Simulation and process integration for tert-amyl-methyl ether (TAME) synthesis

This paper proposes an extended approach to develop a new sustainable process to produce tert-amylmethyl ether (TAME) using as feedstock enriched C-5 fraction (LCN - light cracking naphtha) from fluid catalytic cracking (FCC). To the best of our knowledge, up to now, different authors developed the separation section without considering all possible options. The main contribution is to bring together for comparison different separation techniques of the given mixture and to develop new configurations for the separation section of the plant. In this respect, pressure swing is combined with liquid-liquid separation. Existing technologies consider methanol (MeOH) separation from reactor effluent only by water extraction, combined with distillation. Conceptual design based on residual curve maps (RCM) analysis, considered in this paper, reveals new possibilities to use pressure swing, eventually combined with liquid-liquid separation. Thus, compared to other results reported in literature, new separation sequences are proposed for TAME synthesis reactor effluent separation, in the frame of an extended and detailed analysis for the whole process. To underline process characteristics, three case studies, with those different configurations are presented and analysed using Aspen HYSYS (R) v8.4. Main details are obtained using process simulation, process integration and environmental impact computer tools. In the first case study, classical MeOH separation using water extraction is considered. The second case study is based only on pressure swing distillation to separate the azeotropes between hydrocarbons and methanol. In the third case study, pressure swing distillation is combined with separation based on hydrocarbon-methanol liquid-liquid phase equilibrium. Using process simulation results, setup with Aspen HYSYS (R) v8.4, heat integration analysis, performed with SPRINT (R) v2.8, is accomplished to exploit energy savings. Environmental impact calculations are performed using WAR algorithm, considering different fuel types for utilities generation. Results show that the elimination of water in separation section and the use of liquid-liquid phase separation ensure lower energy consumption (overall heat recovery in case study 3 is 9.87 MW, compared to 7.47 MW for case study 2) and better environmental performance. Economic indicators calculated with Aspen Process Economic Analyzer (R) allow identification of attractive process changes, for the new proposed process configuration. (C) 2015 Elsevier Ltd. All rights reserved.