**Techno-economic analysis of the conversion process of SRF derived syngas to methanol with CO2 capture.**

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**Highlights**

* Complete process flowsheet for SRF derived syngas to methanol.
* Alternative CO2 capture technologies for syngas are assessed.
* Methanol synthesis loop is optimized
* Positive profitability indices are obtained.

**1. Introduction**

Waste production is constantly growing in the developing countries, while in the developed areas, techniques for the exploitation of waste have been gradually introduced. Wastes are used in order to obtain raw materials (separate collection) or to produce energy by thermal treatments (waste-to-energy, gasification). Solid recovered Fuel (SRF) is a type of fuel derived from the processing of non-hazardous solid urban waste. The aim of producing a fuel derived from waste is the creation of an energy carrier with standard features allowing exploitation in energy production processes [1].

A possibility to valorize waste material consists in gasification to produce syngas and subsequently high-added value products, as methanol [2]. Challenges arise to reach the specific features from the obtained raw syngas, in terms of gas pollutant concentration to avoid catalysts deactivation and of H2/CO ratio. Alternative solutions to purify and to condition the syngas were proposed in the literature [2]. These analyses indicate that the purification and conditioning processes require significant additional capital costs, in particular for the CO2 capture units. Improvement of process integration of these two plant sections is necessary to obtain convenient economic indices.

In this work, the process design and the preliminary cost assessment of purification and conditioning section of syngas obtained from a gasification plant of RDF and of the methanol synthesis section are proposed.

**2. Methods**

Process flowsheet was simulated by means of Aspen Plus© V8.8 in order to perform mass and energy balance and to carry out the optimal design of main process units. For this purpose, rigorous models taking into account kinetics were employed to design reactors and rigorous stage by stage methods were used for separation columns accounting non ideal vapor liquid equilibria and mass transfer resistance. Process heat integration was addressed and heat exchanger network was designed by means of Aspen Energy Analyzer V8.8. Cost analysis was carried out with the help of Aspen Process Economic Analyzer V8.8.

**3. Results and discussion**

Main results of the simulation work concern the conditioning section of syngas obtained by gasification of SRF was carried out. Syngas was purified from Sulphur organic compounds (mainly COS and CS2) and from HCN by a hydrolysis reactor with Al2O3-TiO2 catalyst which was properly sized to obtaining conversion larger than 99%. H2S was converted to elemental Sulphur by means of Lo-Cat® technology and remaining traces were further removed by PURASPECTM adsorption technology. Next, the hydrogen content in the clean syngas was increased from 16% to 31% by a high temperature Water Gas Shift stage (Fe3O4/Cr2O3 catalyst), which was sized to obtain 87% CO conversion. Subsequently the CO2 capture was addressed by two alternative absorption processes: Selexol® process and MEA absorption process. For both cases, a CO2 recovery equal to 95% and a CO2 purity equal to 99% were fixed as process specifications. An economic comparison between the two CO2 capture processes was carried out. Comparable operating costs resulted for both processes, while in term of investment costs the Selexol® process appeared more convenient than absorption by MEA.

The Methanol synthesis loop was designed to feed the methanol reactor with a stream with an optimal molar ratio (H2-CO2)/(CO+CO2) by mixing the fresh syngas with the recycled reactants and pure hydrogen separated by PSA. The multitubular fixed bed reactor with heat exchange was designed to attain an optimal temperature profile to minimize the catalyst bed weight for methanol conversion of about 40%. Methanol separation and purification was obtained by a distillation train.



**Figure 1.** Simulation flowsheet of the syngas cleaning section.

**4. Conclusions**

A complete flowsheet for the production of methanol from SRF derived syngas was simulated. CO2 capture was also addressed. Selexol® process resulted the optimal solution in terms of costs. Methanol synthesis loop was optimized to maximize the methanol production. Process heat integration was performed to limit the utilities cost. Final economic analysis provides positive net present value and satisfactory rate of return of the investment confirming the profitability estimated in a previous approximate analysis [2].

**References [Calibri 10]**

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