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《产业生态学报》

2007年冬, 第11卷第4期, 5-25页

题目: 利用热力学定律强化生命周期清单分析**作者:** Jorge L. Hau, Heui-seok Yi, Bhavik R. Bakshi**关键字:** 数据校正, (火用), 产业生态学, 生命周期评价, 物质平衡, 不确定性

摘要: 生命周期清单中的数据往往不完整、存在误差、甚至违反物理和热力学规律, 这损害了生命周期评价结果的可信度。为此有必要根据热力学原理对生命周期清单进行调整校验, 以强化数据的质量。这一观点尽管由来已久, 但目前还缺乏能将其付诸实践的严格的热力统计方法。本文基于过程系统工程中的数据校正原理, 提出了一种利用热力学定律强化生命周期清单分析的方法。方法探讨了现有数据和模型的冗余度; 通过求解一个约束优化问题, 消减了随机误差, 估测了某些缺失数据。通过对模型约束参数和测量值进行统计检验, 可确定生命周期评价结果的质量与总体误差范围。修正数据的精确性很大程度上取决于所用的模型, 如模型是否足够完整准确, 是否包含了生命周期网络、物流成份以及相关化学反应等信息? 生命周期清单数据库往往无法提供这些模型所需的信息, 因此有别于传统的过程数据校正, 研究中遇到了很多新的挑战。随着来自用户的生命周期信息日益详尽, 研究方法也在不断深化。本文所述的方法已用于校验国家可再生能源实验室汇编的氯碱化合物清单。作者结合这一案例探讨了方法的优势与不足。

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Enhancing Life-Cycle Inventories via Reconciliation with the Laws of Thermodynamics

Jorge L. Hau, Heui-seok Yi, and Bhavik R. Bakshi

KEYWORDS:

data rectification, exergy, industrial ecology, life-cycle assessment, material balance, uncertainty

SUMMARY:

Obtaining reliable results from life-cycle assessment studies is often quite difficult because life-cycle inventory (LCI) data are usually erroneous, incomplete, and even physically meaningless. The real data must satisfy the laws of thermodynamics, so the quality of LCI data may be enhanced by adjusting them to satisfy these laws. This is not a new idea, but a formal thermodynamically sound and statistically rigorous approach for accomplishing this task is not yet available. This article proposes such an approach based on methods for data rectification developed in process systems engineering. This approach exploits redundancy in the available data and models and solves a constrained optimization problem to remove random errors and estimate some missing values. The quality of the results and presence of gross errors are determined by statistical tests on the constraints and measurements. The accuracy of the rectified data is strongly dependent on the accuracy and completeness of the available models, which should capture information such as the life-cycle network, stream compositions, and reactions. Such models are often not provided in LCI databases, so the proposed approach tackles many new challenges that are not encountered in process data rectification. An iterative approach is developed that relies on increasingly detailed information about the life-cycle processes from the user. A comprehensive application of the method to the chlor-alkali inventory being compiled by the National Renewable Energy Laboratory demonstrates the benefits and challenges of this approach.

《产业生态学报》

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题目: 废溶剂处理方法的环境影响评价 I: Ecosolvent 工具**作者: Christian Capello, Stefanie Hellweg, Beat Badertscher, Hugo Betschart, Konrad Hungerbühler****关键字: 水泥窑, 蒸馏, 有毒废溶剂焚烧, 产业生态学, 生命周期清单 (LCI) 随机模拟**

摘要: 利用 Ecosolvent 软件, 用户可以自主地评价各类废溶剂混合物处理技术的环境影响。该软件包括两组模型: 一为废溶剂蒸馏模型, 二为有毒溶剂焚烧炉和水泥窑的热处理模型。为了适应多变的信息需求, 软件特采取了层式结构设计, 并结合了生命周期环境影响评价法。文章通过两个涉及多种废溶剂处理技术的工业案例验证了 Ecosolvent 软件的适用性, 进而探讨了其对实际化工决策的支持作用。案例之一为废乙酸乙酯的处理, 评价结果显示蒸馏处理法的溶剂回收率要明显好于焚烧法。案例之二为废甲醇的处理, 不同的处理方案难分优劣。第二部分续文将阐述 Ecosolvent 软件的一些常用经验规则以及对 45 种重要化工溶剂的具体处理建议。此外, 续文还将提出一个废溶剂的环境管理框架, 以便于简单快捷的决策。

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Environmental Assessment of Waste-Solvent Treatment Options, Part I: The Ecosolvent Tool**Christian Capello, Stefanie Hellweg, Beat Badertscher, Hugo Betschart, and Konrad Hungerbühler****KEYWORDS:****cement kiln, distillation, hazardous waste-solvent incinerator, industrial ecology, life-cycle inventory (LCI) stochastic modeling****SUMMARY:**

The software tool ecosolvent is presented that allows for comparative environmental assessment of treatment technologies for specific, user-defined, waste-solvent mixtures. The tool is composed of models for waste-solvent distillation as well as for thermal treatment in hazardous waste-solvent incinerators and cement kilns. It was designed with a tiered structure in order to allow for a high flexibility regarding informational needs. The life-cycle assessment method was used to assess the environmental impact. The applicability of the tool is shown with two case studies from industry. In these case studies, various waste-solvent treatment technologies are compared for two specific waste-solvent mixtures. Potential use of the ecosolvent tool for its role in practical decision making in chemical industry is illustrated by two case studies of waste-solvent systems. In the ethyl acetate case study, the tool indicates that solvent recovery by distillation is clearly better than incineration of the waste solvent. The results from the methanol case study are less clear-cut. In the subsequent article (part II), the ecosolvent tool will be used to derive general rules of thumb and specific recommendations for 45 important solvents used in chemical industries. Additionally, a framework will be presented that provides quick and easy decision support regarding environmentally optimized waste-solvent management.

《产业生态学报》

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题目: 关于环境负担时序分布的动态模型

作者: Stephen H. Levine, Thomas P. Gloria, Eliahu Romanoff

关键字: 动态模型, 环境评价, 产业生态学, 投入产出分析 (IOA), 产业间序列模型 (SIM), 瞬态事件

摘要: 本期刊曾发表一篇时间信息影响生命周期评价的文章。文中, Field 及其同事认为“一组”产品通常比单个产品“更适于作为评价单位”; 着眼于一组产品时, 研究者“明确将时间作为一项重要因素引入生命周期评价之中……”。当一组产品替代另一组产品之时, 系统相应而言是瞬时的而非静态的。分析瞬时系统必须明确考虑时间这一关键因素。

经济投入产出 (EIO) 分析越来越多地应用于生命周期评价, 但它通常并不考虑时间因素。本文讨论了一种可以清晰反映时间信息的 EIO 模型——产业间序列模型 (SIM)——在生命周期评价中的应用。通过计算生产活动所需的时间并排定原料的投入顺序, SIM 引入了时间要素。不过这些是工程而非财会数据, 短期内尚无法满足一般模型的数据需要。尽管如此, 这一模拟方法及方法给出的所谓的综合数据已经在很多领域 (包括社会科学) 得到了长期有效的应用。

基于 Joshi 的研究, 本文利用 SIM 模型有效地结合了 EIO 分析与环境影响评价, 并把产品的使用阶段引入了 EIO 分析之中。本文还简要讨论了如何评价未来事件的不确定性及其对决策的影响。

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A Dynamic Model for Determining the Temporal Distribution of Environmental Burden

Stephen H. Levine, Thomas P. Gloria, and Eliahu Romanoff

KEYWORDS:

dynamic modeling, environmental assessment, industrial ecology, input-output analysis (IOA), sequential interindustry model (SIM), transient events

SUMMARY:

In an article on the role of temporal information in life-cycle assessment in this journal, Field and colleagues argued that frequently it is not the single product but the “fleet” (or cohort) of products that “is the appropriate unit of analysis,” and that in focusing on the fleet one “explicitly introduces the notion of time as a critical element of comparative life-cycle assessments...” Major transitions, such as replacement of one fleet of products by an alternative fleet, correspond to a system in a transient rather than steady state, and explicit consideration of time is central to transient analysis.

One tool increasingly used as part of life-cycle assessment, economic input-output (EIO) analysis, at best deals with time in an implicit fashion. This article illustrates how the sequential interindustry model (SIM), a formulation of the EIO model that explicitly represents time, might be utilized in life-cycle assessment. SIM introduces this temporal component by explicitly accounting for the time required by production activities and the resulting sequencing of the inputs. This can be thought of as engineering rather than accounting information. The data demands of such a model are not likely to be met at present or at any time in the near future. Even so, simulation methods and the use of so-called synthetic data have a history of productive use in a number of fields, including the social sciences.

SIM also utilizes the contribution of Joshi on the application of the EIO model to environmental impact and the inclusion of the use as well as the production phases of a product in EIO analysis. The possibility of accounting for discounting of future events, with its impact on decision making, is also briefly discussed.

《产业生态学报》

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题目: 用于物料流分析的废物投入产出法: 概念及与基本金属相关的应用

作者: Shinichiro Nakamura, Kenichi Nakajima, Yasushi Kondo, Tetsuya Nagasaka

关键字: 重复计算, 产业生态学, 投入产出分析, 物质组成, 实物投入产出表 (PIOT), 三角关系

摘要: 本文提出了一个物料流分析 (MFA) 的通用模型: 该模型不但整合了废物的输入输出, 而且完全符合物料平衡原则。在根据加工程度对产业部门重新排序, 并分析输入系数矩阵三角关系的基础上, 可得到物料组成矩阵, 进而了解产品的物料构成情况。文章还给出了关于总物料 (或物流分析所涉及专门物质) 的正式数学定义, 以排除经济系统物料流分析中可能产生的重复计算问题。通过这一模型, 货币型投入产出 (IO) 表可方便地转换为实物型投入产出表 (PIOT)。PIOT 可包含任意多种物料, 亦可反映一个产品的物料组成及原材料投入情况。与单独编纂 PIOT 表格相比, 这种方法十分简便, 节省了大量开支。该方法已用于计算日本 11 种基本金属及相关废金属的输入输出数据 (详见 JIE 网站上的电子补充资料)。

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The Waste Input-Output Approach to Material Flow Analysis: Concepts and Application to Base Metals

Shinichiro Nakamura, Kenichi Nakajima, Yasushi Kondo, and Tetsuya Nagasaka

KEYWORDS:

double counting, industrial ecology, input-output analysis, material composition, physical input-output tables (PIOT), triangularity

SUMMARY:

A general analytical model of materials flow analysis (MFA) incorporating physical waste input-output is proposed that is fully consistent with the mass balance principle. Exploiting the triangular nature of the matrix of input coefficients, which is obtained by rearranging the ordering of sectors according to degrees of fabrication, the material composition matrix is derived, which gives the material composition of products. A formal mathematical definition of materials (or the objects, the flow of which is to be accounted for by MFA) is also introduced, which excludes the occurrence of double accounting in economy-wide MFAs involving diverse inputs. By use of the model, monetary input-output (IO) tables can easily be converted into a physical material flow account (or physical input-output tables [PIOT]) of an arbitrary number of materials, and the material composition of a product can be decomposed into its input origin. The first point represents substantial saving in the otherwise prohibitive cost that is associated with independent compilation of PIOT. The proposed methodology is applied to Japanese IO data for the flow of 11 base metals and its scrap (available as e-supplement on the JIE Web site).

《产业生态学报》

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题目: 用简化环境评价法分析废旧电器中的金属**作者:** Tomohiro Tasaki, Masahiro Oguchi, Takashi Kameya, Kohei Urano**关键字:** 环境指标, 环境管理, 产业生态学, 金属, 简化环境评价法, 废旧电器(WEEE)

摘要: 除欧盟 RoHS 指令监控的四种金属之外, 废旧电器(WEEE)中的其它各种有毒、有用或稀有金属的数据十分缺乏, 难以对其进行常规的评估。为此, 决策时可采用简化评价分析法。本文即描述了对废旧电器中 36 种金属的简化评价结果。研究首先分析了决策程序以及评价所需的先决条件; 在对现有的评价方法进行分类的基础上找出了三类简化评价指数——资源消耗、水污染对人体健康的影响以及水生生物的保护程度, 以便对多种(20-36 种)金属进行鉴定。研究随后分析了一个关于废旧电视的案例, 指出需对何类电视元件中的何种金属采取一定的环境措施。最后比较了简化评价法与其它六种方法的分析结果, 并以图表的形式明示了简化法的优越之处。此外, 文章还探讨了几种分析鉴定技巧。结论指出, 欧盟的 RoHS 指令并未覆盖所有的有毒金属。本文所述的分析方法可以帮助识别这些金属。方法的选择十分重要, 一个复杂的方法并不一定生成更为精确的结果。

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Screening of Metals in Waste Electrical and Electronic Equipment Using Simple Assessment Methods

Tomohiro Tasaki, Masahiro Oguchi, Takashi Kameya, and Kohei Urano

KEYWORDS:

environmental indicator, environmental management, industrial ecology, metals, simplified environmental assessment, waste electrical and electronic equipment (WEEE)

SUMMARY:

Various toxic, useful, and/or scarce metals in waste electric and electronic equipment (WEEE) have rarely been assessed due to low data availability, except for the four metals regulated by the EU RoHS Directive. This article describes the results of screening 36 metals in WEEE using simple assessment methods for cases where the decision makers do not know for which substances in product countermeasures should be taken and where data cannot be easily obtained. First, this study examines the decision-making process and prerequisites for screening, classifies existing assessment methods, and presents three simple indices for screening—resource consumption and water pollution affecting human health and aquatic biota conservation—so that screening can be readily started for many (20-36) metals. Following this, a case study is conducted for waste TV sets, revealing which metal in which product module or component should be targeted by environmental countermeasures. Finally, the screening results are compared with those of six other methods using diagrams devised to indicate the superiority of screening methods, and several screening techniques are discussed. The conclusions are that the EU RoHS Directive does not necessarily cover all of the toxic metals that could be of concern and the screening methods presented could help identify such metals; the selection of methods is critical; and a more detailed method does not necessarily provide more accurate results.

《产业生态学报》

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题目: 产业生态学的新工具: 基于(火用)的可持续性评价指数的开发及其对两个燃气联合循环电厂的应用

作者: Anita Zvolinschi, Signe Kjelstrup, Olav Bolland, Hedzer J. van der Kooi

关键字: 消减, 决策, 环境协调性, 燃气电站, 可再生性, 热力学

摘要: 生命周期评价是产业生态学的一项重要工具, 但如何分析其分析化工及其它能源密集型工业过程的能耗, 仍需深入探讨。我们认为产业生态学的关键问题之一即对能量这一概念的定义与理解。对此, 最近关于挪威发电政策的讨论提供了一个很好的例证。争议在于为满足挪威不断增长的用电需求, 应该建造一个标准的天然气-燃气循环电厂还是一个新的氢气-燃气循环电厂。对二者进行评价需要几项指标, 其中三项指标——包括(火用)可再生性、(火用)效率与环境协调性——涉及能量计算。文中分析了这些指标, 并用其对两类燃气电站的可持续性作了评价。研究发现, 两个电厂在(火用)可再生性和环境协调性方面的表现不相上下, 但如果引入(火用)效率指标, 标准天然气电站与二氧化碳截存相结合的方案则更受青睐。目前燃气电站的方案选择主要涉及两种情况: 一种情况下(火用)效率高但(火用)可再生性低, 另一种情况则相反。研究案例证明了(火用)分析的重要性: 它有助于促进不同专业对象间的交流, 易于为工程师所理解, 并为决策者提供了有价值的参考标准。

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Exergy Sustainability Indicators as a Tool in Industrial Ecology: Application to Two Gas-Fired Combined Cycle Power Plants

Anita Zvolinschi, Signe Kjelstrup, Olav Bolland, and Hedzer J. van der Kooi

KEYWORDS:

abatement, decision making, environmental compatibility, gas-fired power plant, renewability, thermodynamics

SUMMARY:

Life-cycle assessment is an established tool for industrial ecology. An analysis of the energy use in the chemical and other energy-intensive industries is still under discussion in this field. We argue that the concept of energy can play a role in industrial ecology, using a recent Norwegian power production policy question as illustration. The question is whether to build a standard natural gas- or a hydrogen-fired gas-turbine combined-cycle power plant to meet increased needs for electricity in Norway. Several indicators are relevant for this discussion, and we calculate three based on energy calculations, as proposed in the literature. The indicators are energy renewability, exergy efficiency, and environmental compatibility. We show how these indicators can be used to evaluate paths for sustainable power production in two gas-fired combined-cycle power plants. We found that the two plants in question were equivalent, as judged by their exergy renewability and their environmental compatibility, but not by their exergy efficiency. This indicator favored the standard power plant, possibly in combination with carbon dioxide (CO₂) sequestration in a depleted gas reservoir. The analysis suggested that the present situation for power production in gas-fired combined-cycle power plants is such that one may have to choose in general between power production with high exergy efficiency, but low renewability indicator, or the opposite, low exergy efficiency and high renewability indicator. The general importance of exergy analysis was demonstrated by this example. It enables communication between different professional groups. The technological details, understood by the engineers, can be transposed to meaningful aggregated indicators for decision makers.

《产业生态学报》

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题目: 含有煤焦油的沥青, 资源还是危险废物?**作者:** Yvonne Andersson-Sköld, Karin Andersson, Bo Lind, Anna Nyström Claesson, Lennart Larsson, Pascal Suer, Torbjörn Jacobson**关键字:** 沥青, 能耗, 产业生态学, 生命周期评价 (LCA), 多环芳香烃 (PAH), 道路建设

摘要: 瑞典到 1973 年为止一直使用煤焦油来生产沥青。沥青在修路时填充于砾石之间, 起到稳定的作用。目前瑞典公路中包含煤焦油的沥青总量约为 2000 万吨。煤焦油中含有高浓度的多环芳香烃, 其中部分芳烃具有强致癌性。根据瑞典的废物法, 道路重建而淘汰的沥青属于有害废物, 须加以妥善处置。但需要处理的沥青数量巨大, 处理费用相当高昂。此外相应的环境效益并不明确, 将废沥青运往填埋或焚烧场的过程中也难免产生其它的环境影响。本文以瑞典的三个道路工程项目为研究案例, 分别评价了四种处理废沥青的情景: 再利用、填埋、生物处理与焚烧。结果显示在综合考虑了成本、材料、土地利用、能耗以及废气排放等因素之后, 在道路建设中重复利用含有煤焦油的废沥青是最佳的方案。

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Coal Tar-Containing Asphalt: Resource or Hazardous Waste?

Yvonne Andersson-Sköld, Karin Andersson, Bo Lind, Anna Nyström Claesson, Lennart Larsson, Pascal Suer, and Torbjörn Jacobson

KEYWORDS:

asphalt, energy consumption, industrial ecology, life-cycle assessment (LCA), polycyclic aromatic hydrocarbon (PAH), road construction

SUMMARY:

Coal tar was used in Sweden for the production of asphalt and for the drenching of stabilization gravel until 1973. The tar has high concentrations of polycyclic aromatic hydrocarbons (PAH), some of which may be strongly carcinogenic. Approximately 20 million tonnes of tar-containing asphalt is present in the public roads in Sweden. Used asphalt from rebuilding can be classified as hazardous waste according to the Swedish Waste Act. The cost of treating the material removed as hazardous waste can be very high due to the large amount that has to be treated, and the total environmental benefit is unclear. The transport of used asphalt to landfill or combustion will affect other environmental targets. The present project, based on three case studies of road projects in Sweden, evaluates the consequences of four scenarios for handling the material: reuse, landfill, biological treatment, and incineration. The results show that reuse of the coal tar-containing materials in new road construction is the most favorable alternative in terms of cost, material use, land use, energy consumption, and air emissions.

《产业生态学报》

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题目: 促进绿色创新还是继续依赖现有的技术: 日本和欧洲的氯碱工业环境法规与技术变化的启示

作者: Masaru Yarime

关键字: 横隔膜, 产业生态学, 制度, 离子交换膜, 汞, 研发 (R&D)

摘要: 本文以西欧和日本的氯碱工业为例, 研究了环境法规对技术变化的影响。西欧对氯碱工厂的汞排放制定了日趋严格的标准; 但目前的研发主要集中于改进末端与中间技术以减少汞的排放, 对在氯碱生产阶段完全排除汞使用的新兴清洁生产关注不够。尽管末端治理技术大量消减了汞的排量, 使用汞化学品的新工厂仍然不断出现, 离子交换膜这项更为清洁的新技术的推广受到了很大的影响。因此, 末端治理技术在成功减少汞排放的同时, 也延长了西欧对基于汞的传统氯碱工序的依赖。日本政府则采取了不同的政策, 鼓励企业推进清洁生产与绿色创新而非末端治理, 从而彻底淘汰汞在氯碱工业中的使用。这些严格的环境条例在最初出台时不免失之仓促和僵化, 导致多数日本氯碱制造商匆忙选择了后来被证明为失败的横隔膜技术。随着环境法规的不断调整, 为技术转换留出了更多的时间, 剩余的基于汞工序的企业最终直接转向了最为有效的离子交换膜技术。这一技术转换过程的成本相当高昂: 因为很多氯碱企业在法令的强迫下, 仓促上马了横隔膜技术, 又在短期内转向了离子交换膜技术, 这浪费了大量的投资。

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Promoting Green Innovation or Prolonging the Existing Technology: Regulation and Technological Change in the Chlor-Alkali Industry in Japan and Europe

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KEYWORDS:

diaphragm, industrial ecology, institution, ion-exchange membrane, mercury, research and development (R&D)

SUMMARY:

A case study of the chlor-alkali industry in Western Europe and Japan is conducted to examine the effects of environmental regulation on technological change. In Western Europe, standards were set for mercury emissions from chlor-alkali plants, which were gradually tightened subsequently. Research and development (R&D) efforts were directed to end-of-pipe technologies as well as process improvements for reducing mercury emissions, rather than to clean technologies, which eliminate mercury from within the production process. With a significant reduction in mercury emission with end-of-pipe technologies, new plants continued to be built that relied on the mercury process. As long as these relatively new plants can be utilized, technological transition to the clean ion-exchange membrane process remains slow. The success in reducing mercury emissions with end-of-pipe technologies, in effect, helped to prolong the lifetime of the existing mercury process. In Japan, the government introduced policies to phase out the existing mercury process. The strict approach encouraged innovative companies to make R&D efforts on clean technologies, instead of end-of-pipe technologies for pollution abatement. Applied in a hasty and inflexible way, however, the stringent regulation initially induced most of the chloralkali producers to choose the diaphragm process, which later turned out to be inappropriate. After the regulatory schedule was modified to allow more time for process conversion, the remaining mercury-based plants were converted directly to the most efficient ion-exchange membrane process. The technological transition, however, was costly, as most of the diaphragm-based plants introduced following the regulatory mandate were operated only for a short period of time, with the large investment wasted.

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题目: 用直接法计算捷克的物料“存量净增量”**作者: Jan Kovanda, Miroslav Havranek, Tomas Hak**

关键字: 耐用品, 经济系统的物料流计算与分析 (EW-MFA), 产业生态学, 产业代谢, 基础设施与建筑物, 社会经济系统的代谢

摘要: 物料存量的净增量 (NAS) 是计算与分析经济系统物质流的一项指标, 它反映了一个经济体的实物增长率, 亦可用于估算该经济体未来的废物产生率。NAS 有两种计算方法: 其一为间接法, 通过简单计算物料输入与输出之间的差额得到 NAS 值; 其二为直接法, 对社会各类实物产品的物料投入与废物产出进行专门的评测。

本研究旨在通过直接法计算捷克共和国物料存量净增量, 并用其预测未来的废物排放。研究的另外两个目标是: 1) 基于捷克现有的数据, 开发和完善直接计算存量净增量的方法; 2) 比较并探讨 NAS 直接与间接计算方法的区别。

直接法计算表明捷克 2000 至 2002 年间物料存量的年均净增量约为六千五百万吨, 此数值比间接法计算的结果小了将近 27%。研究分析了 NAS 的直接法计算结果及其不确定范围, 并指出间接法计算结果往往偏大。在直接存量净增量中, 耐用品仅占 2%, 其余的物料净增量皆用于基础设施和建筑物, 其中非金属建筑材料如砖石等占了 NAS 的绝大部分 (89%)。

NAS 的直接算法对捷克有很好的适用性, 相较间接法其误差也更低。今后仍需对两种方法进行完善, 以减少直接和间接数据的不确定性, 并利用直接存量净增数据预测未来的废物流。

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Calculation of the “Net Additions to Stock” Indicator for the Czech Republic Using a Direct Method**Jan Kovanda, Miroslav Havranek, and Tomas Hak****KEYWORDS:**

durables, economy-wide material flow accounting and analysis (EW-MFA), industrial ecology, industrial metabolism, infrastructure and buildings, socioeconomic metabolism

SUMMARY:

Net additions to stock (NAS) are an indicator based on economy-wide material flow accounting and analysis. NAS, a measure of the physical growth rate of an economy, can be used for estimates of future waste flows. It is calculated using two methods: The indirect method of calculation is a simple difference between all input and output flows, whereas the direct method involves measuring the amounts of materials added to particular categories of physical stock and the amounts of waste flows from these stocks.

The study described in this article had one leading objective: to make available direct NAS data for the Czech Republic, which could later be used for prediction of future waste flows. Two additional objectives emerged from the first: (1) to develop a method for direct NAS calculation with regard to data availability in the Czech Republic; (2) to calculate NAS directly, compare the results with those achieved in indirect NAS calculation, and discuss the identified differences.

The NAS for the Czech Republic calculated by the direct method is equal to approximately 65 million tonnes on average in 2000–2002 and is approximately 27% lower than the NAS acquired by the indirect method of calculation. The actual values of directly calculated NAS and its uncertainties suggest that an overestimation of the indirect NAS is more likely than its underestimation. Durables account for about 2% of the total direct NAS, whereas the rest is attributed to infrastructure and buildings. The direct NAS is dominated by nonmetal construction commodities such as building stone and bricks, which equal approximately 89% of the total direct NAS.

Calculation of NAS by the direct method has been proved to be feasible in the Czech Republic. Moreover, uncertainties related to direct NAS are lower than those related to indirectly acquired NAS. The future work in this area will be, above all, focused on decreasing uncertainties related to both indirect and direct NAS figures. The pending objective is elaboration and application of a method for prediction of future waste flows using direct NAS data.