Improving the Quality of LCI Data via the Laws of Thermodynamics

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Life Cycle Inventory (LCI) data are usually collected from diverse sources, which may be unreliable, incomplete or unverifiable. Consequently, the compiled inventory often violates the conservation laws of thermodynamics. Such a violation of basic scientific principles may reduce the reliability of LCA results. Although traditional LCA focuses mainly on emissions and their impact, LCI data are increasingly used for methods like energy and exergy analyses that rely on input information such as consumption of renewable and nonrenewable resources. Unfortunately, such information is often missing or prone to large errors in much LCI data.

Since the underlying data must satisfy the laws of thermodynamics, the quality of LCI data may be enhanced by adjusting them to satisfy these laws along with other constraints imposed by the underlying physics and chemistry of the processes. This talk will describe a rigorous approach for 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 and gross errors. The quality of the results and presence of non-random 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 the life cycle network, stream compositions, reactions, etc. Such information is usually absent from LCI databases, but can be found in the open literature or from domain experts. Moreover, since data are often available at different scales, a multiscale LCI rectification method is described for fusing such data. This approach is a combination of existing hybrid LCA methods and data rectification. Comprehensive applications of the proposed methods to several LCI data such as the chlor-alkali and ammonium nitrate processes demonstrate the benefits and challenges of this approach.