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A B S T R A C T

This Special issue (SI) of Applied Thermal Engineering presents 26 selected contributions from the 16th Conference *Process Integration, Modelling and Optimisation for Energy Saving and Pollution Reduction – PRES'13*. The PRES conference is one of the leading international venues, which contributes towards Applied Thermal Engineering as an integral part of their scope. The long-term cooperation between the PRES conferences and the Applied Thermal Engineering journal has been a mutually beneficial one. Many high quality research works have been presented. The papers selected in this SI cover important subjects related to: (i) Integrated Applied Thermal Engineering in Process Systems and (ii) Industrial and experimental studies of sustainable thermal engineering.

1. Introduction

Applied Thermal Engineering is playing an important role in sustainable development especially in the scope of energy saving, heat transfer technology efficiency, Process Integration and intensification. The conference series of "*Process Integration, Modelling and Optimisation for Energy Saving and Pollution Reduction – PRES*" has played an increasingly active role in finding answers to those issues. PRES international conferences provide an important opportunity to review and advance the state-of-the-art in these scopes. The delegates of PRES'13 presented comprehensive tasks of a considerable scale and widespread interactions to share the solutions to considerable academic and industrial challenges.

Since the first venue of the PRES series organised under the CHISA umbrella in 1998, in Prague, Czech Republic, PRES conferences have also been organised in Hungary, various places in Italy, Canada, and Greece. In the year 2015, for the first time, PRES conference will be held in Asia – at Kuching, Sarawak, Malaysia [1].

PRES'13 was held in Rhodes, Greece in late September 2013 and provided an excellent opportunity for dissemination of novel ideas, process design, industrial and experimental result sharing. The organisers of the PRES conferences, CERTH and Aristotle University of Thessaloniki from Greece and the Italian Association of Chemical Engineering are proud to continuously attract more than 350 professional scientists/researchers from 56 countries and six continents providing a genial platform for the fast and efficient spreading of novel ideas, processes, and especially close working friendships.

PRES conferences offer a comprehensive publication strategy of best papers. This Special Issue (SI) has been already the 15th SI of Applied Thermal Engineering, dedicated to selected contributions from PRES conferences starting from PRES'99 in 2000 [2]. It has been followed by SI of PRES 2000 [3], PRES'01 [4], PRES 2002 [5], PRES'03 [6], PRES 2004 [7], PRES'05 [8], PRES 2006 [9], PRES'07 [10], PRES 2008 [11], PRES'09 [12], PRES 2010 [13], PRES'11 [14], PRES 2012 [15]. In addition to Applied Thermal Engineering, other well-known journals have been collaborating with PRES and related conferences: Energy – PRES 2010 [16] and PRES 2012 [17], Journal of Cleaner Production – PRES'11 [18], Cleaner Technologies and Environmental Policy – PRES 2010 [19], PRES'11 [20], and PRES 2012 [21], Theoretical Foundations of Chemical Engineering [22], Heat Transfer Engineering – PRES 2008 [23], Resources, Conservation and Recycling – PRES 2008 [24] and Waste Management – PRES'99 [25].

2. Selected contributions and the main thematic groups

For this Special Issue of Applied Thermal Engineering, 33 manuscripts had been selected and 25 were accepted after thorough reviews and revisions. They address two major thematic groups: (i) Integrated Applied Thermal Engineering in Process Systems (ii) Industrial and Experimental Studies of Sustainable Applied Thermal Engineering. The authors are from twenty two countries around the world – from Belgium, Bosnia and Herzegovina, China, Czech Republic, Greece, Germany, Hungary, India, Italy, Japan, New Zealand, Malaysia, Mexico, Norway, Romania, Slovenia, Spain, Sweden, Switzerland, UK, Ukraine, and USA.

2.1. Integrated Applied Thermal Engineering in Process Systems

In the first part of the SI, there are 13 papers reporting the last developments of Integrated Applied Thermal Engineering in Process Systems.

The first paper by Gatti et al. presents the integration of low-grade heat power generation (LHPG) into a process system [26]. A low-grade heat flow is normally one available at below 150 °C. The recovery of low-grade heat is important for improving process efficiency. However, to find an appropriate internal heat demand is

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a challenge. One alternative is to use thermal engines (Rankine and Kalina cycles) to convert low-grade heat into electricity for use on site. The paper demonstrates a case study of an LHPG system in operation to attain 3,300 kW of power generation at 8% annual average gross thermal efficiency. From thermodynamic point of view, the LHPG system was found to attain 50.4% in the exergy recovery ratio, which is considered to be supremely high performance in exergy recovery when compared with the efficiency of the average automobile engine of less than 30%.

The second paper from Quijera et al. [27] demonstrates the integration of a solar thermal system in a canned fish factory. The paper evaluates the viability of integrating a solar thermal system, in combination with a heat pump, into the conventional energy structure of a fish canning process based on mathematical models and Pinch Analysis. The energy potential of this combination, for the studied industrial process operating at low and medium temperatures, was considerable, and should be considered in the near future.

Liew et al. [28] present how to apply Algorithmic Targeting for Total Site Heat Integration with Variable Energy Supply/Demand. In this paper, the graphical targeting approach based on the Time Slices (TSLs) has been extended to handle the energy supply/demand variability in Total Site Heat Integration (TSHI) [29]. A novel algorithm is proposed to efficiently perform utility targeting for a large-scale TSHI system involving renewable energy and variable energy supply/demand to include TSL. The tool is featured to analyse the heat excess in specific TSLs that can be cascaded to the next TSL via energy storage system during start-up and operation. The proposed tool can be also used to estimate the required heat storage capacity.

Walmsley and his collaborators [30] introduced a novel method for cost optimal area allocation in heat exchanger networks. They presented a novel Cost Derivative Method (CDM) for finding the optimal area allocation for a defined Heat Exchanger Network (HEN) structure. The approach attempts to add, remove and shift area to exchangers where economic benefits are returned by using the Pinch Design Method. The approach is able to account for differences in film coefficients, heat exchanger types, flow arrangements, exchanger cost functions, and utility pricing. Incorporated into the method is the newly defined “heat duty flow-on” factor. A case study with a distillation process and a milk powder plant is demonstrated.

Ibrić et al. [31] presented a simultaneous optimisation approach for water and energy within integrated water networks with a case study of Heat Integrated water-using and wastewater treatment networks. A two-step solution strategy is proposed for the subsequent solution of two non-linear models and the identifying of a set of good locally optimal solutions. The superstructure includes water-using process units, wastewater treatment (regeneration) units, heat exchangers and all opportunities for water and heat integration within the overall network.

Gatti et al. [32] have given a comprehensive review on modelling, Heat Integration and improved schemes of the Rectisol® -based process for CO_2 capture technologies. The paper evaluates the thermodynamic performance and the energy integration of alternative schemes of a methanol absorption based acid gas removal process designed for CO_2 Capture and Storage (CCS). The paper also identified and compared the alternative schemes with optimised performance for CCS and heat integration with utilities.

A Generic Carbon Cascade Analysis (GCCA) technique has been proposed by Manan et al. [32] for carbon emission management. This algebraic approach enables the minimum carbon targets to be determined for any range of CO_2 concentration. In order to produce the holistic minimum carbon targets, application of the new GCCA was guided by the Carbon Management Hierarchy levels that represent options for direct reuse, source and demand manipulations, regeneration reuse, and carbon sequestration. Application of the GCCA is illustrated with a refinery case study.

The following paper focuses on minimisation of CO_2 emissions and has been authored by Porzio et al. [33].Their paper presents an optimisation tool for a gas network with a case analysing an integrated steel plant. Their decision-making tool is exploiting an evolutionary algorithm, which enable a flexible formulation of the problem. The tool effectively generates a set of different decision solutions. The application of the model to several industrial case studies demonstrates an interesting potential for reduction of CO_2 emission as well the cost.

Zwaenepoel et al. [34] proposed a method to provide ancillary services to the electrical grid with waste heat recovery. This integration approach connects the thermal source to a thermal grid and a thermal storage. The paper describes the concept of a Virtual Power Plant (VPP) and the basic functions of thermal grids. The VPP concept and thermal grids are combined and demonstrated in a case study. The dimensions of a low temperature thermal storage buffer to balance the variability of a wind- or solar plant are determined.

Deng et al. [35] presented a comparative analysis of different scenarios for the synthesis of refinery hydrogen network. A mathematical model is constructed to integrate the hydrogen utility, process hydrogen sources, hydrogen sinks, fuel system, compressor, purifier and all the feasible interconnections. The comprehensive superstructure is embedded with hydrogen utility, process hydrogen sources, hydrogen sinks, fuel system, compressor, purifier and all the feasible interconnections between them. Two schemes of data extraction for the hydrogen consumers are firstly introduced and their effect on the optimal hydrogen utility and the minimum number of connections is compared.

A Scandinavian pulp mill retrofit case study has been demonstrated by Svensson [36]. This paper studies the steam production in a chemical pulp mill that is retrofitted to reduce its process heating demand. A multi-period optimisation model for design decisions is proposed that takes into account operational limits of the boilers and variations in heat demand. The paper illustrates the importance of modelling the process variations and operating load limits instead of taking the simplifications one step too far by modelling a single-period, fixed-value problem.

Kansha et al. [37] extended the application of self-heat recuperation as an innovative methanol synthesis process. In this paper, the feasibility of applying self-heat recuperation technology to the methanol synthesis process is investigated and an innovative process for methanol synthesis is developed from an energy saving point of view. The use of this self-heat recuperation technology in the methanol synthesis process greatly reduces the energy consumption.

Finally, a study was carried out by Pačíska et al. [38] to evaluate the performance and suitability of the commonly available simulation software packages in case of non-standard geometries. Three software tools have been studied via a specific industrial problem. Thermal-hydraulic analyses of an unconventional steam condenser is performed using educational versions of the software packages with operating parameters at the inlet of the apparatus, thermophysical properties of streams, and geometry of the apparatus from a condenser.

2.2. Industrial and Experimental Studies of Sustainable Applied Thermal Engineering

The result analysis and application from the industrial and experimental studies is a crucial step in sustainable Applied Thermal Engineering. There are 13 papers selected reported on the application of Applied Thermal Engineering from different point of view of research studies.