

Comprehensive Multi-Criteria Process Design Methodology

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Multi-criteria decision analysis (MCDA) is a very important tool nowadays. Using MCDA can comprehensively compare several of chosen process design alternatives and reduce their number for the future realisation. Our attention was focused on four criteria in this work: economics, material use and energy efficiency, safety, and environmental aspect. We can create any ranking of these criteria by using analytic hierarchy process (AHP) methodology which we presented in this study. According to this methodology, we are able to identify the best alternatives if economics is the focal point of decision, or on the other hand the best alternatives from the ecological point of view, what is often communicated topic in public nowadays.

We applied this method on the hydrogen production by steam reforming, which is the most frequently used technology in industrial hydrogen production. The subject of this analysis were eight representative process design alternatives. The main difference between alternatives was type of used raw material, half of the analysed variants used natural gas and rest of them used more environmentally friendly alternative – biogas. Extension of post-combustion carbon capture was included in some alternatives to study possible improvement of the environmental part of process. Alternatives of hydrogen production were compared with all possible combinations of criteria to get global feasibility ranking.

Interesting result of this study was the change in final ranking if different criterion was considered as the most important. Natural gas reforming coupled with low temperature shift reactor was identified as the best alternative if economics has dominant importance. This alternative was shifted in the middle of the ranking if environmental aspect is the key decision criterion. Utilisation of biogas coupled with carbon capture in hydrogen production made this process the best alternative in environmental point of view.