

## Optimal design of water networks involving multiple contaminants for global water operations

*Zainatul Bahiyah Handani<sup>a</sup>; Sharifah Rafidah Wan Alwi<sup>b</sup>; Haslenda Hashim<sup>b</sup>; Zainuddin Abdul Manan<sup>b</sup>; Sharifah Hanis Yasmin Sayid Abdullah<sup>b</sup>*

<sup>a</sup>Faculty of Chemical and Natural Resources Engineering, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Kuantan, Pahang, Malaysia

<sup>b</sup>Process Systems Engineering Centre (PROSPECT), Faculty of Chemical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia

### ABSTRACT

This work presents the development of a systematic technique to target the minimum fresh water consumption and wastewater generation to achieve maximum water recovery (MWR) for systems involving multiple contaminants. A generic linear programming (LP) model has been developed based on water network superstructure to simultaneously set the targets and design the MWR network, for both mass transfer-based (MTB) and non-mass transfer-based (NMTB) problems (i.e. global water-using operations). This work also includes cases where fresh water concentrations for all contaminants are assumed to be either zero or non-zero. The proposed method is superior since it can guarantee a global optimal solution. Application of the methodology on three case studies shows significant water savings, illustrating the effectiveness of the proposed approach.

### KEYWORDS:

Mathematical Modeling; Maximum Water Recovery; Multiple Contaminants; Optimization

## REFERENCES

1. Manan, Z.A., Tan, Y.L., Foo, D.C.Y. Targeting the minimum water flow rate using water cascade analysis technique. (2004) *AIChE Journal*, 50 (12), pp. 3169-3183. Cited 262 times. doi: 10.1002/aic.10235
2. Wang, Y.P., Smith, R. Wastewater minimisation (1994) *Chemical Engineering Science*, 49 (7), pp. 981-1006. Cited 938 times. doi: 10.1016/0009-2509(94)80006-5
3. Dhole, V.R., Ramchandani, N., Tainsh, R.A., Wasilewski, M. Make your process. (1996) *Chemical Engineering*, 103 (1), pp. 100-103. Cited 46 times.
4. Sorin, M., Bédard, S.. The Global Pinch Point in water reuse networks. (1999) *Process Safety and Environmental Protection*, 77 (5), pp. 305-308. Cited 88 times. [http://www.elsevier.com/wps/find/journaldescription.cws\\_home/713889/description#description](http://www.elsevier.com/wps/find/journaldescription.cws_home/713889/description#description) doi: 10.1205/095758299530189
5. Hallale, N. A new graphical targeting method for water minimisation. (2002) *Advances in Environmental Research*, 6 (3), pp. 377-390. Cited 300 times. doi: 10.1016/S1093-0191(01)00116-2