Reply:

Liao, Wang, and Yang (Letter to the Editor, July 2007, pp. 1898–1899, DOI 10.1002/aic.11192) have correctly pointed out that the total regeneration targets ($F_{ws} = F_{reg}$ = 37.5 t/h and F_{ww} = 17.5 t/h) for the water network discussed in Example 1 by Agrawal and Shenoy[1] are feasible, based on the observations of Mann and Liu[2] for some special multipinch cases. What must be recognized in such cases is that the regeneration inlet concentration C_{in} can be greater than the pinch concentration C_p (rather than assume $C_{in} = C_p$).

Agrawal and Shenoy[1] setup a system of three equations (Eqs. 2, 8 and 9) for the case of a single pinch point (denoted by subscript P). For the case of two pinch points (denoted by subscripts P and A), the following additional equation (which is a mass balance over the region below pinch point A) needs to be considered

$$m_A = F_{ws}(C_{in} - C_{ws}) + F_{reg}(C_A - C_o)$$

where m_A and C_A are the cumulative mass load and the concentration, respectively, of the pinch point A on the limiting composite. The above equation along with Eqs. 2, 8 and 9 constitutes a system of four equations in five unknowns (F_{ws}, F_{ww}, F_{reg}, C_{ww}, and C_{in}). Since there is one degree of freedom, we specify $F_{ws} = F_{reg}$ for the case of total regeneration, and then use the equations to determine the targets as illustrated below.

For Example 1 of Agrawal and Shenoy[1] with total regeneration, Eq. 8 on substituting C_o = 20 ppm, C_p = 150 ppm, and m_p = 10.5 kg/h gives the freshwater (C_{ws} = 0) and regeneration targets, as $F_{ws} = F_{reg} = m_p/(2\ C_p - C_{ws} - C_o)$ = 37.5 t/h. Then, Eq. 2 with Δ_1 = 20 t/h gives F_{ww} = 17.5 t/h. Now, the new equation given above with C_A = 250 ppm and m_A = 15 kg/h yields $C_{in} = m_A/F_{ws} + C_{ws} + C_o - C_A$ = 170 ppm (which is higher than C_p = 150 ppm). Finally, Eq. 9 with Δ_2 = −10 kg/h gives C_{ww} = 250 ppm.

The targets of 37.5 t/h (for freshwater), 17.5 t/h (for wastewater) and 37.5 t/h (for regeneration) for Example 1 with total regeneration may be achieved in practice through many different network designs. Several networks, all of which feature minimum freshwater consumption, may be designed using the *nearest neighbors algorithm* (NNA)[1,3] depending on the order in which the demands are satisfied. Figure 1 shows a possible network obtained by a straightforward application of the NNA (starting with demand *D1*, and then satisfying demands *D2*, *D3*, and *D4* in that order). The regenerated water provides an additional source *SR* of 37.5 t/h at 20 ppm, which is entirely used to satisfy the demand *D1* (also at 20 ppm). The source SR is itself obtained by regenerating water from sources S3 (30 t/h) and S4 (7.5 t/h) at C_{in} = 170 ppm.

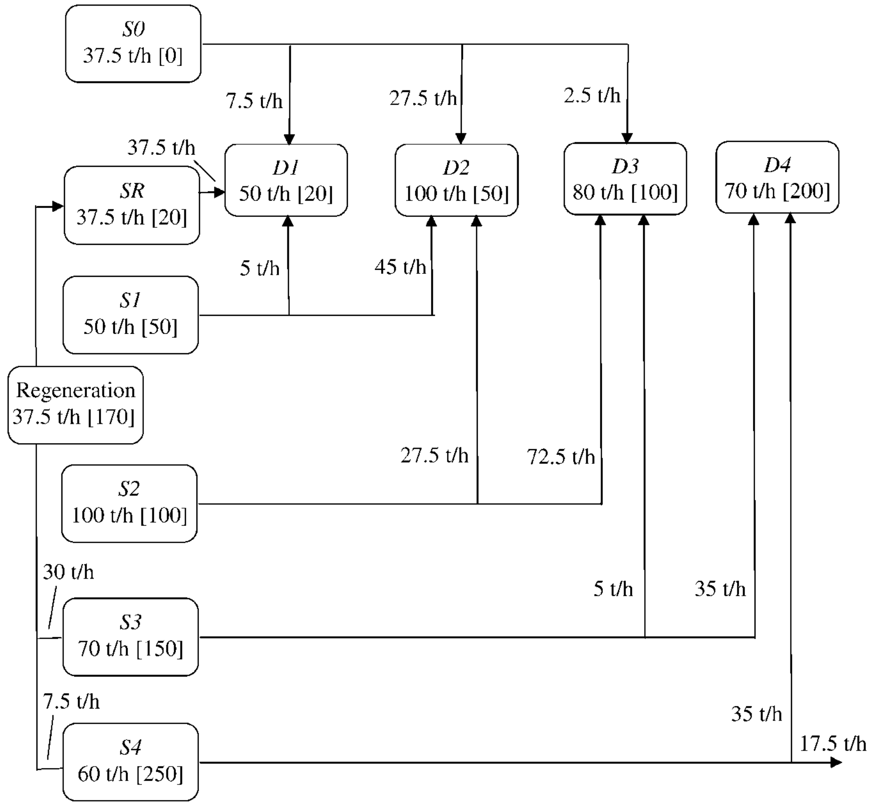

Figure 1. Network for Example 1 by NNA for total regeneration.

Labels show contaminant concentrations [ppm] and flow rates (t/h).

In summary, it may be noted that targets and networks for minimum freshwater may be obtained for total regeneration, provided the regeneration inlet concentration is at or above the pinch concentration ($C_{in} \geq C_p$). To determine C_{in}, a supplementary equation corresponding to the mass balance over the region below the additional pinch must be considered.

Literature Cited

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