Abstract

Two separation trains for the purification of ethylene from OCM reactor effluent are proposed. The reaction for producing ethylene by oxidative coupling is low conversion, meaning a large percentage of the methane enters the separation train. Both flowsheets include two initial tanks, a demethanizer column for separation of the remaining methane from the heavier hydrocarbons, a C_2-splitter for the separation of ethylene from ethane, and a carbon dioxide removal tower which operates at vacuum to break the azeotrope which forms between ethylene and carbon dioxide to obtain polymer grade ethylene. Alternative flowsheet 1 also has a carbon monoxide removal column for the separation of carbon monoxide from methane for reactor recycle, but the contents of this column are instead burned in alternative flowsheet 2. Approximately $6.0 * 10^6 \frac{kg}{day}$ and $1.5 * 10^6 \frac{kg}{day}$ of liquid nitrogen and liquid methane, respectively, are required for proper operation of alternative flowsheet 1, and approximately $1.5 * 10^6 \frac{kg}{day}$ of liquid methane for proper operation of alternative flowsheet 2, leading in both cases to operating costs that generally dwarf other expenses--$77 million and $11.7 million, respectively. The purified ethylene distillate from the carbon dioxide removal tower is 99.95 % pure by mass. In addition, a lifecycle assessment was conducted to compare the environmental impacts of the proposed OCM flowsheet to those from the Stone and Webster thermal cracking facility for the production of ethylene. Stone and Webster uses a factor of 7.7 times more water than OCM on a basis of 10 MT ethylene produced and has CO_2 emissions a factor of 7.2 times larger than that of OCM on a basis of 10 MT ethylene produced; the proposed OCM flowsheet uses a factor of 13.0 times more electricity than Stone and Webster per 10 MT of ethylene produced. On the basis of economics, it was determined that the traditional thermal cracking facility would be preferred and on the basis of environmental impacts the OCM process would be preferred.