On Synthesis and Optimization of Cooling Water Systems with Multiple Cooling Towers

Khunedi Vincent Gololo†‡ and Thokozani Majozi*†

† Department of Chemical Engineering, University of Pretoria, Lynnwood Road, Pretoria, 0002, South Africa

‡ Modelling and Digital Science, Council for Scientific and Industrial Research (CSIR), Pretoria, South Africa

Ind. Eng. Chem. Res., **2011**, *50* (7), pp 3775–3787

DOI: 10.1021/ie101395v

Publication Date (Web): January 13, 2011

Abstract

Cooling water systems are generally designed with a set of heat exchangers arranged in parallel. This arrangement results in higher cooling water flow rate and low cooling water return temperature, thus reducing cooling tower efficiency. Previous research on cooling water systems has focused mainly on heat exchanger network thus excluding the interaction between heat exchanger network and the cooling towers. This paper presents a technique for grassroot design of cooling water system for wastewater minimization, which incorporates the performances of the cooling towers involved. The study focuses mainly on cooling systems consisting of multiple cooling towers that supply a common set of heat exchangers. The heat exchanger network is synthesized using the mathematical optimization technique. This technique is based on superstructure in which all opportunities for cooling water reuse are explored. The cooling tower model is used to predict the thermal performance of the cooling towers. Two case studies are presented to illustrate the proposed technique. The first case resulted in nonlinear programming (NLP) formulation and the second case yield mixed integer nonlinear programming (MINLP). The nonlinearity in both cases is because of the bilinear terms present in the energy balance constraints. In both cases, the cooling towers operating capacity were debottlenecked without compromising the heat duties.