CAPE Forum 2015
Computer Aided Process Engineering
University of Paderborn

April 27-29, 2015
Paderborn
Germany

Two-Step Procedure for Retrofitting of Heat Exchanger Networks within Existing Flexible Total Sites

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Abstract

Heat and Total-Site (TS) Integration and waste heat utilisation within industrial processes and TSs is an efficient way of conserving energy and achieving emission reductions. Several approaches have been developed for this purpose. In general they are divided into an approach based on physical insights – Pinch Analysis (PA), and an approach based on numerical mathematics – Mathematical Programming (MP) (Klemeš and Kravanja, 2013). Over recent years combined MP/PA approaches have also been developed for overcoming the drawbacks of both approaches.

Two situations exist regarding the analyses of heat exchanger networks (HENs) within processes and TSs: i) grassroots or minimum energy requirement (MER) designs for new plants and TSs, and ii) retrofit (also reconstruction, revamp or redesign) for existing plants and TSs. This contribution deals with retrofits within existing process plants and TSs, which is considerably more difficult than for grassroots networks (Yee and Grossmann, 1991) due to several reasons: i) the existing equipment and layout must be considered, ii) plant downtime is required which can be critical, and iii) existing heat exchange (HE) units should be more accurately modelled (Klemeš et al., 2013). There are many ways of improving the existing designs, such as changes in the uses of utilities, topological modifications, installing of additional areas, re-piping of streams, reassignments of matches and heat transfer enhancement (Wang et al., 2012). Also, there are several approaches for the tackling of retrofit projects: i) by inspection, ii) by computer search – MP, iii) by network pinch approach (Asante and Zhu, 1996), and iv)by combined MP/PA approaches.

This contribution presents a novel procedure for the retrofitting of HENs within existing process plants and TSs under fixed and flexible designs by combined MP/PA. The first step is pre-screening of retrofit modifications using MP/PA code TransGen (Čuček and Kravanja, 2014, and upgraded by Čuček and Kravanja, 2015). Retrofit modifications are obtained as the economic objective by considering trade-offs between investment cost and savings in energy costs. During the second step a detailed HEN retrofit design is performed on the reduced spaces of alternatives. Each step contains several loops in order that the obtained results are (near) optimal, verified and feasible. The entire procedure will be illustrated on a simplified example, and applied on an existing refinery TS.

Acknowledgements

The authors acknowledge the financial support from EC FP7 project ENER/FP7/296003/EFENIS 'Efficient Energy Integrated Solutions for Manufacturing Industries' – EFENIS, and from the Slovenian Research Agency (programs P2-0032 and P2-0377).

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