CHEMICAL ENGINEERING TRANSACTIONS

VOL. 62, 2017

A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet

Guest Editors: Fei Song, Haibo Wang, Fang He

ISBN 978-88-95608- 60-0; **ISSN** 2283-9216

DOI: 10.3303/CET1762249

Construction of Evaluation Index System of Petrochemical Industry Based on Material Flow Analysis Method

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In order to solve the problems of high energy consumption, low efficiency and serious pollution in petrochemical industry, based on the theory of circular economy, the operation system of circular economy model in petrochemical industry is analysed. Then, the material flow analysis method is introduced, and its meaning and basic framework are explained. Finally, combining with the material flow characteristics of petrochemical industry, the basic framework and specific index content of the circular economy evaluation index system of petrochemical industry are established. It is suggested that petroleum chemical industry should strengthen the development of circular economy. The results show that the evaluation index system of circular economy not only embodies the quantitative index, but also takes into account the efficiency index. Therefore, it is in line with the concept of circular economy.

1. Introduction

Petrochemical industry is the pillar industry of national economy. Its development has promoted the development of machinery, transportation, iron and steel, electronics, building materials, textile, agriculture and other departments. At the same time, the petrochemical industry is also a high level of energy consumption and polluting industries (Ma et al., 2015). In order to reduce the pressure on the supply of resources in the development of petrochemical industry, circular economy must be vigorously developed. Petrochemical industry demand for resources and the impact of the ecological environment is reduced to a minimum, which fundamentally solves the contradiction between economic development and environmental protection (Zhou et al., 2016). However, we should pay attention to a very important problem while actively developing petrochemical industry's circular economy. The indicators of the development of circular economy in the petrochemical industry can be used to assess the current level of development of circular economy (Michael and Amir, 2016). The development of circular economy evaluation index system is the basic work to quantify the development of circular economy. In addition, it is also the basic content of the research on the development of circular economy theory and the main basis for judging the quality of circular economy development. This paper introduces material flow analysis (David and Helmut, 2016). Its core is to quantitatively analyse the flow of material in socio-economic activities, and to understand and master the flow of material and flow in the whole socio-economic system (Donald et al., 2015). Based on the material flow analysis, the material flow management can improve the efficiency of resource utilization and achieve the set goal (Lothar, 2012) by controlling the direction and flow of material flow. This point is consistent with the purpose of circular economy.

2. The system of circular economy model and the study of circular economy based on material flow analysis

2.1 The system structure of circular economy model

According to the idea of circular economy, the economic activities of the whole society of mankind are composed of the resource input reduction subsystem, the old product reuse subsystem and the waste recycling resource subsystem (Jagdeep and Isabel, 2016), as shown in Figure 1. In the figure, the external resources are entered into the circular economy system. Through the resource reduction subsystem, the old

Please cite this article as: Liang Li, 2017, Construction of evaluation index system of petrochemical industry based on material flow analysis method, Chemical Engineering Transactions, 62, 1489-1494 DOI:10.3303/CET1762249

product reuse subsystem and the waste recycling resource subsystem are circulated. It provides services for human society as a whole (Shu et al., 2015). At the same time, it discharges waste from the environment that is not resourceable (relative to the technical capacity at that time). The system structure of the circular economy is shown in Figure 1.

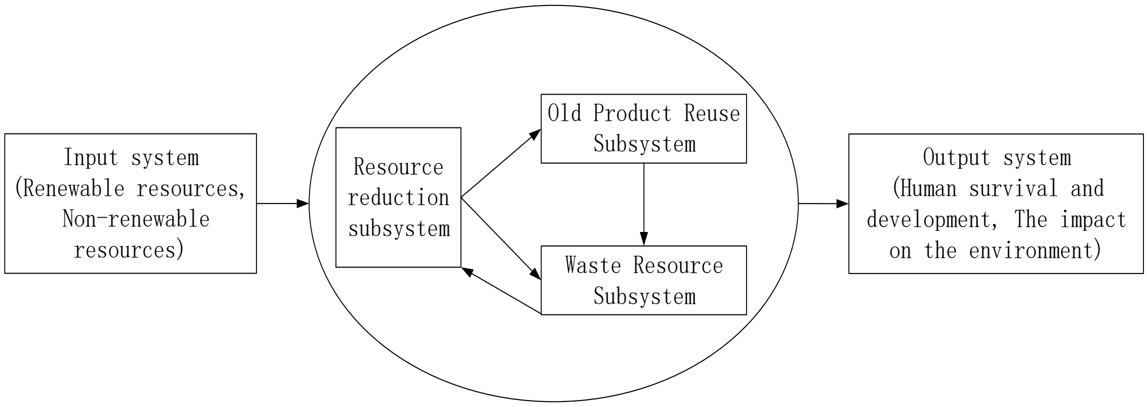

Figure 1: The system structure of the circular economy

2.2 The operating system of circular economy model

In the circular economy system, the reduction is the production process and the construction of resources to reduce the consumption of consumer products consumption reduction (Ming et al., 2016). In the process of production, construction and consumption, the use of tools, machinery, equipment, houses and other old products are reduced. At the same time, waste and pollutants to the environment are reduced (Miriã et al., 2016). The operation of the reduction subsystem is shown in Figure 2.

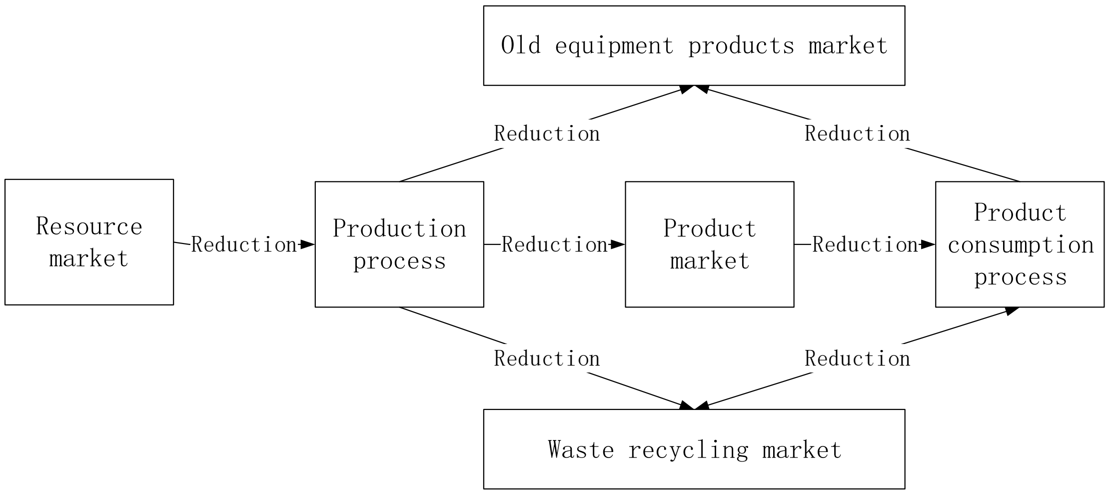

Figure 2: The operation of the reduction subsystem

In the circular economy system, recycling is a process of production, construction and consumption of used tools, machines, equipment, housing and other old products after the demolition, renovation, re manufacturing and assembly process for people to continue to produce the production and consumption of products (Roger, 2016). The reuse subsystem is as shown in Figure 3.

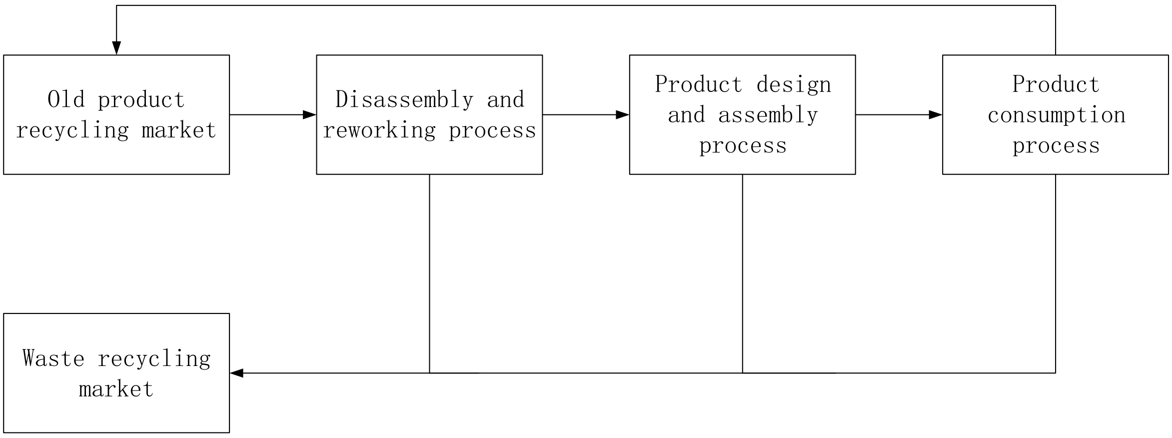

Figure 3: The reuse subsystem

In the circular economy system, recycling refers to the conversion of waste generated by the production process, engineering construction and consumption process through the process of sorting, smelting, reaction and other industrial recycling into renewable resources (Lu et al., 2014). The running process of the resource subsystem is shown in Figure 4.

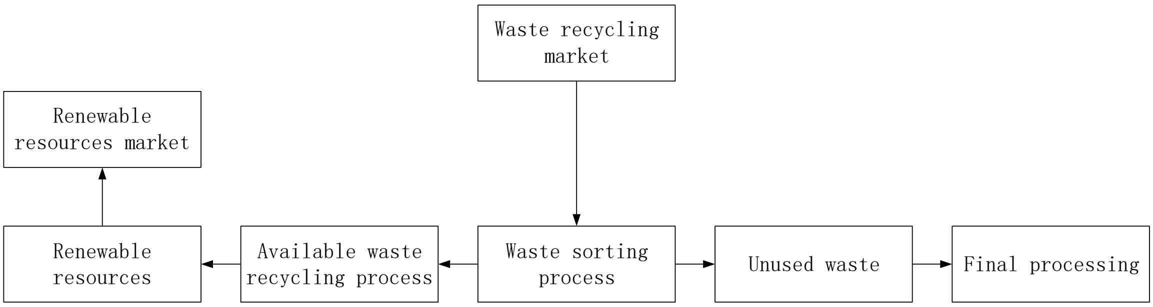

Figure 4: The running process of the resource subsystem

2.3 The meaning of material flow analysis method

Material flow analysis refers to the physical unit of the material from the mining, production, transformation, digestion, recycling until the final disposal of the settlement. The analysed substances include chemical elements, raw materials and products (Zhu et al., 2015). There are two aspects of the analysis. One is the total material analysis model, and the other is the material strength model. The total material analysis model analyses the total material inputs, consumption, and total cycles required for a certain economic scale. Substance intensity model is mainly concerned with the production or consumption of the scale, the use of material strength, consumption intensity and cycle strength (Michael et al., 2016). Material flow analysis can more truly reflect the relationship between resource utilization and environmental impact in the process of economic development and the law of mutual response.

2.4 The basic framework of material flow analysis

Material flow analysis is closely linked to the material circulation system, which usually involves the fields of nature, human production, life and consumption. Thus, the material flow analysis system is composed of units of human activity (Patrizia et al., 2016), such as state or city, park, industry, business, family and a production process. The "substance" in the material flow analysis has a broad meaning, including raw materials for production, such as metals, minerals, agricultural resources, energy, solid waste, etc. (Ma et al., 2014). For the economic system, the input of the material usually refers to raw materials and energy, and the output of the material usually refers to products and by-products (including waste and pollutants). The basic framework of the material flow analysis method is shown in Figure 5.

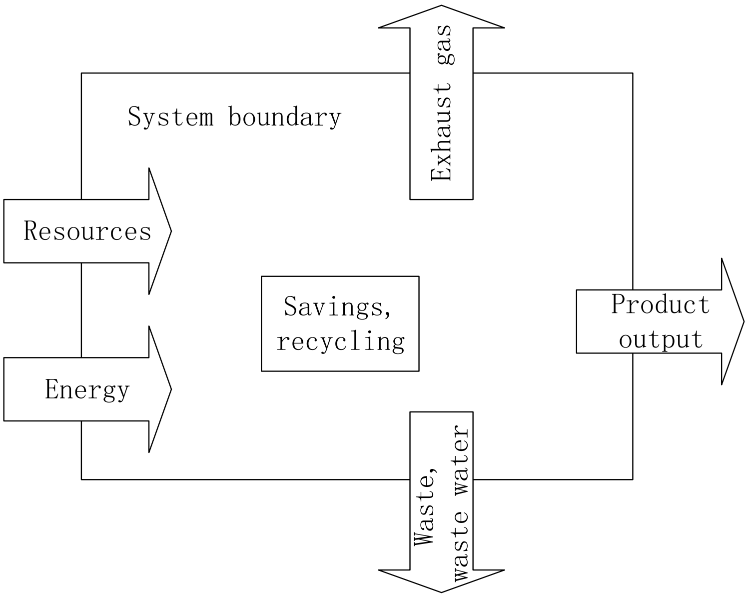

Figure 5: The basic framework of the material flow analysis method

3. Evaluation index system of circular economy in petrochemical industry

3.1 The basic framework of the index system

The method of "purpose tree" is used. Taking the circular economy of petrochemical industry as the target, the evaluation index system of circular economy is designed. First of all, the overall goal of the petrochemical industry circular economy development status is determined (Federica et al., 2015). Secondly, according to the method of material flow analysis, the whole petrochemical industry is regarded as an economic system, and the input material refers to raw materials and energy, that is, crude oil, natural gas, coal, electricity and so on. The exported material usually refers to products and by-products (including waste and contaminants). Taking into account the energy consumption of the petrochemical industry and the seriousness of pollution (Esther et al., 2014), the overall target is decomposed into three sub-targets, according to the evaluation index system of the material flow analysis at the national level. They are resource utilization, resource recycling and waste disposal and disposal. Then, it gradually developed the second sub-target. Finally, the indicators that describe the objectives are presented, that is, the specific indicators of the last level. In this way, the evaluation index system of circular economy in petrochemical industry is established. The purpose tree is as shown in Figure 6.

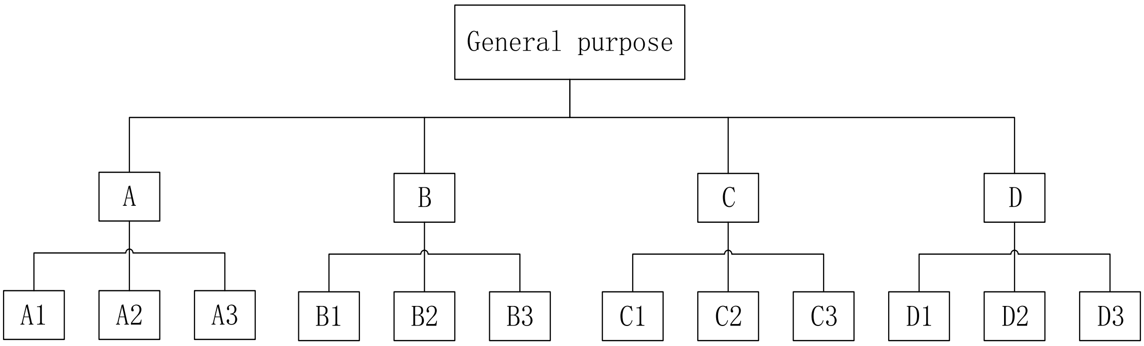

Figure 6: The purpose tree

3.2 Specific indicators for economic evaluation of petrochemical industry

Corresponding to the above-mentioned purpose tree, the specific indicators of economic evaluation of petrochemical industry are as follows:
The overall goal: the development of circular economy in petrochemical industry

A: resource utilization
A1: resource consumption. Its specific indicators include: total energy consumption, crude oil processing capacity, coal consumption, natural gas consumption, power consumption, water consumption.
A2: resource utilization efficiency, the specific indicators for resource productivity.
A3: resource consumption intensity. The specific indicators include the petrochemical industry million yuan output value of resource consumption, key product unit production and resource consumption (David et al., 2014).
B: Recycling of resources
B1: Waste recovery situation. The specific indicators include sulfur dioxide recovery, dust recovery, dust recovery, wastewater discharge compliance rate, solid waste recovery rate.
B2: Resource recycling. Its specific indicators include comprehensive utilization of solid waste, solid waste comprehensive utilization rate, solid waste recycling rate, the "three wastes" comprehensive utilization of product output value, resource recycling rate, industrial water recycling rate.
C: Waste discharge and treatment
C1: Waste discharge. Its specific indicators include emissions, waste water emissions, solid waste emissions.
C2: Waste discharge intensity. The specific indicators include million yuan of industrial added value of emissions, million industrial added value of wastewater emissions, million industrial added value of solid waste emissions.
C3: Waste treatment. The specific indicators for the final disposal of industrial waste rate of change.
Combined with the above indicators, the development of petrochemical industry should include the comprehensive promotion of enterprise clean production, and construction of petrochemical industry eco - industrial park. The resource utilization efficiency is improved. Industrial structure is actively adjusted, in order to develop high-tech products and create an external environment for the development of circular economy. The overall social cycle between industries is strengthened (Yao et al., 2014). Thus, the problems of high consumption, high emission and serious pollution in petrochemical industry have been solved.

4. Conclusions

In order to better promote the development of circular economy in China, the establishment of the corresponding index system to measure and guide the development of circular economy is imminent. Based on the deep analysis of the circular economy model, this paper introduces the three modes of circular economy model into the petrochemical industry. In addition, the material flow analysis method is introduced. Combined with the characteristics of high consumption and high emission of petrochemical industry, the evaluation index system of circular economy suitable for petrochemical industry is constructed by using material flow analysis method. The development of circular economy in petrochemical industry is evaluated from three aspects of resource consumption, resource recycling and waste discharge. It not only embodies the quantitative index, but also takes into account the efficiency index. In order to achieve maximum economic and social benefits with minimal resource consumption and waste emissions, this is in line with the concept of circular economy.

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