FFW - Liquid and gas Fischer-Tropsch fuel production from olive industry waste: Fuel From Waste

PROJECT DESCRIPTION

Fossil fuels taken as a whole represent more than 85% of the world's primary energy sources. However the exploitation of these fuels is not without problems, considering their limited availability, also in geographical terms, changes in their price in function of various and unpredictable causes and, from the environmental point of view, the greenhouse gas emissions. At the same time, in the Mediterranean countries there is a large availability of residues, deriving from olive tree cultivation and oil production, which must be disposed of, representing a cost for farmers and producers.

The FFW project had the general objective of optimizing a process for the co-production of synthetic natural gas (SNG) and diesel starting from the residues of olive cultivation (pruning) and olive oil production (pomace) using the "Fischer-Tropsch" synthesis process. Fischer-Tropsch is a catalytic process by which a synthetic gas (syngas) stream, consisting mainly of CO and H2, can be converted into a mixture of gaseous, liquid and solid hydrocarbons.

The specific objectives of the project were:

a. Study the availability of the starting biomass in the major producing countries (pruning residues and residues from the oil extraction process);
b. Define the optimal physical and chemical requirements of the starting biomass;
c. Identify the most suitable technologies for the physical (mixing, drying, grinding, pelletizing) and chemical (gasification and purification of the syngas) pre-treatment of the starting biomass;
d. Define the economic and environmental impact of the process;
e. Evaluate the best combination for the production system and the best process conditions including type, composition and operating conditions of the catalyst/ catalysts to be used;
f. Test the technology on a pilot level;
g. Evaluate the performance of the entire system.

The expected results of the project are the following:

Environmental results: reduction of greenhouse gas emissions thanks to the use of biomass-based fuels; reduced impact of the oil production industry (waste treatment becomes part of the fuel production process).

Economic results: replace waste treatment with fuel production, with undoubted economic advantages. The new process can also lead to the creation of new jobs and the possibility of exporting the developed technologies.

PROJECT PHASES

The work plan was divided into seven workpackages (WP), each of which followed a logical phase in coherence with the project objectives. The main activities focused on the availability study of the biomass of interest in the olive and oil producing countries, on its physical and chemical pre-treatment and on the synthesis process (Fischer Tropsch and methanation). Moreover demonstration activities were implemented and the impacts of the proposed technologies were measured by Life Cycle Assessment (LCA). The Environmental Technology Verification (ETV - the European initiative for the verification, on voluntary basis, of environmental technologies by qualified verification bodies), was also envisaged.

More specifically, the main research activities were as follows:

a. Study of the raw material's availability (starting biomass) in the major producing countries and of the optimization of its physical pre-treatment before gasification;
b. Optimization of the gasification and purification of syngas;
c. Development of new catalysts for the Fischer-Tropsch process, cracking in the presence of hydrogen and methanation capable of improving the performance of the process;
d. Demonstration activity of the developed innovations in an industrial plant;
e. Implementation of LCA and ETV for the environmental, social and economic evaluation of the synthetic natural gas and diesel developed within the FFW project.

PROJECT RESULTS

During the project, a mixture of pomace and pruning residues with a composition suitable to meet the specifications of the subsequent gasification process was evaluated, selected and produced. The pilot-scale tests confirmed the feasibility of the scale-up of the physical pre-treatment process of the used raw materials. During the chemical pre-treatment (gasification) phase in laboratory, the biomass was converted into syngas identifying also the most important factors capable of preventing sintering.

Suitable locations have been identified for the realization of biomass gasification plants in Italy (Puglia) and Spain (Andalucia), in the territories which could be considered by the FFW project. The use of a molten salt reactor (Molten Salt Reactor - MSR) has been tested to remove impurities present in the syngas (e.g. tar, sulfur and halogen compounds). The results showed that MSR is effective in the purification of synthesis gas with large quantities of impurities. However, this technology is not able to respond to the needs of synthesis processes where extreme syngas purity is required.

Suitable catalysts for the Fischer-Tropsch process and methanation were prepared, characterized and selected. The results of the scale-up activities and the evaluation of the Key Performance Indicators have shown that a complete line for the production of liquid hydrocarbons from olive pellets can be installed and operated. It was understood that high efficiency of the heat removal system in the Fischer-Tropsch reactors is essential.

The raw materials have been successfully gasified in a stable autothermal process at acceptable temperatures. The composition of the syngas obtained was consistent with the limits set. The composition of the syngas obtained was consistent with the limits set. The production of waxes and liquid fuels from synthetic gas, the production of SNG from synthetic gas and the methanation process have been successfully demonstrated.

An energy integration of the entire process was carried out through simulation studies aimed at optimizing and scaling up the FFW system. The results of the LCA analysis have shown that to improve the ecological performance of the system, the

electricity consumption must be reduced as much as possible and the location of the FFW plant must be chosen carefully. It has been calculated that the system could produce a sufficient quantity of diesel fuel to cover the national transport of olive biomass from the cultivation fields to the transformation plants and thus the process could be self-sufficient in terms of energy.

Lastly, the most suitable production capacities of the FFW plants and the investments necessary for their construction were determined.

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