

464f Input-Output Analysis of Sulfur Metabolism in Lubei Eco-Industrial Community

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An Eco-Industrial Community (EIC) is such a complex enterprise, in which several industrial chains assemble a symbiosis network through material, energy and information exchanges in order to improve resource utilize efficiency and reduce environmental pollution. As Eco-industrial Park (EIP), EIC is conducted by the principle of industrial ecology, but the latter is more likely to realize material reuse and energy cascading due to easier common management of members. Both EIC and EIC need quantitative researches from a system perspective with structural approaches which can handle the complexity of network. In fact, input-output analysis is such an approach which enables a full consideration of all direct and indirect conservative flow interactions among members in a system. It has been using in the analysis of economic system for a long time, and extended by a group of ecologists to research the material and energy flows in natural ecosystems. They presented several indices which profoundly reveal the material use efficiency and structure of system with quantities. The indices include cycling index, average path length of system and node importance orders in food web. Following the ecologists' steps, approach which applied input-output techniques to the physical flows of an industrial system has been asserted. In this paper, a new index, system couple degree, is presented based on predecessors' work. It may be viewed as a measure of system's stiffness caused by the flow connections among members. The system couple degree is a synthesis metric, derived from node couple degree and referring to the importance difference of nodes. And the node couple degree takes into account the path length and amount of flow (both direct and indirect) between nodes of system. The new index is helpful for realizing the nature of industrial ecosystem.

Lubei Group, a chemical complex, is a successful EIC located in China. It is deeply explored with the approach developed above. The community contains two industrial chains. One is to use ardealite, which is the by-product of ammonium phosphate, to produce sulfuric acid in joint production with cement (PSC chain), the other is the multi utilization of seawater in joint production of Br₂, salt and alkali. Two cycling use of sulfur element is the key of the system. One is the regenerate and reuse of H₂SO₄ within the PSC chain. The other is between the two chains, couples which together, though not very much tightly. The PSC chain provides SO₂ from its sulfuric acid node as a necessary raw material for Br₂ production which applies sulphite process. The seawater multi utilization chain provides salt gypsum to join the cement production. These also contribute to the reduction of products' costs. The quantitative vision of entire sulfur element flows and their transformation is depicted, which actually provide a sulfur element input-output table for the following input-output analysis. The analysis shows that about 71% of the sulfur element entering the system is cycled; on average 10.44 nodes are passed by sulfur element entering the system before its leaving; and the system's couple degree is 0.0279, a quarter of that of oyster reef community, an ecosystem used for comparing. A hypothesis case with broken sulfur cycle in the PSC chain is also evaluated with same metrics.

Keywords: industrial ecology; industrial metabolism; input-output analysis; substance flow analysis