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Economic Optimization of

Steam Plant Operation Tianbo Liu 2013 The utility system plays an important role in efficient plant operations of chemical processes. In this thesis, economic optimization of steam utility system is investigated in detail. The objective is: 1) to calculate the optimal generation amount of steam and electricity under uncertainty in process and electricity market; 2) to distribute the generated steam in a most efficient way throughout the steam network. In this work, steam distribution system is represented as a network with dynamic process equipment models. Operating constraints and uncertain process disturbances are included to accurately represent plant operations. A cost-benefit analysis reveals that electricity price plays an important role in optimal plant operations. Thus, to maximize the economic profit of a steam plant in the long term, a high quality electricity price prediction model is developed based on a robust switched system identification algorithm. The algorithm is formulated using Expectation-Maximization (EM) algorithm to estimate parameters in prediction model, noise distribution and switching dynamics. Dynamic process models and electricity price prediction models are integrated into a linear programming problem that uses plant profit as the performance objective. Random process variables are included to represent process uncertainty. The optimization effect is evaluated by comparing the plant profit from routine operations and from optimized operations. The distribution of optimized plant profit is obtained by solving the distribution problem of stochastic linear programming (SLP). A metric based on Earth Mover's Distance (EMD) is introduced to measure the difference between plant profit distributions. Based on the validation results of developed models and proposed performance evaluation method, the optimized steam plant operations show significant advantage over the routine ones when electricity prices vary considerably.

Environmental and Economic Comparison of Cooling System Designs for Steam-electric Power Plants

Kenneth Fred Najjar 1979 The selection of waste heat rejection systems for steam-electric power plants involves a trade-off among environmental, energy and water conservation, and economic factors. This study compares four general types of cooling systems on the basis of these factors. The cooling systems chosen for study are: once-through systems including surface canals and submerged multiport diffusers; shallow closed cycle cooling ponds; mechanical and natural draft evaporative cooling towers; and mechanical draft dry towers. The cooling system comparison involves, first, an optimization of each cooling system and then a comparison among optimal systems. Comparison is made for an 800 MWe fossil unit and a 1200 MWe nuclear unit located at a hypothetical midwestern river site. A set of models has been developed to optimize the components of each cooling system based on the local meteorological and hydrological conditions at the site in accordance with a fixed demand, scalable plant concept. This concept allows one to compare the costs of producing the same net power from each plant/cooling system. Base case economic parameters were used to evaluate the optimum system for each of the four general cooling systems followed by a sensitivity study for each parameter. Comparison of energy and water consumption follows from the results of the performance model, while comparison of environmental impacts is mostly qualitative. Some quantitative modelling was performed for the environmental effects of thermal discharges from once-through systems, fogging from wet cooling towers and water consumption from the ponds, wet towers and once-through. The results of the optimization models of each of the systems are compared on the basis of: performance - discrete distributions of environmental conditions and transient simulation; economics - using base case scenarios and sensitivity values to arrive at costs expressed in terms of production costs, annualized costs and present value costs; energy and water consumption; and environmental effects. The once-through systems were found to be the least expensive of the four systems, the most energy efficient, but potentially the most environmentally damaging. On the other extreme, dry cooling towers are the most environmentally sound while being the most expensive and least energy efficient. Finally, the results of the economic optimization are compared with results from previous comparative studies. *Mathematical Modelling of an Industrial Steam Methane Reformer* Dean Latham 2008 A mathematical model of a steam-methane reformer (SMR) was developed for use in process performance simulations and on-line monitoring of tube-wall temperatures. The model calculates temperature profiles for the outer-tube wall, inner-tube wall, furnace gas and process gas. Reformer performance ratios and composition profiles are also computed. The model inputs are the reformer inlet-stream conditions, the geometry and material properties of the furnace and catalyst-bed. The model divides the furnace and process sides of the reformer into zones of uniform temperature and composition. Radiative-heat transfer on the furnace side is modeled using the Hottel Zone method. Energy and material balances are performed on the zones to produce non-linear algebraic equations, which are solved using the Newton-Raphson method with a numerical Jacobian. Model parameters were ranked from most-estimable to least estimable using a sensitivity-based estimability analysis tool, and model outputs were fitted to limited data from an industrial

SMR. The process-gas outlet temperatures were matched within 4 °C, the upper and lower peep-hole temperatures within 12 °C and the furnace-gas outlet temperature within 4 °C. The process-gas outlet pressure, composition and flow rate are also accurately matched by the model. The values of the parameter estimates are physically realistic. The model developed in this thesis has the capacity to be developed into more specialized versions. Some suggestions for more specialized models include modeling of separate classes of tubes that are in different radiative environments, and detailed modeling of burner configurations, furnace-gas flow patterns and combustion heat-release patterns.

International Seminar of Horizontal Steam Generator Modelling : March 11 - 13, 1991, Lappeenranta, Finland. 2(1991) 1991

Medium Scale Modeling and Controller Optimization of a Boiler-turbine System 1983 "A mediun scale physically based boiler-turbine model is developed to solve a class of controller optimization problems. The model has 7 states in the process and 25 in the control system. The model simulates the normal operating conditions of a '235 MW boilerturbine system when the load and load rate trajectories are known in advance. The model is validated using steady state and dynamic field test data. The validation results shew model errors of critical plant variables to be less than 2% for steady state loads and less than 3% in dynamic load excursions. A Rosenbrock optimization algoritrm is used to solve the optimal set-point scheduling problem for hot reheat steam temperature, main steam temperature and pressure in the steam cycle. The optimization strategy uses control vector parameterization in which the boiler controller set-point function generators are modified to produce suboptimun signals. The performance index consists of the total BTU input to the system from fuel and punp work. Variable limits and constraints are implemented using two monitors that provide observations of critical alarm limits in the boiler-turbine variables and hoop stresses in the boiler heat exchanger tubes." hoja vii.

Advances in Steam Turbines for Modern Power Plants Tadashi Tanuma 2022-07-29 Advances in Steam Turbines for Modern Power Plants

Technology Report and Product Directory, Land, Sea & Air 1998

Integrated Approaches to the Optimization of Process-utility Systems Nasser Ahmed Al-Azri 2010 The goal of this work is to develop a conceptual framework and computational tools for the optimization of utility systems in the process industries. The emphasis is devoted to the development of systematic design techniques aimed at identifying modifications to the process and the associated utility-systems to jointly optimize the process and the utility system. The following contributions describe the specific results of this work: · Development of shortcut methods for modeling and optimizing steam systems and basic thermodynamic cycles with the objective of using these methods in the optimization of combined heat and power. To enable efficient mathematical programming formulations, simple yet accurate correlations have been developed for the thermodynamic properties of steam in the utility system. · Optimization of multi-level steam system for combined process requirements and power cogeneration. A general procedure is developed to determine rigorous cogeneration targets and the optimal configuration of the system with the associated design and operating variables.· Graph theory methods are also used to optimize the pipeline layout in the plant for the distributing the utilities. · Finally, because of the nonconvex nature of much of the developed optimization formulations, a global optimization method has also been suggested by using interval analysis and simulated annealing. The techniques proposed in this work are compared to previous works and their applicabilities are presented in case studies. These techniques outperform previously suggested ones in terms of the accuracy, computational efficiency and/or optimality.

Electrical & Electronics Abstracts 1997

Optimisation and development of existing steam plant by modelling, IMechE HQ, 1st December 1998 Steam Power Committee 1998

Real Life Applications of Soft Computing Anupam Shukla 2010-05-21 Rapid advancements in the application of soft computing tools and techniques have proven valuable in the development of highly scalable systems and resulted in brilliant applications, including those in biometric identification, interactive voice response systems, and data mining. Although many resources on the subject adequately cover the theoretic concepts, few provide clear insight into practical application. Filling this need, Real Life Applications of Soft Computing explains such applications, including the underlying technology and its implementation. While these systems initially seem complex, the authors clearly demonstrate how they can be modeled, designed, and implemented. Written in a manner that makes it accessible to novices, the book begins by covering the theoretical foundations of soft computing. It supplies a concise explanation of various models, principles, algorithms, tools, and techniques, including artificial neural networks, fuzzy systems, evolutionary algorithms, and hybrid algorithms. Supplying in-depth exposure to real life systems, the text provides: Multi-dimensional coverage supported by references, figures, and tables Warnings about common pitfalls in the implementation process, as well as detailed examinations of possible solutions A timely account of developments in various areas of application Solved examples and exercises in each chapter Detailing a wide range of contemporary applications, the text includes coverage of those in biometric systems, including physiological and behavioral biometrics. It also examines applications in legal threat assessment, robotic path planning, and navigation control. The authors consider fusion methods in biometrics and bioinformatics and also provide effective disease identification techniques. Complete with algorithms for robotic path planning, the book addresses character recognition and presents the picture compression technique by using a customized hybrid algorithm. The authors conclude with a discussion of parallel architecture for artificial neural networks and supply guidelines for creating and implementing effective soft computing designs.

Modelling, Control and Optimisation of Geothermal Organic Rankine Cycle Power Plants Matthew Proctor 2016 The organic Rankine cycle (ORC) is a heat recovery technology with applications in renewable energy generation such as geothermal power and waste heat recovery. In this thesis the ability of model based control and optimisation techniques to increase the value generated from geothermal ORCs is examined. Existing geothermal ORCs use decentralised proportional-integral (PI) control loops to regulate plant operation. This thesis analyses the benefit to be gained by applying advanced process control to geothermal ORCs. The design and operation of geothermal ORCs relies on analysis that does not consider the full range of disturbances that are likely to impact the plant. This thesis also investigates the additional value of considering the disturbances during design and operation of geothermal ORCs. In the literature ORCs are modelled mechanistically and this approach is also used in this thesis. Models consist of unit operations connected by process streams. Typically these are lumped parameter models but some distributed parameter modelling is observed in heat exchanger models. The model equations consist of thermodynamic state, mass and energy balance, heat transfer, and adiabatic compression and expansion calculations which describe the physical processes in the plant. Steady-state models have been constructed for geothermal and waste heat recovery ORCs and dynamic models have been constructed for waste heat recovery ORCs but there is a gap in the literature in dynamic models of large scale geothermal ORCs like the one examined in this thesis. To address this gap a dynamic model of a commercial geothermal ORC plant was built using the process simulator VMGSim, and validated using twenty-four hours of plant data. This validation showed that the plant data agreed reasonably well with the model output. A novel outcome of this model was that the results indicated that the dynamics of the working fluid cycle are fast compared to plant disturbances. The existing PI controllers are able to provide control that is adequate and in general advanced control techniques cannot provide additional benefits commensurate with their cost and complexity. The control of small scale ORCs including the application of advanced control techniques such as model predictive control was examined in the literature. The literature on ORC control focusses mainly on highly variable heat resources such as those seen in waste heat recovery applications. There is a gap in the literature in the control of large scale ORCs in geothermal applications, although some research has been done on the control of hybrid systems that combine geothermal with other heat resources such as solar. From the results of the dynamic model it is known that the dynamics of the system are fast enough that sophisticated control techniques are unlikely to have an impact on plant performance above simpler PI controllers. Instead, a specific area where advanced control could provide a benefit was examined. The impact of feed-forward control on using the geothermal wellhead valves to maintain pipeline pressure was examined using the dynamic model. A novel result of this study was a demonstration that feed-forward control can reduce the amount of geothermal fluid released to the atmosphere. This has sustainability benefits for the geothermal reservoir and also prevents emission of CO2 and other pollutants present in the geothermal fluid to the atmosphere. This study also found the impact of the feed-forward controller on net power was minimal. There is substantial literature on optimisation of a wide variety of ORCs and heat source types including geothermal ORCs. Optimisation research in this area has examined ORCs using multiple objective functions including net power, efficiency, exergy, and thermoeconomic functions that measure both thermodynamic and economic value. One area that the literature does not consider explicitly is the consideration of disturbances when performing ORC plant optimisation. This thesis seeks to address this gap and does so in three ways. The first is in investigation of sizing of the air-cooled condenser in the modelled geothermal ORC plant. The size of this heat exchanger was examined with respect to the range of air temperatures that were recorded over a period of one year at the site. The original sizing of the condenser was done by assuming the average air temperature as the design point. A new condenser sizing was found by applying the heuristic that the sizing of the condenser should be based on the 95th percentile of the recorded air temperatures. An economic analysis was then performed that considered how the net power of the plant would be changed across the entire air temperature range. This concluded that an increase in the air condenser to the new size would have a payback period of only a couple of years, which indicates it may be profitable. The second way the consideration of disturbances when optimising geothermal ORCs is addressed by this thesis is through building and validating a steady state model of a commercial geothermal ORC in VMGSim and MATLAB. This model includes the geothermal gathering system which is essential to properly understanding the behaviour of geothermal ORCs. MATLAB was used to converge the model more quickly and coordinate the solution of large datasets. This was used for model validation and to optimise geothermal flow rate and turbine choked area for the plant, which identified an improvement in net power by adjusting the geothermal flow rate and turbine choked area. The behaviour of the plant for a range of turbine choked areas and geothermal flow rates and for different fouling conditions in the heat exchangers was also analysed which allowed the nature of heat transfer between the geothermal gathering system and ORC to be determined. This revealed a link between the pressure-flow dynamic of the geothermal gathering system and the pressure-flow dynamic of the ORC which will be useful to plant designers in the future. The third and final way disturbances were accounted for in the optimisation of ORCs was by applying self-optimising control to the plant steady state model. This demonstrated that this method can show an improvement in net power when the plant is subject to disturbances. Using a MATLAB program, controlled variables were selected that optimise the plant when they are held at a constant set point over a range of disturbance scenarios. This method is a slightly modified version of the existing self-optimising control method that greatly increases the speed of the analysis without impacting the improvement in net power output of the plant. An approximate self-optimising control method was developed and applied to the plant steady state model to show that it can provide an improvement in net power when the plant is subject to disturbances. Using a MATLAB program, a controlled variable—which is a linear combination of plant measurements—is selected that optimises the plant when it is held at a constant set point over a range of disturbance scenarios. This method is a modified version of the existing self-optimising control method that greatly increases the speed of the analysis without significantly impacting its accuracy. It can also be used with a model created in process simulation software, which allows it to be implemented more easily. It was found that the controlled variable that was selected caused the plant to operate at its optimum point across the range of expected disturbances. From the work presented in this thesis it is demonstrated that advanced process control will not bring significant benefits to large scale geothermal ORCs, but in certain niche applications it can provide a benefit. It is also shown that by considering plant disturbances improvements can be made to plant design and operation that generate greater value from geothermal ORCs.

Monte Carlo Simulation of Ultra-Supercritical Pulverized Coal-Fired Power Plant Yaowaluk Thongprasat 2014

Handbook of Liquefied Natural Gas Saeid Mokhatab 2013-10-15 Liquefied natural gas (LNG) is a commercially attractive phase of the commodity that facilitates the efficient handling and transportation of natural gas around the world. The LNG industry, using technologies proven over decades of development, continues to expand its markets, diversify its supply chains and increase its share of the global natural gas trade. The Handbook of Liquefied Natural Gas is a timely book as the industry is currently developing new large sources of supply and the technologies have evolved in recent years to enable offshore infrastructure to develop and handle resources in more remote and harsher environments. It is the only book of its kind, covering the many aspects of the LNG supply chain from liquefaction to regasification by addressing the LNG industries' fundamentals and markets, as well as detailed engineering and design principles. A unique, well-documented, and forward-thinking work, this reference book provides an ideal platform for scientists, engineers, and other professionals involved in the LNG industry to gain a better understanding of the key basic and advanced topics relevant to LNG projects in operation and/or in planning and development. Highlights the developments in the natural gas liquefaction industries and the challenges in meeting environmental regulations Provides guidelines in utilizing the full potential of LNG assets Offers advices on LNG plant design and operation based on proven practices and design experience Emphasizes technology selection and innovation with focus on a "fit-for-purpose design Updates code and regulation, safety, and security requirements for LNG applications

Steam Plant PEP (Professional Engineering Publishers) 1999-03-19 The papers in this text focus on system modelling to determine effects beyond the basis of the original steam plant design, including new applications of standard techniques and novel solutions of known problems.

Simulation of Large State Variations in Steam Power Plants Richard Dolezal 2013-03-12 The present simulation method has been developed at the Institute for Power Technology and Steam Generation (IVD) of the University of Stuttgart. It is being successfully employed in the analysis of processes involving large state changes such as start-ups, shut downs, malfunctions and failures in steam power generating unit, which is a large scale system consisting of several subsystems with distributed parameters, to which the steam generator also belongs. This research resulted from the increasing use of the once-through boiler, while simultaneously raising the steam parameters into the region of the supercritical state, using sliding pressure operation, combined processes with gas and steam turbines etc. The objective of this system simulation is to reduce losses of heat and condensate and to minimise unavoidable thermal stresses. The project was financed between 1979 and 1983 by the German Research Society (DFG) as part of the special research section Nr. 157 'Thermal power plants'. The Westfalen Power Company Inc. (VEW) sponsored the start-up code 'DYSTAR'. We would like to express our thanks for this support. The following members of the IVD were involved in this research project: Dr.-Ing. J. Kley Dipl.-Ing. G. Riemenschneider Dr.-Ing. A. Rolf Dipl.-Ing. U. Mayer Dipl.-lng. E. Dr.-lng. M. Klug Pfleger Dr.-Ing. G. Berndt Presently it is intended to use this non-linear, time-variant model of a power generating unit with a variable process and system struc ture as the basis for simple code versions, which one can employ e.g.

Energy Research Abstracts 1978

Process and Chemical Engineering 1999-06

International Seminar of Horizontal Steam Generator Modelling International Seminar of Horizontal Steam Generator Modelling 1991, Lappeenranta 1991

Development and Implementation of a Nuclear Power Plant Steam Turbine Model in the System Code ATHLET Jordi Bassas de Sivatte 2010 In order to improve the simulation of the whole secondary loop with the system code ATHLET a steam turbine model has to be implemented. This paper deals with the development of a thermo-hydraulic model of a Nuclear Power Plant steam turbine and its implementation in the system code ATHLET. The model is based on

Stodola's cone law and simulates the pressure drop and the enthalpy drop along the different turbine stages as well as the steam and water extractions. The influence of the steam and water extractions on the turbine behaviour as well as the importance of an accurate model for the steam and water extrac-tions are carefully explained. Heat and mass balances of the Nuclear Power Plant Philippsburg 2 are used for reference purposes as well as for validation purposes of the implemented model. The comparison between steady state simulations and the real plant data indicate a satisfactory accuracy of the model and of the thermodynamic approach used.

CEP Software Directory 1998

The Energy Index 1985

Chemical Engineering Design Gavin Towler 2012-01-25 Chemical Engineering Design, Second Edition, deals with the application of chemical engineering principles to the design of chemical processes and equipment. Revised throughout, this edition has been specifically developed for the U.S. market. It provides the latest US codes and standards, including API, ASME and ISA design codes and ANSI standards. It contains new discussions of conceptual plant design, flowsheet development, and revamp design; extended coverage of capital cost estimation, process costing, and economics; and new chapters on equipment selection, reactor design, and solids handling processes. A rigorous pedagogy assists learning, with detailed worked examples, end of chapter exercises, plus supporting data, and Excel spreadsheet calculations, plus over 150 Patent References for downloading from the companion website. Extensive instructor resources, including 1170 lecture slides and a fully worked solutions manual are available to adopting instructors. This text is designed for chemical and biochemical engineering students (senior undergraduate year, plus appropriate for capstone design courses where taken, plus graduates) and lecturers/tutors, and professionals in industry (chemical process, biochemical, pharmaceutical, petrochemical sectors). New to this edition: Revised organization into Part I: Process Design, and Part II: Plant Design. The broad themes of Part I are flowsheet development, economic analysis, safety and environmental impact and optimization. Part II contains chapters on equipment design and selection that can be used as supplements to a lecture course or as essential references for students or practicing engineers working on design projects. New discussion of conceptual plant design, flowsheet development and revamp design Significantly increased coverage of capital cost estimation, process costing and economics New chapters on equipment selection, reactor design and solids handling processes New sections on fermentation, adsorption, membrane separations, ion exchange and chromatography Increased coverage of batch processing, food, pharmaceutical and biological processes All equipment chapters in Part II revised and updated with current information Updated throughout for latest US codes and standards, including API, ASME and ISA design codes and ANSI standards Additional worked examples and homework problems The most complete and up to date coverage of equipment selection 108 realistic commercial design projects from diverse industries A rigorous pedagogy assists learning, with detailed worked examples, end of chapter exercises, plus supporting data and Excel spreadsheet calculations plus over 150 Patent References, for downloading from the companion website Extensive instructor resources: 1170 lecture slides plus fully worked solutions manual available to adopting instructors

Process Modelling and Simulation César de Prada 2019-09-23 Since process models are nowadays ubiquitous in many applications, the challenges and alternatives related to their development, validation, and efficient use have become more apparent. In addition, the massive amounts of both offline and online data available today open the door for new applications and solutions. However, transforming data into useful models and information in the context of the process industry or of bio-systems requires specific approaches and considerations such as new modelling methodologies incorporating the complex, stochastic, hybrid and distributed nature of many processes in particular. The same can be said about the tools and software environments used to describe, code, and solve such models for their further exploitation. Going well beyond mere simulation tools, these advanced tools offer a software suite built around the models, facilitating tasks such as experiment design, parameter estimation, model initialization, validation, analysis, size reduction, discretization, optimization, distributed computation, co-simulation, etc. This Special Issue collects novel developments in these topics in order to address the challenges brought by the use of models in their different facets, and to reflect state of the art developments in methods, tools and industrial applications.

Model-based Efficiency Analysis of Power Plants with Carbon Footprint Constraints Chen Chen 2020 To address the issues caused by CO_2 emissions from the fossil-fueled combustion process by the power generation system, the comprehensive analysis of large-scale dynamic power plant systems with varying power load and supervisory control architecture that include carbon footprint constraints is presented. Model-based, system-scale dynamic simulation and optimization are useful tools for assessment and prediction of plant performance, decisions on the design configuration, and the tuning of operating procedures and control strategies. Efficiency estimates are provided for all the scenarios studied, and these estimates are optimal in terms of design configuration, control architecture and process sequencing. Moreover, the need to mitigate CO2 emissions leads power plant operators to explore advanced options for efficiency optimization and integration of power plants with carbon capture and storage (CCS) technologies. Process intensification options are explored for near-carbon-neutral, natural-gas-fueled combined cycle power plants, wherein the conventional combustor is replaced by a series of chemical-looping combustion reactors. Integrated power plant models are presented in this work, such as models of steam thermal power plants and combined cycle power plants. This work shows a complete workflow of data collection, model development, validation, control tuning, dynamic optimization formulation and solution, and supervisory control architectures for power generation systems. With the consideration of further reducing CO2 emissions, dynamic modeling and optimization are deployed to design chemical-looping combustion integrated with combined cycle power plants with optimal configuration and performance. The overall plant efficiency is improved by optimizing the chemical-looping reactor design and operation, and modifying the combined plant configuration and design. Moreover, process intensification for chemical-looping combustion reactors was explored in the form of reactor modularization. Specifically, fixed bed reactors were explored that are split into small reactor modules emulating the performance of a simulated moving bed reactor. The scheduling of the reactor modules was solved as a dynamic optimization problem that decides process variables and time intervals for the operation of each module at different chemical looping stages. The optimal scheduling of semi-batch reactors in cyclic arrangement revealed more complex patterns of gas switching that improve the thermodynamic efficiency of the process.

International Aerospace Abstracts 1998

Nuclear Science Abstracts 1972-11

The Chemical Engineer 1998

Simulation, Design and Optimization of Membrane Gas Separation, Chemical Absorption and Hybrid Processes for CO2 Capture Mohammad Hassan Murad Chowdhury 2011 Coal-fired power plants are the largest anthropogenic point sources of CO_2 emissions worldwide. About 40% of the world's electricity comes from coal. Approximately 49% of the US electricity in 2008 and 23% of the total electricity generation of Canada in 2000 came from coal-fired power plant (World Coal Association, and Statistic Canada). It is likely that in the near future there might be some form of CO_2 regulation. Therefore, it is highly probable that CO_2 capture will need to be implemented at many US and Canadian coal fired power plants at some point. Several technologies are available for CO_2 capture from coal-fired power plants. One option is to separate CO_2 from the combustion products using conventional approach such as chemical absorption/stripping with amine solvents, which is commercially available. Another potential alternative, membrane gas separation, involves no moving parts, is compact and modular with a small footprint, is gaining more and more attention. Both technologies can be retrofitted to existing power plants, but they demands significant energy requirement to capture, purify and compress the CO_2 for transporting to the sequestration sites. This thesis is a techno-economical evaluation of the two approaches mentioned above along with another approach known as hybrid. This evaluation is based on the recent advancement in membrane materials and properties, and the adoption of systemic design procedures and optimization approach with the help of a commercial process simulator. Comparison of the process performance is developed in AspenPlus process simulation environment with a detailed multicomponent gas separation membrane model, and several rigorous rate-based absorption/stripping models. Fifteen various single and multi-stage membrane process configurations with or without recycle streams are examined through simulation and design study for industrial scale post-combustion CO2 capture. It is found that only two process configurations are capable to satisfy the process specifications i.e., 85% CO2 recovery and 98% CO2 purity for EOR. The power and membrane area requirement can be saved by up to 13% and 8% respectively by the optimizing the base design. A post-optimality sensitivity analysis reveals that any changes in any of the factors such as feed flow rate, feed concentration (CO2), permeate vacuum and compression condition have great impact on plant performance especially on power consumption and product recovery. Two different absorption/stripping process configurations (conventional and Fluor concept) with monoethanolamine (30 wt% MEA) solvent were simulated and designed using same design basis as above with tray columns. Both the rate-based and the equilibrium-stage based modeling approaches were adopted. Two kinetic models for modeling reactive absorption/stripping reactions of CO2 with aqueous MEA solution were evaluated. Depending on the options to account for mass transfer, the chemical reactions in the liquid film/phase, film resistance and film non-ideality, eight different absorber/stripper models were categorized and investigated. From a parametric design study, the optimum CO_2 lean solvent loading was determined with respect to minimum reboiler energy requirement by varying the lean solvent flow rate in a closed-loop simulation environment for each model. It was realized that the success of modeling CO_2 capture with MEA depends upon how the film discretization is carried out. It revealed that most of the CO_2 was reacted in the film not in the bulk liquid. This insight could not be recognized with the traditional equilibrium-stage modeling. It was found that the optimum/or minimum lean solvent loading ranges from 0.29 to 0.40 and the reboiler energy ranges from 3.3 to 5.1 (GJ/ton captured CO_2) depending on the model considered. Between the two process alternatives, the Fluor concept process performs well in terms of plant operating (i.e., 8.5% less energy) and capital cost (i.e., 50% less number of strippers). The potentiality of hybrid processes which combines membrane permeation and conventional gas absorption/stripping using MEA were also examined for post-combustion CO_2 capture in AspenPlus®. It was found that the hybrid process may not be a promising alternative for post-combustion CO_2 capture in terms of energy requirement for capture and compression. On the other hand, a stand-alone membrane gas separation process showed the lowest energy demand for CO_2 capture and compression, and could save up to 15 to 35% energy compare to the MEA capture process depending on the absorption/stripping model used.

Status on the Component Models Developed in the Modelica Framework 2016 This report has been prepared as part of an effort to design and build a modeling and simulation (M & S) framework to assess the economic viability of a nuclear-renewable hybrid energy system (N-R HES). In order to facilitate dynamic M & S of such an integrated system, research groups in multiple national laboratories have been developing various subsystems as dynamic physics-based components using the Modelica programming language. In fiscal year (FY) 2015, Idaho National Laboratory (INL) performed a dynamic analysis of two region-specific N-R HES configurations, including the gas-to-liquid (natural gas to Fischer-Tropsch synthetic fuel) and brackish water reverse osmosis desalination plants as industrial processes. In FY 2016, INL has developed two additional subsystems in the Modelica framework: a high-temperature steam electrolysis (HTSE) plant and a gas turbine power plant (GTPP). HTSE has been proposed as a high priority industrial process to be integrated with a light water reactor (LWR) in an N-R HES. This integrated energy system would be capable of dynamically apportioning thermal and electrical energy (1) to provide responsive generation to the power grid and (2) to produce alternative industrial products (i.e., hydrogen and oxygen) without generating any greenhouse gases. A dynamic performance analysis of the LWR/HTSE integration case was carried out to evaluate the technical feasibility (load-following capability) and safety of such a system operating under highly variable conditions requiring flexible output. To support the dynamic analysis, the detailed dynamic model and control design of the HTSE process, which employs solid oxide electrolysis cells, have been developed to predict the process behavior over a large range of operating conditions. As first-generation N-R HES technology will be based on LWRs, which provide thermal energy at a relatively low temperature, complementary temperature-boosting technology was suggested for integration with the HTSE process that requires higher temperature input. Simulation results involving several case studies show that the suggested control scheme could maintain the controlled variables (including the steam utilization factor, cathode stream inlet composition, and temperatures of the process streams at various locations) within desired limits under various plant operating conditions. The results also indicate that the proposed HTSE plant could provide operational flexibility to participate in energy management at the utility scale by dynamically optimizing the use of excess plant capacity within an N-R HES. A natural-gas fired GTPP has been proposed as a secondary energy supply to be included in an N-R HES. This auxiliary generator could be used to cover rapid dynamics in grid demand that cannot be met by the remainder of the N-R HES. To evaluate the operability and controllability of the proposed process during transients between load (demand) levels, the dynamic model and control design were developed. Special attention was given to the design of feedback controllers to regulate the power frequency, and exhaust gas and turbine firing temperatures. Several case studies were performed to investigate the system responses to the major disturbance (power load demand) in such a control system. The simulation results show that the performance of the proposed control strategies was satisfactory under each test when the GTPP experienced high rapid variations in the load.

Report - David W. Taylor Model Basin David W. Taylor Model Basin

Analytical Steam Injection Model for Layered Systems 1993 Screening, evaluation and optimization of the steam flooding process in homogeneous reservoirs can be performed by using simple analytical predictive models. In the absence of any analytical model for layered reservoirs, at present, only numerical simulators can be used. And these are expensive. In this study, an analytical model has been developed considering two isolated layers of differing permeabilities. The principle of equal flow potential is applied across the two layers. Gajdica's (1990) single layer linear steam drive model is extended for the layered system. The formulation accounts for variation of heat loss area in the higher permeability layer, and the development of a hot liquid zone in the lower permeability layer. These calculations also account for effects of viscosity, density, fractional flow curves and pressure drops in the hot liquid zone. Steam injection rate variations in the layers are represented by time weighted average rates. For steam zone calculations, Yortsos and Gavalas's (1981) upper bound method is used with a correction factor. The results of the model are compared with a numerical simulator. Comparable oil and water flow rates, and breakthrough times were achieved for 100 cp oil. Results with 10 cp and 1000 cp oils indicate the need to improve the formulation to properly handle differing oil viscosities.

Power Electronics Applications in Renewable Energy Systems Gilsoo Jang 2021-06-04 The renewable generation system is currently experiencing rapid growth in various power grids. The stability and dynamic response issues of power grids are receiving attention due to the increase in power electronics-based renewable energy. The main focus of this Special Issue is to provide solutions for power system planning and operation. Power electronics-based devices can offer new ancillary services to several industrial sectors. In order to fully include the capability of power conversion systems in the network integration of renewable generators, several studies should be carried out, including detailed studies of switching circuits, and comprehensive operating strategies for numerous devices, consisting of large-scale renewable generation clusters.

Second International Seminar of Horizontal Steam Generator Modelling International Seminar of Horizontal Steam Generator Modelling (2, 1992, Lappeenranta) 1993

Theoretical Chemical Engineering Abstracts 1978

CJChE 1998-02

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2012-12-31 This book deals with exergy and its applications to various energy systems and applications as a potential tool for design, analysis and optimization, and its role in minimizing and/or eliminating environmental impacts and providing sustainable development. In this regard, several key topics ranging from the basics of the thermodynamic concepts to advanced exergy analysis techniques in a wide range of applications are covered as outlined in the contents. Offers comprehensive coverage of exergy and its applications, along with the most up-to-date information in the area with recent developments Connects exergy with three essential areas in terms of energy, environment and sustainable development Provides a number of illustrative examples, practical applications, and case studies Written in an easy-to-follow style, starting from the basics to advanced systems

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