Are renewable-based processes economically sustainable today? The case of H_2 production and distributed energy cogeneration from bioethanol

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The possibility to obtain chemicals and/or fuels from renewable sources is an attractive option in order to develop an integrated biorefinery concept. Bioethanol can be a suitable starting material for the production of H_2 as fuel or syngas. Hydrogen is considered as future energy vector that can meet the ever growing world energy demand in a clean and sustainable way.
In this work, the centralized production of pure hydrogen from bioethanol was investigated using the process simulation software AspenONE Engineering Suite®. After designing the process and the implementation of kinetic expressions based on experimental data collected in our lab for the steam reforming of bioethanol, an economic evaluation and sensitivity analysis were carried out, assessing conventional economic indicators such as the net present value (NPV), internal rate of return (IRR) and pay-out period of the plant. In particular, three scenarios were studied by changing the fuel of the furnace that heats up the ethanol steam reformer, *i.e.* the main energy input, using methane, ethanol or part of the produced hydrogen. Heat integration was also optimised for the best scenario.
Sensitivity analysis was applied to investigate the economic performance of bioethanol steam reforming under different circumstances, changing feedstock cost, hydrogen selling price, taxes and capital expenditure (CAPEX). The results highlight the advantages and drawbacks of the process on a large scale (mass flow rate of bioethanol 40,000 ton $year^{-1}$) for pure hydrogen production from bioethanol. The higher return is achieved when using methane as auxiliary fuel. The process was strongly OPEX sensitive and very tightly correlated to the bioethanol cost and hydrogen selling price.
This case was compared with the use of bioethanol in a distributed heat and power cogeneration system, where the cost determining item was as expected the fuel cell, together with the H_2 purification section.
In all the cases, the possibility to operate with less expensive, diluted bioethanol streams was investigated.

References

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