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Editorial

Special issue — Energy systems engineering

Energy is one of the most critical international issues at the moment and most likely to be so for the years to come. As part of the energy debate, it is becoming gradually accepted that current energy systems, networks encompassing everything from primary energy sources to final energy services, are becoming unsustainable. Driven primarily by concerns over urban air quality, global warming caused by greenhouse gas emissions and dependence on depleting fossil fuel reserves, a transition to alternative energy systems is receiving serious attention. Such a tradition will certainly involve meeting the growing energy demand of the future with greater efficiency as well as using more renewable energy sources (such as wind, solar, biomass, etc.). While many technical options exist for developing a future sustainable and less environmentally damaging energy supply, they are often treated separately driven by their own technical communities and political groups.

Energy systems engineering provides a methodological scientific framework to arrive at realistic integrated solutions to complex energy problems, by adopting a holistic, systems-based approach. This special issue demonstrates the potential of an energy systems engineering based approach to systematically quantify different options at different levels of complexity (technology, equipment, plant, energy supply chain, mega-system).

This special issue brings together researchers from around the world with an interest in the development and application of process systems engineering techniques to improve the design and operation of energy systems. A traditional interest in the field is the development of process design, synthesis, integration and optimization techniques for energy savings in the process industries: Allman and Daoutidis (2018) present an optimization-based approach for the scheduling of wind-powered ammonia generation and they investigate the effect of key design parameters in the optimal operation cost. Ploskas et al. (2018) present an efficient derivate-free optimization approach for the circuitry arrangements for heat exchangers. Liu and Karimi (2018), propose a method for simulating the part-load operation of a typical combined cycle gas turbine followed by a simulation-based approach that yields an optimal operating strategy. Dimian and Bildea (2018) introduce a methodology for the conceptual design of an energy efficient and cost-effective methanol-to-olefin process. Long et al. (2018) illustrate a practical approach that employs a coordinate descent methodology that is assisted by a grid search to find promising solutions for the optimal retrofit design of existing divided-wall distillation columns. Knapik et al. (2018) present a cryogenic method for the efficient separation of liquid CO_2 from flue gases produced by oxy-fuel combustion. Wu et al. (2018) propose an integrated high temperature and low temperature system with advanced coal gasification and Fischer–Tropsch techniques for high value chemicals coproduction. Huang et al. (2018) present a high temperate and low temperature Fischer–Tropsch combined plant in olefin production and evaluate its economic performance. El-Agouz et al. (2018) investigate the theoretical performance of humidification–dehumidification desalination units using a desiccant wheel or heat exchanger to increase the thermal performance Han et al. (2018) present an integrated gasification combined cycle model based on coal water slurry gasification that provides the basis for investigating the effect of various operating parameters on the performance and energy recruitments of the plant.

The design and operation of energy supply chains is an area of growing interest: Ascenso et al. (2018) describe a spatial multi-period mixed-integer linear programming framework for the optimisation of a multi-echelon supply chain simultaneously in terms of economic and environmental performance. Medina-González et al. (2018) propose an efficient strategy to design a sustainable supply chain under uncertain raw material conditions. Martín-Hernández et al. (2018) present a mixed-integer nonlinear programming strategy to design integrated facilities that simultaneously recover power and nutrients from organic waste. Pan et al. (2018) propose a dynamic input–output model to present the interaction mechanisms between energy supply and demand, and provide optimal design for energy supply–consumption systems. Fubara et al. (2018) describe a comprehensive model for assessing the technological entry paths for biogas and bio- synthetic natural gas into the sector of domestic energy supply. Zulkafli and Kopanos (2018) present a general spatial optimization framework that relies on the use of a modified state-task network representation for design and planning problems in material and energy supply chain networks. Nikas et al. (2018) use a systematic approach to study the potential contribution to biogas national production, by cultivating sunflower. A case study from Greece is used to illustrate their approach. Zore et al. (2018) introduce the concept of

sustainability net present value for the synthesis of renewable energy supply networks. Weber and Papageorgiou (2018) develop a mixed-integer linear programming model with the aim of designing a pipeline network for hydrogen transmission. Ogumerem et al. (2018) present a multi-objective, multi-period, mixed-integer linear programming formulation to analyse a hydrogen supply chain network.

The application of process systems engineering in the design and operation of microgrids has recently received significant attention: Silvente et al. (2018) present a mixed-integer linear programming approach for the optimal management of microgrids under stochastic uncertainty. Koltsaklis et al. (2018) propose a general optimization framework for the optimal design and operational scheduling of energy microgrids. Gao et al. (2018b) present a new approach for the day-ahead price forecasting of electricity markets. Kohsri et al. (2018) describe a pilot-scale evaluation of the potential of a hybrid solar PV/biomass system with battery energy storage to meet the electrical load demand at night or on cloudy days.

Carbon management is also an area of growing interest in chemical engineering, with applications in industry and energy conversion processes: Nikolaidis et al. (2018) study the synergistic benefits between material and process design in pressure/vacuum swing adsorption processes for post combustions CO2 capture. Zhang et al. (2018) present a 2D symmetric model fora CO_2-piperazine (PZ)-membrane absorption process. Aftab et al. (2018) study experimentally the equilibrium solubility of CO_2 in aqueous Na-βala for various concentrations and used a Kent Eisenberg model to correlate experimental data. Dehjalali and Avami (2018) discuss how experimental data can be used to identify the economic operating conditions of a pressure swing adsorption process. Hu et al. (2018) use a zero-length column technique to study the stability of novel adsorbents in the presence of water, SOx and NOx impurities typically met in coal-fired power plant flue gasses. Damartzis et al. (2018) present an evaluation of the operation of alternative solvents for post-combustion CO_2 capture under varying process conditions. He et al. (2018) implement model predictive control strategies to address different stripper configurations for the CO_2 capture process as part of supercritical pulverized coal-fired power plants. Vooradi et al. (2018) present a brief review of the available energy sources, CO_2-emissions and management, and sustainable chemical processing, where energy consumption, CO_2-emissions, as well as economics and environmental impacts are considered.

Efficient modelling techniques for energy intensive process is a challenging area in the process systems engineering community: Tran et al. (2018) introduce a statistical-based model identification scheme that generates a high-fidelity model for the outer reforming tube wall temperature distribution in a steam methane reforming process. Morin et al. (2018) study experimentally the kinetic of steam gasification of biomass char in a fluidized bed reactor at atmospheric pressure. Hajizadeh et al. (2018) discuss the feasibility of three methods for Flare gas recovery systems and their application in a real gas refinery. Epelle and Gerogiorgis (2018) present a comprehensive steady and unsteady state analysis of drill cuttings transport phenomena under turbulent conditions using Eulerian–Eulerian and Lagrangian–Eulerian multiphase modelling methods. Blay and Bobadilla (2018) analyse in silico some typical thermowell configurations used in small-scale reactors by coupling computational fluid dynamics with conjugated heat transfer phenomena. Azamipour et al. (2018) propose an improved optimization workflow for oil production and water injection allocation for oil reservoirs under waterflooding. Payet et al. (2018) present a model-based methodology for assessing the flexibility of heat exchange networks.

Another key focus area is the design and optimisation of novel advanced energy systems: Lai and Adams (2018) present the design and analysis of a new integrated direct steam generation concentrated solar power plant with a decalin/naphthalene thermochemical storage system. Pantoleontos et al. (2018) discuss a first simplified approach on the exploitation of “direct” solar heat during on-sun operation, and stored solar-heat through thermochemical energy storage involving redox pair cycles during off-sun operation, for the production of solar hydrogen using concentrated solar energy. Wang et al. (2018) present a model-based approach to identify design improvements of a CO_2 transcritical refrigeration cycle in air-conditioning applications. Tumsa et al. (2018) discuss a parametric study of the efficiency of NO_x and SO_x removal from the flue gas of an oxy-fuel combustion process. Kong et al. (2018) introduce a Bauxite-modified oxygen carrier for chemical looping combustion as an efficient solution to the heat of combustion compensation. Ma et al. (2018) present an optimization model for synthesizing cooling water system with air coolers. Ziogou et al. (2018) illustrate the experimental application of different model predictive control strategies in a PEM fuel system. Chen et al. (2018) present an electric vehicle and multi-region load-dispatch grid-structure-based mathematical model to study the interaction between electric vehicles and the power sector.

The final group of papers describe the application of Life Cycle Analysis (LCA) methodologies in energy systems: Tagliaferri et al. (2018) discuss the environmental potential of electricity and CO_2 production through oxyfuel combustion of lignite. Peng et al. (2018) present an extended electric vehicle LCA model to analyse the life cycle energy consumption and greenhouse gas emissions of electric vehicles. Gao et al. (2018a) illustrate the application of a LCA approach in coal-based synthetic natural gas plants for the supply of heat and electricity.

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