Hybrid Waste to methanol scheme: an innovative approach to achieve zero CO_2 emission waste conversion

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The waste to chemical technology is perfectly in line with the aim of GHG emissions reduction. The conversion of carbon and hydrogen contained in waste through partial oxidation allows to reduce globally GHG emissions since a fraction of the carbon of waste is entrapped into the methanol molecule. In this article, we are going to show how it is possible even to reduce almost to zero CO2 emission when converting waste, thank to the integration of waste to methanol technology with electrolytic green hydrogen.

The waste to methanol technology is composed of different sections:
- Gasification - the core of the process where solid waste is converted into syngas;
-Cleaning and purification - main pollutants contained in waste are removed from syngas;
-Conditioning - required to achieve the proper syngas composition for methanol synthesis;
-Methanol synthesis and distillation – adjusted syngas reacts into conventional synthesis loop and final purified methanol is produce.

Conditioning is required since the syngas coming directly from gasifier reflects the composition of waste – about 50%w of carbon and 8 %w of hydrogen – and it presents a low methanol ratio ($\frac{H2-CO}{CO+CO2}$). Indeed, methanol reaction stoichiometry requires a defined methanol ratio, equal at least to 2. To enhance methanol ratio a fraction of syngas is sent to water gas shift reaction, increasing H2 but producing CO_2, then CO_2 is separated and recovered by PSA or amine unit. In this way, the proper syngas composition is achieved. But CO_2 is fatally produced. Coming from a separation unit this CO_2 stream is highly pure and can be directly stored or used for several applications, such as carbon fertilization or food&beverage sector.

Nevertheless, conditioning can be done differently: pure hydrogen stream can be directly mixed to syngas in order to reach the proper methanol ratio. With this solution all the carbon contained in waste is converted into methanol. To have a real benefit in terms of environmental impact of the technology, H_2 should be green, i.e. it has to be produced through electrolysis powered by renewable energy. Electrolytic H_2 integration enhances the strength of waste to methanol technology: the yield of the process is doubled, meanwhile zero CO_2 is directly produced by the process.

In conclusion, when renewable energy will be widely available, the integrated waste to methanol process will become, at once, a threefold beneficial technology for:
- waste conversion ensuring material recovery;
- zero emissions methanol production;
- long term energy storage.