**Abstract**

To maintain operational stability and flexibility, chemical processes can input steam and electricity as required through a combined heat and power system (CHP). This study demonstrates how an existing CHP system can be retrofitted, when extant equipment cannot satisfy current multi-period steam and power loads.

Two case studies have been investigated which involve the retrofit of existing CHP systems with 2 and 3 pressure levels of steam demands and different electricity requirements in each period. With increased steam and power loads, the retrofit optimization problem considers the multi-period operation strategy of the two CHP systems, including the decisions on the acquisition of new equipment. Feasible CHP retrofitting superstructures are constructed, based on which the CHP retrofit tasks can be transformed into mixed-integer nonlinear programming (MINLP) optimization problems. The optimization results show that one new boiler and one new turbine need to be purchased in case 1, while in case 2 one new boiler and three new turbines need to be acquired. The retrofit target of the two cases is aimed at minimizing total annual cost. To sum up, this study provides optimal design and operation solutions to the existing CHP systems.