Global multi-objective optimization of a nonconvex MINLP problem and its application on polygeneration energy systems design

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In this problem, we propose a multi-objective mixed-integer nonlinear programming (MINLP) formulation of a typical polygeneration process operating over a (long-term) horizon time. A typical polygeneration complex for the combined production of methanol and electricity has been selected to illustrate the methodology. Net present value (NPV) of the plant over its overall operating horizon is selected as the economic objective function, while a cradle-to-gate life cycle assessment based GHG emission indicator is considered as the environmental objective function. The polygeneration process is presented as a network of several interconnected functional blocks. Each block involves alternative technologies or types of equipment as candidates - the resulting superstructure captures all possible technical combinations (within the postulated set). For all blocks except the methanol synthesis one, mass and energy balances are established for all input and output streams. For the methanol synthesis block, the model involves chemical kinetics and phase equilibrium relationships to handle the different mole compositions of inlet syngas resulted from different technologies implemented in upstream blocks. The entire operating horizon time is discretized into a number of discrete time intervals, where all time-variant parameters are considered as piecewise constant functions (over these time intervals). A generic polygeneration process is divided into several functional blocks, where each block could involve several technology options. A superstructure representation is shown in Figure 1.

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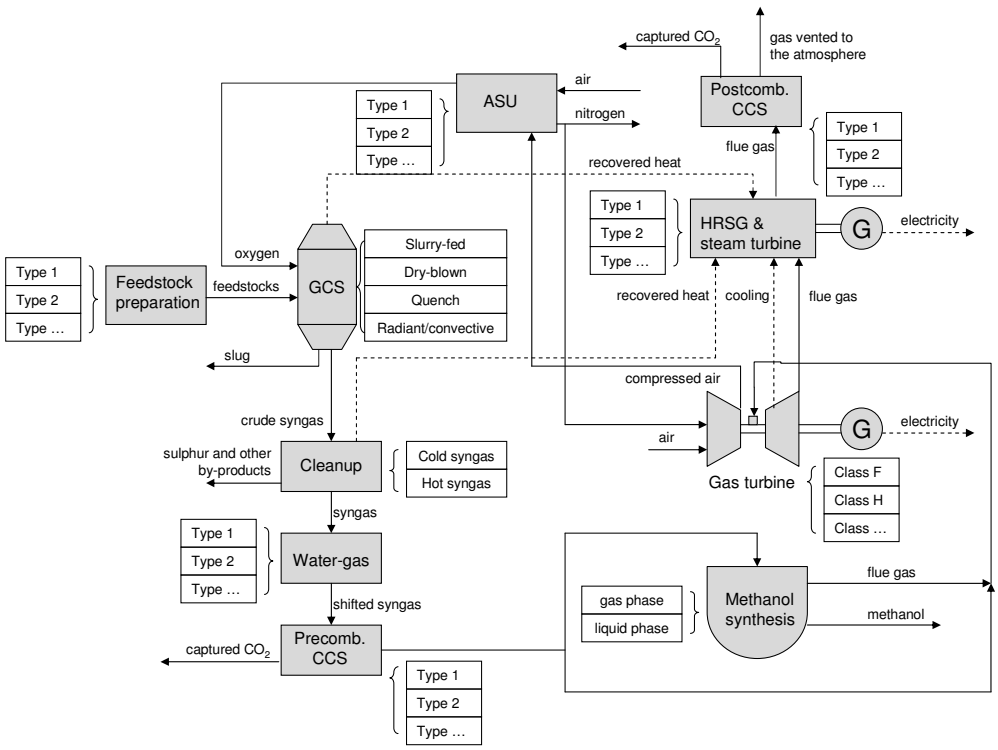

Figure 1: A superstructure representation of a polygeneration process.