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Editorial

Green Applied Energy for sustainable development

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ABSTRACT

This special issue of Applied Energy contains articles developed from initial ideas related to the 17th Conference Process Integration, Modelling and Optimisation for Energy Saving and Pollution Reduction (PRES 2014) held in Prague, Czech Republic, during 23–27 August 2014. The conference has been organised jointly with CHISA 2014. Both events have benefitted from the shared pool of participants as well as the expanded opportunities for exchanging ideas. From all contributions presented at the conference, high-quality ones suitable for Applied Energy, have been invited. Overall, 37 extended manuscripts have been invited as candidate articles. Of those, after a thorough review procedure, 11 articles have been selected to be published. The topics attained in the focus of this Special Issue include Process Integration and Energy Management, CO_2 capture, and Green Energy Applications.

1. Introduction

The 17th Conference on Process Integration, Modelling and Optimisation for Energy Saving and Pollution Reduction, PRES 2014, was held at Prague, 23–27 August 2014 [1]. The aim of the PRES conference is to review the latest development and applications of Green Applied Energy such as Process Integration for energy conservation, pollution reduction and related topics for sustainable development. PRES international conferences provide an important platform to review and advance the state-of-the-art in these areas. The delegates of PRES 2014 have presented comprehensive contributions of a considerable scale and widespread interactions to share the solutions to considerable academic and industrial challenges especially in the scope of green technologies.

PRES 2014 attracted 551 abstracts authored by 2133 authors from 57 countries. From those 199 papers were selected for oral presentation, including 3 plenary lectures and 29 Keynote lectures. Also, 291 posters were competing for the traditional "Zdeněk Burianec Award" – Gold, Silver and Bronze given to the best posters nominated by the Best Poster Selection Committee. Very important for PRES development was the introduction of CET – Chemical Engineering Transactions [2], which PRES joined from Volume 7 in 2005. From 2009 CET introduced DOI (Digital Object Identifier) and has been listed by SCOPUS and later by ISI Thompson Reuters. PRES 2014 selected manuscripts were published in Vol. 39 [3]. This brought more publication opportunities, however much higher demand on precision in following the journal template and style.

From PRES 2014 conference 31 papers were invited as candidates to be published in Applied Energy Special Issue following up on the success of the Special Volume from SDEWES (Conference on Sustainable Development of Energy, Water and Environment Systems) [3]. After thorough reviewing process 11 papers have been accepted. They focus on the Green Applied Energy Management for the Sustainable Development with three main subject topics: (i) Process Integration and Energy Management; (ii) CO_2 Capture and Mitigation; and (iii) Alternative Green Energy Applications.

2. Process Integration and Energy Management

There is typically large potential for energy savings through heat recovery from industrial processes. Process Integration using Pinch Analysis [4] has been an effective and reliable tool for the design of energy-efficient industrial processes. The technique has led to significant energy as well as capital-cost savings management.

Wan Alwi and Abd Manan [5] proposed a simultaneous Process Integration strategy for energy targeting, placement of utilities with flue gas, and design of heat recovery networks with a novel extension of the previously presented Stream Temperature versus Enthalpy Plot (STEP) [6]. In this work [5], the capability of the STEP has been further extended to include flue gas targeting. The extended STEP technique is capable of targeting the heat loads and temperature levels of multiple utilities. STEP also simultaneously provides a graphical visualisation tool to design a HEN that is integrated with variable-temperature utilities, to identify the exact location of, stream splitting, and to guarantee temperature feasibility as well as enthalpy balance for each heat exchanger match. This new proposed approach contributed to the process modifications and process retrofit that require detailed analysis of individual streams in a heat exchanger network.

Another method to improve the Process Integration performance in the context of Heat Exchanger Networks (HENs) has been

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developed by Pan et al. [7]. It presents new insights of heat transfer intensified technologies for HEN retrofitting. This paper reports on a method to improve heat recovery during Heat Exchanger Network retrofit using heat transfer intensification, while accounting for pressure drop constraints and fouling mitigation. To solve such complex optimisation problems, a new Mixed-Integer Linear Programming (MILP) model has been developed to consider fouling effects in retrofitting HENs with heat transfer intensification. A two-loop iterative algorithm has been developed to solve this large scale HEN retrofit problem efficiently. This paper demonstrates several case studies, to conclude that the existing retrofit methods without considering fouling effects might reduce exchanger operating periods, which is not suitable for HEN retrofitting problems because of considerable energy losses as exchangers are taken off duty for cleaning. This new approach demonstrates the best economic trade-offs among energy savings, investment and operating periods in HEN retrofit problems by achieving greater retrofit profits with high energy saving, suitable exchanger operating times, and reasonable pressure drops.

Oluleye et al. [8] developed a methodology to identify the potential for waste heat recovery in process sites. They consider the temperature and quantity of waste heat sources from the site processes and the site utility system. Within this proposed methodology, the concept of the energy efficiency of a site is illustrated where the fraction of the energy inputs that is converted into useful energy such as heat or power or cooling. The simplified mathematical model of waste heat recovery technologies has been developed to assess the potential for recovery of useful energy from waste heat. This work can be extended to determine the architecture for complex cycles for waste heat utilisation and the development of a thermo-economic optimisation framework.

System analysis is necessary to comprehensively evaluate site-wide steam generation, steam distribution, and power generation [9]. In the past decades, research efforts focused on Process Integration to improve energy efficiency [10] at multiple scales [11]. Sun et al. [12] demonstrated the complexity of costing steam for complex utility systems. It shows that true steam cost can only be evaluated by an optimisation model of the whole utility system. The proposed optimisation framework based steam costing explores the interaction of steam savings at different mains on steam costs, and shows that steam saving at one steam header would affect steam prices of other steam headers. The case study illustrates that not always higher pressure steam saving in the process retrofit can result in larger economic benefit than the lower pressure steam saving based on the previous methods. The steam costing analysis provides guidance for process and system retrofit scenarios.

Furthermore, Process Integration analysis can be extended with some economic-environmental implications for an innovative environmentally friendly recovery and pre-treatment [13]. This work demonstrates a case study featuring simultaneous preheat and removal of the coating from the scrap surface before the melting phase. The zinc in coating is removed in the gas phase by chloride containing syngas combustion and collected in a dedicated recovery system. Two possible innovative process routes are described, which involve plastic waste pre-treatment, shredded plastic gasification/pyrolysis, steel scrap preheating and zinc recovery processes. The routes have been modelled in an integrated flowsheet, in order to allow a comprehensive simulation and optimisation of the pre-treatment processes. Flow-sheeting models have been exploited for the simulation of the process and several scenarios have been investigated from an economic and environmental point of view. The proposed framework has several advantages such as the recovery of automotive waste and conversion into energy and raw material.

3. CO_2 Capture and Mitigation

Population growth and industry development have led to energy demand rise. The direct consequence of this issue is the significant CO_2 emission from the energy production related to global warming. Developing CO_2 capture and storage technologies for improving the energy generation life cycle has been suggested to be a promising solution to mitigate CO_2 emission impacts.

Nguen et al. [14] has proposed several CO_2-mitigation options for the offshore oil and gas sector. Different CO_2-mitigation options for the offshore oil and gas sector were presented and compared based on thermodynamic, economic and environmental performance indicators. The integration of processes such as steam bottoming cycles, pre- and post-combustion CO_2-capture has been analysed, using a multi-disciplinary approach that combines thermodynamic analysis tools with optimisation routines and process integration methods. The aims of the present methodology are to: (i) extract, analyse and optimise simultaneously various process designs considering process, energetic, economic and environmental indicators; (ii) develop flow-sheets that represent appropriately the physical and chemical processes taking place in oil and gas processes, as well as in CO_2-capture systems; (iii) pinpoint possible system improvements by process and energy integration; (iv) perform consistent economic evaluations based on cost correlations; (v) assess the environmental impacts of integrating CO_2-capture processes in off shore conditions; and (vi) identify the most optimal configurations by multi-objective optimisation and comparing systematically CO_2-mitigation processes.

Pan et al. [15] presented a new insight to the application of energy efficient technologies in retrofitting natural gas combined cycle power plants with CO_2 capture unit. This paper proposed optimal retrofitting strategies to minimise the efficiency penalty caused by integrating carbon capture units into the power plant. A case study of NGCC power plant and a CO_2 capture plant with CO_2 compression train have been built and integrated for 90% capture level has been demonstrated. Important techniques have been developed such as (i) implementing heat transfer intensification techniques to increase energy saving in the heat recovery steam generator, (ii) extracting suitable steam from the heat recovery steam generator to supply the heat required by the capture process, (iii) employing exhaust gas recirculation to increase the overall energy efficiency of the integrated process. This can increase power plant efficiency and reduce heat demands of the capture process simultaneously. The paper concludes that optimal solution based on the proposed approaches can provide sufficient heat to CO_2 capture process, and keep the same power generation.

Li et al. [16] demonstrated a simulation and analysis of CO_2 capture process with aqueous monoethanolamine solution. An improved rate-based model of CO_2 capture process is developed in this study. It is validated by a pilot plant and compared with an existing example model within a simulation tool. Comparison shows that the new model can properly predict the operating parameters of the pilot plant and is much more accurate than the example model. Especially, the error on mass balance has been and the washing section of the absorber column has been modelled successfully by a separate column. Their work shows that accurate rate-based model can be built by selecting suitable unit models and providing proper optional estimates with simulation software and much labour work can be saved. In addition, the function of washing section has been clearly demonstrated and the factors to