Techno-economic evaluation of different CO2-based processes for dimethyl carbonate production

In this work, several chemical processes for production of dimethyl carbonate (DMC) based on CO2 utilization are evaluated. Four CO2-based processes for production of DMC are considered: (1) direct synthesis from CO2 and methanol; (2) synthesis from urea; (3) synthesis from propylene carbonate; and (4) synthesis from ethylene carbonate. The processes avoid the use of toxic chemicals such as phosgene, CO and NO that are required in conventional DMC production processes. From preliminary thermodynamic analysis, the yields of DMC are found to have the following order (higher to lower): ethylene carbonate route > urea route > propylene carbonate route > direct synthesis from CO2. Therefore, only the urea and ethylene carbonate routes are further investigated by comparing their performances with the commercial BAYER process on the basis of kg of DMC produced at a specific purity. The ethylene carbonate route is found to give the best performance in terms of energy consumption (11.4% improvement), net CO2 emission (13.4% improvement), in global warming potential (58.6% improvement) and in human toxicity-carcinogenic (99.9% improvement) compared to the BAYER process. Also, the ethylene carbonate option produces ethylene glycol as a valuable by-product. Based on the above and other performance criteria, the ethylene carbonate route is found to be a highly promising green process for DMC production. © 2014 The Institution of Chemical Engineers.