DOWNLOAD PDF EXERGY ANALYSIS OF THERMAL CHEMICAL AND METALLURGICAL PROCESSES

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Exergy factors presented in Table A19 which are the ratio of the standard chemical exergy of the organic fuels (or energy carrier in electrical and heat flows) to the LHV were retrieved from Ref.

Prior studies have focused on operational energy consumption as a proxy for sustainability, but this metric only captures part of the environmental impact. In this paper, we argue that to understand the total imp In this paper, we argue that to understand the total impact, we need to examine the entire lifecycle of the system, beyond operational energy to also include material use and manufacturing. We make two main contributions. We present a methodology that allows such a lifecycle analysis, specifically providing attribution of sustainability bottlenecks to individual system architecture components. Using this methodology, we compare the sustainability tradeoffs between popular energy-efficiency optimizations and discuss sustainability bottlenecks and optimizations for future system designs. Show Context Citation Context Exergy analysis of nutrient recovery processes by D. Abstract In an exergy analysis, the actual consumption of resources in physical and chemical processes is calculated. Energy and chemical elements are not consumed in the processes â€" they are only transformed into other forms with lower quality. The principals of exergy analysis are illustrated by c The principals of exergy analysis are illustrated by comparing different wastewater treatment systems for nutrient recovery. One system represents an end-of-pipe structure, whereas other systems include source separation of grey water, black water, and urine. The exergy flows analysed in this paper are those related to management and treatment of organic matter and nutrients. The study shows that the total exergy consumption is lowest for the system with source separation of urine and faeces and greatest for the conventional wastewater treatment system complemented by processes for nutrient recovery. Many impact assessment methods use weighing factors to agregate the different environmental effects into a single score value for the total impact caused by a product life cycle. The introduction of subjectivity in the decision process during product development, by using this kind of weighting fact The introduction of subjectivity in the decision process during product development, by using this kind of weighting factors, should be avoided. A more objective approach uses indicators based on laws of physics, for example the notion exergy. Construction and implementation in Simapro of an exergetic indicator is illustrated in this paper. In section 5 an example of the application of this method in Simapro is discussed. Exergy indicator From figure 1, an exergy indicator can straightforwardly be constructed. This indicator is simply Crawford, Viswanathan Krishnan, Gary C. Wood , "

Chapter 2 : Exergy Analysis of Thermal, Chemical, and Metallurgical Processes : Jan Szargut :

Exergy Analysis of Thermal, Chemical, and Metallurgical Processes Jan Szargut, David R. Morris, Frank R. Steward Hemisphere, - Technology & Engineering - pages.

In Depth Tutorials and Information Exergy: Analysis Energy Engineering Abstract Exergy analysis is an assessment technique for systems and processes that is based on the second law of thermodynamics. Exergy analysis has been increasingly applied over the last several decades largely because of its advantages over energy analysis: In this article, the role of exergy analysis in assessing and improving energy systems is examined. Also, exergy and its use as an analysis technique are briefly described, the range of energy systems that have been assessed with exergy analysis are surveyed, and several example applications of exergy analysis are presented, ranging from simple to complex. INTRODUCTION Energy analysis is based on the first law of thermodynamics, which embodies the principle of conservation of energy and is the traditional method used to assess the performance and efficiency of energy systems and processes. Exergy analysis is a thermodynamic analysis technique for systems and processes that is based on the second law of thermodynamics. Exergy analysis has been increasingly applied over the last several decades, in large part because of its advantages over energy analysis: In this article, the role of exergy analysis in the assessment and improvement of energy systems is examined. First, exergy and its use as an analysis technique are briefly described. Second, the ranges of energy systems that have been assessed with exergy analysis are surveyed. Third, several example applications of exergy analysis are presented, ranging from simple devices to large and complex systems. Technically, exergy is defined as the maximum amount of work that can be produced by a stream of energy or matter, or from a system, as it is brought into equilibrium with a reference environment. Unlike energy, exergy is consumed during real processes due to irreversibilities and conserved during ideal processes. Exergy and related concepts have been recognized for more than a century. In general, more meaningful efficiencies are evaluated with exergy analysis rather than energy analysis because exergy efficiencies are always a measure of the approach to the ideal. Therefore, exergy analysis accurately identifies the margin available to design more efficient energy systems by reducing inefficiencies. In evaluating exergy, the characteristics of the reference environment must be specified,[] usually by specifying the temperature, pressure, and chemical composition of the reference environment. The results of exergy analyses, consequently, are relative to the specified reference environment, which in most applications is modeled after the actual local environment. The exergy of a system is zero when it is in equilibrium with the reference environment. The tie between exergy and the environment has implications regarding environmental impact. The intensive properties of the reference environment in part determine the exergy of a stream or system. The reference environment is in stable equilibrium, with all parts at rest relative to one another and with no chemical reactions occurring between the environmental components. The reference environment acts as an infinite system and is a sink and source for heat and materials. It experiences only internally reversible processes in which its intensive state remains unaltered i. The exergy of the reference environment is zero. Environmental Impact Assessment Applications. Energy accumulation refers to build-up either positive or negative of the quantity within the system. Exergy is consumed due to irreversibilities, with exergy consumption proportional to entropy creation. Definitions It is helpful to define some terms related to exergy for readers. The following are exergy quantities: A general term for the maximum work potential of a system, a stream of matter, or a heat interaction in relation to the reference environment see definition below as the datum state; or the maximum amount of shaft work obtainable when a steady stream of matter is brought from its initial state to the dead state see definition below by means of processes involving interactions only with the reference environment. The maximum amount of shaft work obtainable from a substance when it is brought from its initial state to the environmental state see definition below by means of physical processes involving interaction only with the environment. The maximum work obtainable from a substance when it is brought from the environmental state to the dead state by means of processes involving interaction only with the environment. The maximum amount of shaft work obtainable from a given heat interaction using the environment as a thermal energy reservoir. The exergy consumed during a process due to irreversibilities within the system boundaries. The following terms relate to the reference environment and its state: An idealization of the natural environment, which is characterized by a perfect state of equilibrium, i. The reference environment constitutes a natural reference medium with respect to which the exergy of different systems is evaluated. The state of a system when it is in thermal, mechanical, and chemical equilibrium with a conceptual reference environment, which is characterized by a fixed pressure, temperature, and chemical potential for each of the reference substances in their respective dead states. The state of a system when it is in thermal and mechanical equilibrium with the reference environment, i. A state with respect to which values of exergy are evaluated. Several reference states are used, including environmental state, dead state, standard environmental state, and standard dead state. Many engineers and scientists suggest that devices are best evaluated and improved upon using exergy analysis in addition to or in place of energy analysis. A journal devoted to exergy matters entitled The International Journal of Exergy has recently been established by Inderscience. A simple procedure for performing energy and exergy analyses involves the following steps: In practice, the goal when selecting energy sources and utilization processes is not to achieve maximum efficiency, but rather to achieve an optimal trade-off between efficiency and such factors as economics, sustainability, environmental impact, safety, and societal and political acceptability. This optimum is dependent on many factors controllable by society. Furthermore, these factors can be altered to favor increased efficiency e. Next, consider theoretical limitations on efficiency, which must be clearly understood to assess the potential for increased efficiency. Lack of clarity on this issue in the past has often led to confusion, in part because energy efficiencies generally are not measures of how nearly the performance of a process or device approaches the theoretical ideal. The consequences of such confusion can be significant. For example, extensive resources have at times been directed towards increasing the energy efficiencies of devices that in reality were efficient and had little potential for improvement. Conversely, devices at other times have not been targeted for improved efficiency even though the difference between the actual and maximum theoretical efficiencies, which represents the potential for improvement, has been large. The difficulties inherent in energy analysis are also attributed to the fact that it only considers quantities of energy and ignores energy quality, which is continually degraded during real processes. Exergy analysis overcomes many of the problems associated with energy analysis. The types of applications of exergy methods that have been reported over the last several decades include: This understanding is erroneous; however, energy analysis ignores the fact that in this process, high-quality energy electricity is used to produce a relatively low-quality product warm air. The exergy results are useful. In practical terms, one can achieve space heating with a greatly reduced electricity input using an electric heat pump see Part B of Fig. Here, r denotes energy efficiency and COP coefficient of performance. Thermal Storage System A thermal energy storage system receives thermal energy and holds it until it is required. Thermal storages can store energy at temperatures above or below the environment temperature, and they come in many types e. The evaluation of a thermal energy storage system requires a measure of performance which is rational, meaningful, and practical. The conventional energy storage efficiency is inadequate. A more perceptive basis is needed if the true usefulness of thermal storages is to be assessed and their economic benefit optimized, and exergy efficiencies provide such performance measures. The notion that energy efficiency is an inappropriate measure of thermal storage performance can be illustrated. This heat addition raises the storage temperature 1. The exergy recovered in this example is 70 kJ and the exergy supplied kJ. Consequently, a device which appears to be ideal on an energy basis is correctly shown to be far from ideal on an exergy basis, clearly demonstrating the benefits of using exergy analysis for evaluating thermal storage. Coal-Fired Electrical Generating Station Energy and exergy analyses are applied to the Nanticoke coal-fired electrical generating station in Ontario, Canada, which has a net unit electrical output of approximately MWe and is operated by the provincial electrical utility,

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Ontario Power Generation formerly Ontario Hydro. This example illustrates how exergy analysis allows process inefficiencies to be better pinpointed than an energy analysis does and how efficiencies are to be more rationally evaluated. A detailed flow diagram for a single unit of the station is shown in Fig. The symbols identifying the streams are described in Table 1a-c for material, thermal, and electrical flows, respectively, with corresponding data. Eight pulverized-coal-fired natural circulation steam generators each produce Air is supplied to the furnace by two kW rpm motor-driven forced draft fans. Regenerative air preheaters are used. The flue gas passes through an electrostatic precipitator rated at The steam passes through a series of turbine generators linked to a transformer. Extraction steam from several points on the turbines preheats feedwater in several low- and high-pressure heat exchangers and one spray-type open deaerating heat exchanger. The low-pressure turbines exhaust to the condenser at 5 kPa. Each station unit has a rpm, tandem-compound, impulse-reaction turbine generator containing one single-flow high-pressure cylinder, one double-flow intermediate-pressure cylinder, and two double-flow low-pressure cylinders. Steam exhausted from the high-pressure cylinder is reheated in the combustor. Cooling water from Lake Erie condenses the steam exhausted from the turbines. The cooling-water flow rate is adjusted to achieve a specified cooling-water temperature rise across the condenser. The temperature and pressure of the feedwater are increased in a series of pumps and feedwater-heater heat exchangers. Energy and exergy values for the streams identified in Fig. Exergy-consumption values for the devices are listed, according to process section, in Table 2. Lines exiting the turbines represent extraction steam. The station has four main sections: The external inputs for Device A are coal and air, and the output is stack gas and solid waste. The external outputs for Device E are electricity and waste heat. Table 1a Data for material flows for a unit of the coal-fired electrical generating station Mass flow Temperature Pressure.

Chapter 3 : Exergy analysis of thermal, chemical, and metallurgical processes in SearchWorks catalog

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Chapter 4 : Exergy: Analysis (Energy Engineering)

The exergy analysis is based upon the assumption of a constant chemical composition of the environment. In reality the emission of some waste products changes this.

Chapter 5 : CiteSeerX â€" Citation Query Exergy analysis of thermal, chemical and metallurgical processes

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