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Energy Transfer Diagrams and Efficiency Analysis of Coal Industry Chain in Jing-Jin-Ji Region

Siheng Ren[a], Gengyuan Liu[a,b,*], Yan Hao[a,b], Yan Zhang[a,b], Meirong Su[c]

[a] State Key Joint Laboratory of Environment Simulation and Pollution Control, School of Environment, Beijing Normal University, Beijing 100875, China

[b] Beijing Engineering Research Center for Watershed Environmental Restoration & Integrated Ecological Regulation, Beijing 100875, China

[c] School of Environment and Civil Engineering, Dongguan University of Technology, Dongguan 523808, China

Abstract

Nowadays, the air pollution of China is more and more serious, especially in Jing-Jin-Ji region. The improper energy consumption structure and the pollutants emission of coal industry chain are the main cause of the air pollution. In this study, based on the Energy Balance Tables of Beijing, Tianjin and Hebei in 2012, we used the model of inter-regional transportation, proposed a Regional Coal Industry Chain Balance Table, clarified the material/energy flows, and accounted the energy utilization efficiency in Jing-Jin-Ji region. It can help to realize the optimal balance of pollutant emissions control and energy supply, which is scientifically innovative.

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Keywords: Jing-Jin-Ji Region, Energy Transfer Diagrams, Energy Transfer Efficiency, Coal industry Chain;

1. Introduction

The "Jing-Jin-Ji" region consists of Beijing, Tianjin, and Hebei Province, first developed by the capital economy circle, including the political, economic, and cultural center of China. It has a very important strategic position in China. For now, however, it is confronted with a severe atmospheric pollution problem. For example, the annual average concentrations of $PM_{2.5}$ in the air in 2015 reached 80.57 $\mu g/m^3$, which is 2.30 times that of the national standard limit. Similarly, the annual average concentrations of

* Corresponding author.
E-mail address: liugengyuan@bnu.edu.cn. (G.Y. LIU)

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$PM_{2.5}$ in the air in Hebei Province amount to 77 μg/m^3, 2.19 times that of the national standard limit, the annual average concentrations of $PM_{2.5}$ in the air in Tianjin amount to 70 μg/m^3, 2.02 times that of the national standard limit. Studies show that pollution caused by $PM_{2.5}$ poses a threat to people's health in the Jing-Jin-Ji region [1]. In addition, smog caused by atmospheric pollution in the Jing-Jin-Ji region also has a certain influence on China's international image.

Coal is the pillar of energy in the Jing-Jin-Ji region, and its associated atmospheric pollution problem is closely related to the energy structure. Supposing that the energy structure remains unchanged, it is difficult to fundamentally solve this pollution problem. It is certainly typical and representative in the north of China [2]. Promoting the upgrading and transformation of the industry chain related to coal can both improve the ecological environment in the region and serve as a guide and exemplary role in northern China where coal is the main energy source. It is advantageous to provide more targeted emission decreases and alternative countermeasures, as well as offer certain theoretical support and policy suggestions, for government decision-making [3].

In this study, based on the Energy Balance Tables of Beijing, Tianjin and Hebei in 2012, we used the model of inter-regional transportation, proposed a Regional Coal Industry Chain Balance Table, clarified the material/energy flows, and accounted the energy utilization efficiency in Jing-Jin-Ji region. From the scientific sense, the introduction of the research method of the coal industrial chain and energy analysis provides a new viewpoint to solve atmospheric pollution problems in the Jing-Jin-Ji region and can make an overall and systematic evaluation of accounting on the coal utilization in the region from the angle of the industry chain [4]. It can help to realize the optimal balance of pollutant emissions control and energy supply, which is scientifically innovative [5].

2. Method

According to the 2012 energy balance tables of Beijing, Tianjin, and Hebei, we can only obtain respective inputs and outputs of the three provinces (municipalities). Without inputs and outputs among the three provinces (municipalities), the overall input and output of the three provinces (municipalities) cannot be obtained. However, the following model can be used to calculate net energy carrying in the Jing-Jin-Ji region (net energy carrying = input - output).

For a region Ω with n sub-regions, the input and output of some type of energy has the following model.

$$C_1 = \alpha_1 + c_{12} + c_{13} + \ldots\ldots c_{1n} \tag{1}$$

In equation (1), C_i represents the output of region i, α_i is the amount that region i transfers to other regions from region Ω, and c_{ij} is the amount that region i transfers to region Ω.

$$R_1 = \beta_1 + r_{21} + r_{31} + \ldots\ldots r_{n1} \tag{2}$$

In equation (2), R_i is the output of region i, β_i is the amount that region Ω transfers to region i, and r_{ji} is the amount that region i receives from region j.

$$c_{ij} = r_{ji} \tag{3}$$

In equation (3), in region Ω, the output from region i to region j is equal to the amount that region j receives from region i.

From equations (1), (2), and (3), we can derive equation (4):