Clean Techn Environ Policy
DOI 10.1007/s10098-013-0631-5

Optimal reconfiguration of water networks based on properties

César Sotelo-Pichardo · José María Ponce-Ortega · Fabricio Nápoles-Rivera · Medardo Serna-González · Mahmoud M. El-Halwagi · Sergio Frausto-Hernández

Received: 12 June 2012 / Accepted: 3 May 2013

Abstract This paper presents a mathematical programming model for the reconfiguration of existing water networks based on the stream properties that impact the performance of the process units and the environment. To develop an improved configuration, the model simultaneously evaluates the repiping of the existing network through the placement/reassignment of the existing treatment units, and the addition of new treatment units while addressing environmental constraints. The model also accounts for the options of process modification and increased capacity of the plant. The objective function of the optimization model seeks to minimize the total annualized cost of the system which incorporates the capital investment associated with process retrofitting and the operating cost which includes the cost of fresh resources. The applicability of the proposed model is illustrated through several case studies.

Keywords Property-based · Retrofit · Reconfiguration · Water integration · Recycle and reuse · Optimization · Environmental constraints

C. Sotelo-Pichardo · J. M. Ponce-Ortega (✉) · F. Nápoles-Rivera · M. Serna-González
Chemical Engineering Department, Universidad Michoacana de San Nicolás de Hidalgo, 58060 Morelia, Michoacán, Mexico
e-mail: jmponce@umich.mx

M. M. El-Halwagi
Chemical Engineering Department, Texas A&M University, College Station, TX 77843, USA

M. M. El-Halwagi
Adjunct Faculty at the Chemical and Materials Engineering Department, King Abdulaziz University, Jeddah, Saudi Arabia

S. Frausto-Hernández
Biochemical and Chemical Engineering Department, Instituto Tecnológico de Aguascalientes, 20256 Aguascalientes, Aguascalientes, Mexico

List of symbols

Indexes

i	Process sources
in	Inlet
j	Sinks
max	Maximum
min	Minimum
n	Sections for the capital cost for the treatment units
out	Outlet conditions
p	Properties
pla	Stages
r	Fresh sources
u	Treatment units
$u'u$	Treatment units existing prior to the retrofit process
$u''u$	New treatment units required after the retrofit process

Sets

$NPROP$	Set for the properties ($p\|p = 1,\ldots, NPROP$)
$NFRESH$	Set for the fresh sources ($r\|r = 1,\ldots, NFRESH$)
$NPLATES$	Number of stages for the treatment units ($pla\|pla = 1,\ldots,NPLATES$)
$NSECTION$	Set for the disjunctions for the capital costs ($n\|n = 1,\ldots, NSECTION$)
$NSINKS$	Set for the sinks ($j\|j = 1,\ldots, NSINKS$)
$NSOURCES$	Set for the process sources ($i\|i = 1,\ldots, NSOURCES$)
$NTREAT$	Set for the treatment units ($u\|u = 1,\ldots, NTREAT$)

Published online: 18 May 2013