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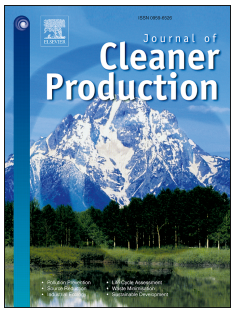

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Total Site Mass, Heat and Power Integration Using Process Integration and Process Graph

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Abstract

This paper aims to develop a novel method to visualise and solve Total Site Mass, Heat and Power Integration problem using a combination of Process Integration and P-graph techniques. Previous methods dealing with mass, heat and power integration are based on Mathematical Programming, which has the disadvantage of lacking adequate visualisation tools during the construction and optimisation of the problem. It also can face computational issues as problems become increasingly complex. The new method incorporates three important process engineering tools: (1) process modelling of mass and energy balance, (2) Pinch Analysis of individual processes and Total Site Heat Integration of clusters of related processes, and (3) the construction of a Total Site superstructure within the P-graph framework to represent the possible mass, heat, and power interconnections between process and utility systems. To demonstrate the method, a biorefinery case study is investigated. The basis for the biorefinery is a Kraft pulp mill in combination with three potential processes, combined heat and power, and geothermal steam. The three considered new processes are gasification for dimethyl-ether production, simultaneous scarification and co-fermentation of pine for ethanol production, and hydrothermal liquefaction for bio-oil production. Results from the case study show the current optimal solution as a Kraft mill with geothermal heat achieving a profit (revenue less energy and capital costs) of NZD $283 M/y. A near-optimal solution has hydrothermal liquefaction added to the Kraft mill with geothermal heat with a profit of NZD $252 M/y.