Special Issue on “Energy, Economy and Environment for Industrial Production Processes”

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Editorial

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1. Introduction

Facing significant natural resource consumption, environmental degradation, and climate warming, governments and international organizations have increased their focus on ecological modernization, green growth, and low carbon development, with various sustainable development strategies. The industrial sector, recognized as an important pillar in many nations' economy, brings vast amounts of energy consumption at low efficiency and high carbon emissions, becoming the walls to the coordinated development of the energy, economy, and environment. Studying the nexus among energy, economy, and environment (3E) of industrial production processes is of great importance in promoting sustainable industrial development. For these reasons, we have invited high quality papers on energy, economy and environment for industrial production processes for consideration for publication in the Processes journal.

The aim of this special issue has been to publish the articles dealing with analytical, theoretical and empirical issues related to 3E in industrial production processes. The special issue has accepted and published 30 papers addressing a wide spectrum of topics following but not restricted to:

(1) The nexus among energy, economy and environment (3E) in industrial production processes;
(2) 3E modeling and analysis in industrial production processes;
(3) 3E assessment and optimization in industrial production processes;
(4) Green production and process optimization;
(5) Cleaner energy production;
(6) Carbon emission and accounting in the industrial sector;
(7) Industrial energy efficiency.

2. Macro Analysis Issues

Busu [1] proposes a panel data econometric model to measure the relationship between renewable energy, energy productivity, population, urbanization, motorization and Gross Domestic Product (GDP) per capita, and the impacts of these on carbon dioxide (CO2) emissions. The results show that a 1% increase in renewable energy consumption would reduce CO2 emissions by 0.11 million tons, while population growth and urbanization add more restrictions to the econometric equation of the impact on carbon emissions. Iqbal et al. [2] measure energy consumption, carbon emission and economic–environmental efficiency in terms of the environmental performance of the top 20 industrial countries by employing a data envelopment analysis (DEA) model from 2013 to 2017. Their results show that most countries exhibit higher performance in economic efficiency than environmental efficiency. Zhang et al. [3] present a real option model in order to analyze the investment decisions of a coal-fired power plant on Carbon capture, utilization, and storage (CCUS) technologies under imperfect carbon emission trading schemes in China, and the research results show that the utilization ratio of captured CO2 has significant impacts on the net present value and investment value of the CCUS project. Hou et al. [4] evaluate the energy efficiency and environmental performance of South Asia, using a DEA (data envelopment analysis)-like mathematical composite indicator. They propose a policy that increases the cross-border trade of renewable energy for long term energy efficiency and environmental performance. Wang et al. [5] use a variety of models to assess the performance of Thailand's energy industry in two different phases, the first being from 2013 to 2017, and the second from 2018 to 2020. Their results show that the magnitude of the change in efficiency during the first period was stable, and some major changes in the technical level of some companies can be observed. Busu et al. [6] propose a methodology for modeling circular economy processes at the EU level, using an evaluation algorithm based on Shannon Entropy. Their results are similar to the international rankings, consolidating and confirming the accuracy and reliability of their methodology.

3. New Energy Issues

Dong et al. [7] develop a combined wind speed forecasting strategy that includes data pretreatment, optimization, forecasting and assessment, by considering the prerequisite of data preprocessing and the objective of simultaneously optimizing accuracy and stability. It achieves high accuracy in wind speed forecasting. Wang et al. [8] study a hybrid forecasting model using a data preprocessing strategy and improved extreme learning machine with kernel. Their experimental results indicate that the hybrid method has higher forecasting accuracy for short-term wind power forecasting. Siyal et al. [9] develop a new hybrid mathematical model that combines a wind-speed range with the log law to derive the wind energy potential for wind-generated hydrogen production in Pakistan, and electrolyze wind-generated power in order to assess the generation capacity of wind-generated renewable hydrogen. They offer a strategy for reducing the energy shortfall, and thus contribute to the fight against climate change and global warming. Li et al. [10] propose an industrial application-oriented wind farm automatic generation control strategy to stabilize wind farm power output under power limitation conditions, and the results demonstrate that the performance is markedly improved by using the proposed strategy over the conventional strategy. Chu et al. [11] propose a receding-horizon optimization strategy for optimizing wind farm active power distribution with power tracking error and transmission loss. Their simulation results show significant improvement in both the optimization targets of the proposed strategy.

Variny et al. [12] present a novel conceptual design and techno-economic analysis of an alkylation reaction effluent fractionation revamp, in order to cut the energy cost of the fractionation process without the need to revamp the rectification columns themselves, thus providing an alternative approach to a more sustainable alkylation process. Liu et al. [13] study an integrated optimization methodology to ensure the optimal performance of a plug-in hybrid electric bus, with a view toward its design and applications. Their verification results demonstrate that the proposed model-free adaptive control-based method is applicable to both the typical and unknown stochastic driving cycles, and can further improve fuel economy over a conventional proportional–integral–differential (PID) controller.

4. Manufacturing Engineering Issues

Xiao et al. [14] propose an energy saving and low-cost-oriented multi-objective optimization model and approach to blank dimensions design, using the non-dominated genetic algorithm-II (NSGA-II), aiming at the minimization of energy consumption and cost during blank manufacturing. Peng et al. [15] address an approach to optimizing and evaluating the ecological efficiency (EE) of a remanufacturing process. Their results indicate that the probability of deviation of the evaluation function established using polynomial function fitting is 5%, and the accuracy of the evaluation can effectively meet the requirements. To quantitatively evaluate and improve the sustainability of machining systems, Sun et al. [16] present an energy-based sustainability evaluation and improvement method for machining systems, contributing to the improvement of energy efficiency, resource efficiency and environmental performance, and realizing sustainability development. Considering that most of the existing integrations of scheduling and process planning mainly focus on optimization techniques for improving the makespan criterion, instead of the more efficient use of energy, Jin et al. [17] introduce a multi-objective memetic algorithm with a variable neighborhood search (VNS) technique for this problem. Their results show that energy saving can be realized by completing machining as early as possible on a machine tool, and taking advantage of machine flexibility. Lv et al. [18] illustrate a composite evaluation method for sustainable manufacturing in a machining process for typical machine tools in terms of energy efficiency, carbon efficiency and green degree, by considering the theory and experimenting with a resource, energy and emission modeling method. They propose corresponding strategies for energy conservation and emission reduction. For metal forming, which is an important process in manufacturing, Gao et al. [19] perform a comprehensive literature review on the energy consumption, energy efficiency and energy saving of metal-forming processes from different hierarchies, and describe the relationships among equipment, processes and manufacturing systems, thus providing a methodological guideline for energy efficiency and saving in metal forming, and serving as a reference for the decisions made by producers and managers in order to realize energy efficiency and energy saving at the system level.

5. Petrochemical Engineering Issues

Variny et al. [20] study the process of heat source change in industrial conditions for the purpose of an objective assessment from energetic, environmental and economic points of view, thereby aiding engineers and energy managers in working towards sustainable production. Tutak et al. [21] perform a comparison study of two combustion systems of fuels with different reactivities; the first of which is combustion of the fuel mixture, and the second is combustion in a dual-fuel engine. They analyze both the advantages and disadvantages for both methods of co-firing fuels. Wang et al. [22] study the synergistic high-value reuse of waste tires and used catalysts in spent fluid catalytic cracking (FCC) catalysts to address the serious ecological and environmental problems caused by waste tires and spent FCC catalysts. Their results show that the content of 2-methyl-1-propylene in catalytic cracking gas is found to be up to 65.59%. Hence, they introduce a new method for producing high-value chemical raw material by the catalytic cracking of waste tires with spent FCC catalysts. Zhu et al. [23] study the enhancement effect of ordered hierarchical pore configuration on the SO_2 adsorption and desorption process. Their results show that the ordered hierarchical carbon can promote H_2SO_4 desorption efficiency and cycled SO_2 adsorption–desorption performance, further indicating that interconnecting micro and mesopores facilitates the diffusion of adsorbates. Liu et al. [24] describe the formation mechanism of trailing oil in pipelines, and study the influence of dead-legs on the formation of trailing oil. They find that the oil replacement rate in a dead-leg is exponentially related to the flow speed, and the length of the dead-leg is exponentially related to the replacement time of the oil.

6. Other Issues

These are some accepted papers in the Special Issue on Energy, Economy and Environment for Industrial Production Processes, besides the macro analysis issues, new energy issues, manufacturing engineering issues and petrochemical engineering issues. Lei et al. [25] perform an optimization study of tubular microalgal photobioreactors with spiral ribs under single-sided and double-sided illuminations, and study a spiral rib structure. This is introduced into a tubular microalgal photobioreactor (PBR) to improve the mixing performance and the light utilization efficiency. Atmaca et al. [26] perform an investigation into the total efficiency of water and air used together as the working fluid in photovoltaic thermal systems. Their results show that when water and air are used together, it is more efficient than their respective single usage in a photovoltaic-thermal (PV/T) system. Sánchez et al. [27] propose the new advanced configuration of an absorption heat transformer that improves the coefficient of performance by utilizing a double generation process. They establish a numerical model of operation for the new configuration. Their main findings are discussed and presented by emphasizing the effects of several parameters on the system's performance. Miao et al. [28] present a scenario-based optimization model for planning sustainable water-resource process management under uncertainty. Their results reveal that different water-distribution proportion scenarios and uncertainties can lead to changed water allocations, sewage discharges, chemical oxygen demand (COD) emissions and system benefits, and the variation of scenarios (i.e., from S2 to S3) can result in a change of 9% over the planning horizon for water allocation in the industrial sector. Wang et al [29] integrate the Holt–Winters model into a number cruncher statistical system (NCSS) to estimate the forecasting data and the undesirable model in data envelopment analysis (DEA), in order to calculate the efficiency of electricity production in 14 countries from the past to the future. Li et al [30] propose a two-step many-objective optimal power flow (MaOPF) solution method based on a knee point-driven evolutionary algorithm, and through examining the two-step method via the IEEE 118-bus system and the real-world Hebei provincial power system they verify that the approach is suitable for addressing the MaOPF problem of power systems.

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