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《产业生态学报》

2002 年冬, 第 6 卷第 1 期, 15-28 页

题目: 利用层次分析法和 LCA 来评价制浆造纸行业的环境表现

作者: Ruby Pineda-Henson, Alvin B. Culaba, Guillermo A. MendozaSource

关键字: 层次分析法(AHP), 面向环境的设计(DfE), 环境决策分析, 制浆造纸, 价值评估, 权重确定

摘要: 为评价造纸过程的环境影响, 本文引入了一种结构化的综合评价方法: 在对环境作用因素开展层次分析的基础上, 找出相关的环境影响及其改进措施, 并采用简化生命周期评价法分析具体的工业操作过程。该方法可对环境影响进行定性和定量评价, 为环境决策提供依据。文中还利用此法分析了制浆造纸工业的生产过程, 其中 AHP 还被用来分析环境影响因素及其改进措施的影响权重, 结果说明本评价方法十分有效。

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Evaluating Environmental Performance of Pulp and Paper Manufacturing Using the Analytic Hierarchy Process and Life-Cycle Assessment

Ruby Pineda-Henson, Alvin B. Culaba and Guillermo A. MendozaSource

KEYWORDS:

analytic hierarchy process (AHP), design for environment (DfE), environmental decision making pulp and paper manufacturing, valuation, weighting

SUMMARY:

This article addresses the need for a structured and comprehensive methodology for assessing the environmental performance of manufacturing processes. The analytic hierarchy process (AHP) is used as the basic framework for analyzing environmental impacts and improvement options following a streamlined life-cycle assessment (LCA) approach that is focused on the manufacturing operation. The multicriteria decision analysis approach of the AHP is consistent with the LCA concept because the environmental factors can be hierarchically structured into impacts and improvement options. Its potential as a valuation tool for impact and improvement assessment addresses both qualitative and quantitative issues in environmental decision making. Through application to a pulp and paper manufacturing case study, the viability of the AHP for evaluating environmental impacts and prioritizing process improvement options relative to these impacts is demonstrated. AHP was used to provide a quantitative tool for the design of a set of weighting factors for impact and improvement analyses.

《产业生态学报》

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题目: 产业生态系统的食物网分析

作者: Catherine Hardy, Thomas E. Graedel

关键字: 生物学类比, 关联度, 生态产业园区 (EIP), 食物网, 产业共生 (IS), 集成生物系统 (IBS)

摘要: 产业系统内的产品与废物交换与自然生态系统内的资源交换有诸多类似之处。本文应用食物网理论分析了 19 个现实的或虚拟的生态产业园区和集成生物系统, 以期加深对“产业生态系统”的理解。研究发现系统内企业个体的数目与系统关联度存在着线性关系, 产业生态系统的关联度介于 0.5 到 0.6 之间, 近似于一个典型生物生态系统的关联度。本文的研究成果对于生态产业园区设计具有一定的指导意义, 可为园区的资源利用最大化及废物减量化设计提供理论指导。值得注意的是, 产业生态系统关联度的增加, 并不意味着系统稳定性的增强及环境表现的改善。

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Industrial Ecosystems as FoodWebs

Catherine Hardy and Thomas E. Graedel

KEYWORDS:

biological analogy, connectance, eco-industrial park (EIP), food webs, industrial symbiosis (IS), integrated biological systems (IBSs)

SUMMARY:

Colocated industries exchange products and by-products in ways reminiscent of the exchange of resources in biological ecosystems. To better understand these "industrial ecosystems," we have applied food-web theory to a set of 19 actual and hypothetical eco-industrial parks and integrated biosystems. We find a linear relationship between number of industrial tenants and number of linkages among them and connectance values of 0.5 to 0.6 (typical of biological ecosystems). The results may provide initial perspective on designing ecoindustrial parks to maximize the utilization of resources and minimize the generation of wastes. Increased connectance in industrial ecosystems, however, does not necessarily imply increased stability or improved environmental performance.

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题目: 废物管理的投入产出分析

作者: Shinichiro Nakamura, Yasushi Kondo

关键字: 工程模型, 投入产出分析, 垃圾填埋场减少, 生命周期评价(LCA), 废物产生, 废物处理

摘要: 本文介绍了一种新的混合生命周期评价模型——废物投入产出模型(WIO), 利用该模型可明确计算产品与废物物流间的相互关系。WIO 模型具有两个特点。首先, 它将 Leontief 环境投入产出模型(EIO)扩展, 包括废物流因素, 证明 EIO 模型是 WIO 模型在废物类型与其处理方法在严格一一对应条件下的一个特例。WIO 提供了一个更为广泛的对废物进行 LCA 分析的框架。其次, WIO 模型考虑了废物处置的多样性, 通过引入一个废物处理工程模型, 反映出废物管理的投入产出关系与废物的组成紧密相关的特点。废物管理的目标是能够处理任何工业及家庭废物, 因此妥善考虑这一问题成为废物 LCA 分析的关键。文中通过一个日本的废物投入产出表对不同的废物管理政策进行了研究: 如地区性垃圾集中焚烧以及根据可燃性进行垃圾分类等。研究发现, 使用较少的大型垃圾焚烧炉对废物进行集中处置, 同时增加垃圾分类收集水平, 能够同时减少垃圾填埋场的消耗和 CO₂ 的排放。

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Input-Output Analysis of Waste Management

Shinichiro Nakamura and Yasushi Kondo

KEYWORDS:

engineering model, input-output analysis, landfill consumption, life-cycle assessment (LCA), waste generation, waste treatment

SUMMARY:

A new scheme of hybrid life-cycle assessment (LCA) termed the waste input-output (WIO) model is presented that explicitly takes into account the interdependence between the flow of goods and waste. The WIO model has two distinguishing features. First, it expands the Leontief environmental input-output (EIO) model with respect to waste flows. It turns out that the EIO model is a special case of the WIO model in which there is a strict one-to-one correspondence between waste types and treatment methods. By relaxing this condition, the WIO model provides a general framework for LCA of waste management. Second, the WIO model takes into account the "dynamics of waste treatment," which refers to the fact that the input-output relationships of waste treatment are significantly affected by the level and composition of waste feedstock, by incorporating an engineering process model of waste treatment. Because waste treatment is expected to accept whatever waste is generated by industry and households, a proper consideration of this feature is vital for LCA of waste management. We estimated a WIO table for Japan and applied it to evaluating effects of alternative waste management policies with regard to regional concentration of incineration and the sorting of waste with regard to flammability. We found that concentrating treatment in a small number of large incinerators combined with an increased degree of sorting could decrease both landfill consumption and the emission of carbon dioxide.

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题目: 实物经济代谢的定量化方法之比较研究

作者: Peter L. Daniels

关键字: 工业代谢, 质量平衡, 材料流分析 (MFA), 实物经济, 社会代谢, 物质流分析 (SFA)

摘要: 本文是关于描述和分析人类经济活动对自然环境物质需求的9种“实物经济”(physical economy)研究方法的文献综述的后半部分。这类分析方法是我们的实践产业生态学理论, 提高生态经济效率, 减少人类经济活动环境影响的重要手段。前文已经对物流分析的一般概念、方法分类、有关技巧及主要的物流分析方法作了概述。本文作为后续部分, 对前文中的物流代谢概念及其特性进行了更加深入细致的分析, 并给出了详尽的参考信息。文中纵览了如下实物经济的环境分析方法, 包括: 物流总体需求与产出模型、IFF(奥地利大学社会生态学系跨学科研究院)的主要材料流分析、物质投入产出表、物质流分析、生态足迹分析、环境空间分析、单位服务物质强度、生命周期评价、可持续发展指数以及企业水平上的物流分析等。

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Approaches for Quantifying the Metabolism of Physical Economies: A Comparative Survey

Peter L. Daniels

KEYWORDS:

industrial metabolism, mass balance, materials flow analysis (MFA), physical economy, societal metabolism, substance flow analysis (SFA)

SUMMARY:

This article is the second of a two-part series that describes and compares the essential features of nine "physical economy" approaches for mapping and quantifying the material demands of the human economy upon the natural environment. These approaches are critical tools in the design and implementation of industrial ecology strategies for greater ecoefficiency and reduced environmental impacts of human economic activity. Part I of the series provided an overview, methodological classification, and comparison of a selected set of major materials flow analysis (MFA) and related techniques. This sequel includes a convenient reference and overview of the major metabolism measurement approaches in the form of a more detailed summary of the key specific analytical and other features of the approaches introduced in part I. The surveyed physical economy related environmental analysis approaches include total material requirement and output models, bulk MFA (IFF (Department of Social Ecology, Institute for Interdisciplinary Studies of Austrian Universities) material flow balance model variant), physical input-output tables, substance flow analysis, ecological footprint analysis, environmental space, material intensity per unit service, life-cycle assessment (LCA), the sustainable process index, and company-level MFA.

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题目: 水泥生产过程及其环境影响 I: 化学过程与技术

作者: Hendrik G. van Oss, Amy C. Padovani

关键字: 替代燃料, 钙化, 二氧化碳熟料, 温室气体 (GHGs), 硅酸盐水泥

摘要: 硅酸盐水泥 (波特兰水泥) 作为混凝土和泥灰的粘合剂, 是一个国家建筑业的基础材料, 也是人类生产的最为丰富的原料。硅酸盐水泥的主要成分是碾磨得很细的可水硬化的硅酸钙熟料, 通过在窑炉中高温煅烧石灰石等物质得到。每生产 1 吨水泥熟料需要消耗 1.7 吨原材料并产生 1 吨左右的二氧化碳。其中二氧化碳的排放一半来自石灰石煅烧, 另一半则来自燃料燃烧。水泥生产是两个最主要的释放温室气体的工业过程之一, 尽管在很多国家水泥生产的燃料消耗量与电力和交通行业相比只占很小的比例。水泥工业需要大量的原材料及燃料, 如能应用产业生态学的概念, 对过程中的副产物加以利用, 实现物流的闭路循环和工业共生, 则意义非凡。本文是一个连载文章的第一部分, 总结了水泥制造业的化学过程和技术特性。水泥工业的主要环境挑战及改进机遇将在未来的文章第二部分加以阐述。考虑到美国的水泥生产在世界上占有重要规模, 文中的分析主要基于美国水泥产业的数据和实例。

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**Cement Manufacture and the Environment – Part I:
Chemistry and Technology**

Hendrik G. van Oss and Amy C. Padovani

KEYWORDS:

alternative fuels, calcination, carbon dioxide clinker, greenhouse gases (GHGs), portland cement

STUMMARY:

Hydraulic (chiefly portland) cement is the binding agent in concrete and mortar and thus a key component of a country's construction sector. Concrete is arguably the most abundant of all manufactured solid materials. Portland cement is made primarily from finely ground clinker, which itself is composed dominantly of hydraulically active calcium silicate minerals formed through high-temperature burning of limestone and other materials in a kiln. This process requires approximately 1.7 tons of raw materials per ton of clinker produced and yields about 1 ton of carbon dioxide (CO₂) emissions, of which calcination of limestone and the combustion of fuels each contribute about half. The overall level of CO₂ output makes the cement industry one of the top two manufacturing industry sources of greenhouse gases; however, in many countries, the cement industry's contribution is a small fraction of that from fossil fuel combustion by power plants and motor vehicles. The nature of clinker and the enormous heat requirements of its manufacture allow the cement industry to consume a wide variety of waste raw materials and fuels, thus providing the opportunity to apply key concepts of industrial ecology, most notably the closing of loops through the use of by-products of other industries (industrial symbiosis). In this article, the chemistry and technology of cement manufacture are summarized. In a forthcoming companion article (part II), some of the environmental challenges and opportunities facing the cement industry are described. Because of the size and scope of the U.S. cement industry, the analysis relies primarily on data and practices from the United States.

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题目: 纸浆造纸企业的绿色化

作者: Marquita Hill, Thomas Saviello, Stephen Graves

关键字: 企业社会责任(CSR), 牛皮纸浆污染预防 (P2), 公众参与, 纸浆造纸工业, 有毒化学品减量化(TUR)

摘要: 本文是对 Androscoggin 造纸厂的案例分析, 描述了这家位于美国东北缅因州杰伊 (Jay) 镇, 为世界上最大的林产品制造公司——International Paper (IP) 公司——所拥有的一家大型造纸厂, 如何采取一系列环境管理措施从背负污染恶名转变成一家绿色工厂。在 20 世纪 80 年代末, 由环境问题引发的一场持续 18 个月的罢工不仅使该造纸厂名誉扫地, 也使得工人及杰伊镇居民吃尽了苦头。针对造纸厂的环境违规行为, 杰伊镇通过了严格的污染控制条例。90 年代初期, 新的企业管理层 (包括两名 IP 总部管理人员) 经过不懈努力, 终于使该厂成为 IP 公司旗下的一个环境模范。起初, Androscoggin 造纸厂把重点放在遵守环境法规方面, 随后与缅因州及美国联邦环保局联合进行了一系列积极的污染预防工作, 后来又引入了一些产业生态学措施: 通过实现物流闭路循环和废物综合利用, 有效地替代了一批有毒化学品的使用并减少了固体及有害废物的排放。造纸厂还与周围一家以造纸副产品为原料的企业以及另一家供应蒸汽的企业研究了实现产业共生的问题。1992 年, 造纸厂成立了公众咨询委员会, 就重大管理决策 (其后包括了工厂的可持续发展原则) 征求公众意见, 以此作为榜样, IP 公司在其各个下属造纸厂都建立了类似的公众咨询机构。

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The Greening of a Pulp and Paper Mill

Marquita Hill, Thomas Saviello and Stephen Graves

KEYWORDS:

corporate social responsibility (CSR), kraft pulping pollution prevention (P2), public participation pulp and paper industry, toxics use reduction (TUR)

SUMMARY:

International Paper (IP), the world's largest forest products company, owns the Androscoggin Mill, a large pulp and paper mill in Jay, Maine, in the northeastern United States. This case study describes the transformation of the Androscoggin Mill from an object of public opprobrium and conflict to a showcase for environmental management. In the late 1980s, an 18-month strike had embittered workers and townspeople and left the mill's reputation in tatters. In response to mill environmental violations, some of which were considered crimes by state regulators, the town of Jay passed its own environmental ordinance to control mill emissions. Early in the 1990s, new management, including two former corporate-level employees, sought to change the mill's business approach and turn the Androscoggin Mill into IP's best environmental performer. The initial emphasis on establishing and maintaining compliance was expanded to include aggressive pollution prevention efforts that led to cooperative projects with the Maine Department of Environmental Protection, the U.S. Environmental Protection Agency, and stakeholder groups. The mill's approach in the 1990s evolved further to essentially follow principles of industrial ecology. New approaches focused on "closing the loop" by finding beneficial uses for previously landfilled wastes, replacements for most hazardous chemicals, and reductions in solid and hazardous waste generation. The mill also pursued the establishment of symbiotic relationships with a facility that began using a mill by-product on-site and an onsite natural gas burning facility that provided part of the mill's steam demand. IP also established a public advisory committee in 1992 to advise management on operational and "bigpicture" issues, which later included the application of sustainability criteria to the mill. IP has since formed community advisory committees at each of their integrated pulp and paper mills.