**Alternative industrial routes to maleic anhydride: a life cycle perspective**

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Sustainability in the chemical industry represents a recent issue which reached importance during the last decades, in particular after the release of the Green Chemistry and Green Engineering principles. However, in order to address sustainability along the entire production process, a Life Cycle Assessment (LCA) approach with its holistic perspective seems a very useful tool to support the further green metrics, such as E-factor and Process Mass Intensity. Moreover, LCA is a standardized methodology (ISO 14040 and 14044) internationally well recognized and established. Therefore, in order to assess the LCA potentiality applied to chemical industrial sector the synthesis of maleic anhydride (MA) was selected as a case study. MA is commonly obtained by direct oxidation of benzene or n-butane as feedstock. In this study, three different routes were modeled in order to compare the obsolete synthesis from benzene with the alternatives pathways which use n-butane using both a fixed-bed reactor and a fluidized-bed technology (the so called ALMA process).

A cradle to gate perspective was considered, from raw materials extraction up to the MA production, including all the intermediate stages and utilities. Direct industrially available data were used in order to fill the life cycle inventories. The ReCiPe and Cumulative Energy Demand (CED) were selected as analysis methods to carried out the impact assessment stage.

Scores achieved for the climate change category revealed a lower sustainability associated with the benzene based process, while the butane oxidation using fixed-bed reached higher impacts in terms of fossil fuel depletion. The mainly reason is the lower energy efficiency of the fixed-bed reactor, confirmed also by the CED method. On the other hand, although the ALMA process reaches a slightly lower yield, the fluid-bed technology seems more efficient reaching the lower global impact classifying it as the more environmental friendly route. Finally, in order to confirm results obtained, a sensitivity analysis using Monte Carlo method was carried out considering a 95% confidence interval.