hydrogen generation from sugarcane bagasse by dry syngas reforming and downstream storage in fuel precursors
Part of	German-Brazilian Research Cooperation in the Energy Sector - NoPa 2.0/ Cooperation in the area of Green Hydrogen/PtX, Direct Electrification and Energy Storage
Project financed by	German Federal Ministry for Economic Cooperation and Development (BMZ)
Project Partners	Karlsruher Institut für Technologie – KIT and Institute for Technological Research – IPT
Duration	1st January 2023 to 31st December 2023

German-Brazilian Cooperation

The ”German-Brazilian research cooperation in the energy sector - NoPa 2.0” is a Cooperation in the fields of green hydrogen/PtX, direct electrification and energy storage between the German Academic Exchange Service (DAAD) and the projects H2Brasil and E2Brasil. Both projects are part of the German-Brazilian Cooperation for Sustainable Development and are implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the Brazilian Ministry of Mines and Energy (MME) with funding from the German Federal Ministry for Economic Cooperation and Development (BMZ).

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