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Targeting and design for batch regeneration and total networks

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Abstract Resource conservation for batch processes is gaining good attention in recent years. This is mainly due to the recent trend in chemical engineering that focuses on product engineering, as well as in the rise of various low volume and high value-added products (e.g. pharmaceutical, specialty chemicals, etc.) in the market. In this study, a systematic procedure to perform targeting and design of a batch resource conservation network (RCN) involving material regeneration and waste treatment (also known as a *total RCN*) is proposed. The procedure is applicable for all fixed-schedule-type batch RCNs with mass storage facilities. Literature examples are used to elucidate the proposed procedure.

Keywords Process integration · Batch processes · Pinch analysis · Targeting · Resource conservation

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Introduction

The rising cost of fresh resources and waste discharge, increasingly stringent environmental legislation, and the rise of public awareness towards environmental sustainability are among factors that drive waste minimisation initiatives in recent years. Concurrently, the development of various *process integration* techniques for resource conservation has seen significant achievement. Process integration may be defined as *a holistic approach to process design, retrofitting, and operation which emphasises the unity of the process* (El-Halwagi 1997, 2006). Over the past two decades, it has evolved from energy-saving tools (Linnhoff et al. 1982/1994; Smith 1995, 2005) into systematic design techniques for various waste minimisation purposes. In particular, the synthesis of RCN for continuous processes, such as water reuse/recycle (Wang and Smith 1994; El-Halwagi et al. 2003; Manan et al. 2004; Prakash and Shenoy 2005; Bandyopadhyay 2006; Foo et al. 2006a), regeneration (Bandyopadhyay and Cormos 2008; Bai et al. 2007; Feng et al. 2007; Ng et al. 2007a, 2008a), and total water networks (Ng et al. 2007b, c), as well as hydrogen recovery (Alves and Towler 2002; El-Halwagi et al. 2003; Foo and Manan 2006) and property networks (Kazantzi and El-Halwagi 2005; Foo et al. 2006b), has gained good attention from both academic and industrial practitioners. In general, the developed techniques for RCN synthesis can be classified into *insight-based* (often known as *pinch analysis*) and *mathematical optimisation* tools. Most of the abovementioned works are analysed in several important review papers (Bagajewicz 2000; Foo 2009; Jeżowski 2010).

In recent years, other than RCN synthesis for continuous processes, significant developments have also been observed for process integration techniques for various