Study on industrial pollution discharge and environmental control in Beijing, Tianjin and Hebei

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Abstract. Prevention and control of pollution and improvement of environment are the internal requirements of regional coordinated development. Industrial pollution is the main cause of air pollution in Beijing, Tianjin and Hebei, which has affected people's quality of life. The development strategy of "integration of Beijing, Tianjin and Hebei" has risen to the level of national strategy. The contradiction between the rapid development of regional industrialization and environmental pollution is becoming more and more serious. The pollution situation is obviously regional and the pollution is becoming more and more serious. Therefore, taking Beijing Tianjin Hebei region as an example, it is of practical significance to study the current situation of industrial pollution control in Beijing Tianjin Hebei region, so as to promote the "integration of environmental protection" in Beijing Tianjin Hebei region.

Keywords: Industrial pollution, pollution control, environmental protection.

1. Introduction

Beijing Tianjin Hebei region is becoming the third largest growth pole of China's economic growth. With the rapid economic development, various problems have emerged in the urban agglomeration, such as obvious differences between cities, unbalanced infrastructure construction level, and serious environmental pollution [1]. The discharge of industrial pollutants is one of the three main sources of environmental pollution, and almost half of the environmental pollution comes from industrial pollution directly or indirectly. Therefore, investment in industrial pollution control is an important means of environmental protection. Beijing's tertiary industry accounts for a high proportion and has reached the basic goal of modernization. Hebei and Tianjin are still dominated by the secondary industry [2]. Obviously, the industrial structure of Tianjin Hebei is more important than that of Beijing, which is one of the main reasons for the increase of industrial pollution emissions in Beijing Tianjin Hebei region. The investment in industrial pollution control in Tianjin and Hebei is basically the same as the national average, which is slightly higher than the national average in recent years. The industrial exhaust emissions of Beijing, Tianjin and Hebei are on the rise in general. The industrial exhaust emissions of Beijing and Tianjin are relatively stable, but in recent years, the industrial exhaust emissions of Beijing and Tianjin have increased slightly year by year, and the growth rate of Tianjin is faster than that of Beijing. Different from Beijing and Tianjin, Hebei's industrial exhaust emissions have been growing rapidly [3].
2. Research models and methods

In this paper, the industrial pollution emission is studied by the method of comprehensive graph of full arrangement polygon, and the standardization of index value is by hyperbolic standardization function:

\[ F(x) = \frac{a}{bx + c} \]  

(1)

\[ F(x) \text{ satisfy:} \]

\[ F(x) \Big|_{x=L} = -1, \quad F(x) \Big|_{x=T} = 0, \quad F(x) \Big|_{x=U} = 1 \]  

(2)

\( U \) is the upper limit value of the indicator \( X \); \( L \) is the lower limit value of the indicator \( X \); \( T \) is the critical value. When the index value is below the critical value, the growth rate of the standardized index gradually decreases. When the index value is above the critical value, the growth rate of the standardized index gradually increases, that is, the index changes from the linear growth along the axis \( x \) before no standardization to the fast slow fast nonlinear growth after standardization, and the critical value is the turning point of the growth rate of the index. According to the above conditions, we can get:

\[ F(x) = \frac{(U-L)(x-T)}{(U+L-2T)x+UT+LT-2LU} \]  

(3)

Single index value \( S_i \):

\[ S_i = \frac{(U_i-L_i)(x_i-T_i)}{(U_i+L_i-2T_i)x_i+U_iT_i+L_iT_i-2LU_i}, \quad (S_i \in [-1, 1]) \]  

(4)

The formula for calculating the comprehensive index of fully arranged polygons is:

\[ S = \frac{\sum_{j} (S_j + 1)(S_j + 1)}{2n(n-1)}, (n > 1, \quad S \in [0, 1]) \]  

(5)

3. Analysis of the current situation of environmental pollution

Environment is the carrier of human sustainable development. Without a good natural environment, human sustainable development is just a fantasy. In recent years, the environmental problems such as the aggravation of haze and water pollution in Beijing, Tianjin and Hebei urban agglomerations have gradually emerged, which have posed a serious threat to people's health, and the environmental pollution has been paid attention to. Due to the disadvantages of our extensive economic development model in the past, the industrial development has caused irreparable damage to the environment. This paper analyzes the current situation of environmental pollution in Beijing, Tianjin and Hebei Urban Agglomerations with the discharge of "three industrial wastes".

3.1. Industrial pollution discharge

In recent years, the environmental problems such as the aggravation of haze and water pollution in Beijing, Tianjin and Hebei urban agglomerations have gradually emerged, which have posed a serious threat to people's health, and the environmental pollution has been paid attention to.

3.1.1. Current situation of industrial wastewater discharge  In recent years, the total discharge of industrial wastewater in most cities has maintained a horizontal trend, only in some cities in Hebei Province, the total discharge has been significantly reduced. According to the data, each city is evenly distributed within the range of 0-300 million tons, and the top five cities are Shijiazhuang, Tianjin, Tangshan, Baoding and Handan. In addition to Tianjin's total emissions of 200 million tons, the total emissions of the other four cities have been reduced to varying degrees; among the last eight cities, Cangzhou's total emissions in 2017 have been slightly reduced, and the total emissions of other cities in other years have remained stable.
3.1.2. Current situation of industrial SO\(_2\) emission. The total emission of industrial SO\(_2\) and the emission per unit GDP are decreasing year by year. The larger the total emission is, the faster the reduction is. It shows that the emission of SO\(_2\) is controlled in general and the emission is significantly reduced. The 13 cities of Beijing, Tianjin and Hebei are roughly divided into three levels. The first level city with the highest total SO\(_2\) emission is Tangshan. In the past four years, the total emission has decreased by 163300 tons, which is the city with the largest reduction in emissions. Tianjin, Handan and Shijiazhuang belong to the second tier cities, and their emissions have declined significantly in the past four years. The total SO\(_2\) emission of the remaining nine cities is concentrated in the range of 0-100000 tons, and the emission is also decreasing year by year, but it is relatively slow.

3.1.3. Current situation of industrial smoke (powder) dust emission. In recent years, the total emission of industrial smoke and dust and the emission of unit GDP in Beijing, Tianjin and Hebei have not changed significantly, but the emission of unit GDP fluctuates greatly. Qinhuangdao has the largest emission per unit of GDP due to the sudden increase of total emission in 2015. Among the remaining 12 cities, Tangshan, Handan and Xingtai have higher total emissions and unit GDP emissions, which indicates that the level of industrial smoke and dust emissions is still high, and the key pollution control is needed.

3.2. Analysis of pollution discharge
In order to eliminate the impact of the difference of urban economic development on the pollution discharge, this paper selects the "three wastes" discharge per unit GDP to evaluate the current situation of the pollution discharge in each city. The more pollution discharge, the less sustainable development of the environment.

The basic data of industrial "three wastes" can be obtained through formula (4) and formula (5). The pollution emission index value of Beijing Tianjin Hebei Urban Agglomeration is shown in Table 1.

|   | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|------|------|------|------|------|
| Beijing | 0.96 | 0.98 | 1.00 | 1.00 | 1.00 |
| Tianjin | 0.73 | 0.74 | 0.79 | 0.83 | 0.88 |
| Shijiazhuang | 0.25 | 0.33 | 0.42 | 0.58 | 0.63 |
| Tangshan | 0.25 | 0.26 | 0.31 | 0.42 | 0.51 |
| Qinhuangdao | 0.11 | 0.15 | 0.05 | 0.12 | 0.09 |
| Handan | 0.19 | 0.22 | 0.33 | 0.42 | 0.40 |
| Xingtai | 0.06 | 0.06 | 0.14 | 0.13 | 0.21 |
| Baoding | 0.35 | 0.38 | 0.49 | 0.63 | 0.67 |
| Zhangjiakou | 0.18 | 0.18 | 0.29 | 0.30 | 0.42 |
| Chengde | 0.34 | 0.28 | 0.41 | 0.49 | 0.62 |
| Cangzhou | 0.52 | 0.51 | 0.58 | 0.67 | 0.72 |
| Langfang | 0.50 | 0.51 | 0.58 | 0.65 | 0.73 |
| Hengshui | 0.31 | 0.34 | 0.44 | 0.53 | 0.60 |

From Table 1, it can be seen that the pollution emission index of Beijing, Tianjin and Hebei in 2017 is significantly larger than that in 2013, indicating that the overall industrial pollution emission has improved. Among the 13 cities, Beijing has the largest pollution emission index value, which indicates that Beijing has the least pollution emission in Beijing, Tianjin and Hebei, followed by Tianjin; Qinhuangdao and Xingtai have been the cities with low index value for five years, which indicates that there are more pollution emissions. The index value of pollution discharge in most cities has increased, but it is still at a low level, and the pollution discharge needs to be further effectively controlled.
4. Analysis of environmental governance

4.1. Analysis of comprehensive utilization rate of industrial solid waste

Tab. 2 Comprehensive treatment rate of industrial solid waste (%)

|                | 2013   | 2014   | 2015   | 2016   | 2017   |
|----------------|--------|--------|--------|--------|--------|
| Beijing        | 86.58  | 87.67  | 83.33  | 87.23  | 88.34  |
| Tianjin        | 99.39  | 98.91  | 98.58  | 98.62  | 99.22  |
| Shijiazhuang   | 98.61  | 95.10  | 98.00  | 98.23  | 98.56  |
| Tangshan       | 73.32  | 70.00  | 72.50  | 72.66  | 72.98  |
| Qinhuangdao    | 49.32  | 65.00  | 68.55  | 68.73  | 69.56  |
| Handan         | 95.40  | 95.00  | 97.00  | 97.33  | 97.56  |
| Xingtai        | 94.47  | 95.29  | 95.31  | 95.34  | 95.46  |
| Baoding        | 89.64  | 86.20  | 93.00  | 92.33  | 93.45  |
| Zhangjiakou    | 38.93  | 44.10  | 57.16  | 54.45  | 57.18  |
| Chengde        | 5.49   | 6.00   | 24.00  | 18.00  | 20.24  |
| Cangzhou       | 99.58  | 99.88  | 100.00 | 100.00 | 100.00 |
| Langfang       | 98.90  | 100.00 | 97.00  | 98.34  | 99.22  |
| Hengshui       | 99.77  | 96.60  | 99.30  | 100.00 | 99.45  |

From table 2, it can be seen that the utilization rate of solid wastes in most cities of Beijing, Tianjin, and Hebei is over 50%, and most of them show an increasing trend, except for Tangshan and Tianjin, which show a small decline; especially in 2013, the utilization rate of solid wastes in seven cities has been greatly improved. The utilization rate of Tianjin's solid wastes is the highest in the urban agglomeration, close to 100%, and the comprehensive utilization of industrial solid wastes is in good condition; the three cities with significantly lower utilization rates are Qinhuangdao, Zhangjiakou, and Chengde, and the utilization rate of the three cities should be improved, and the improvement trend of Chengde is the least obvious. In 2013 and 2014, the utilization rate has been below 10%, and only increased to 20.24% in 2017, lagging behind more and more volatility.

4.2. Status quo of centralized treatment rate of sewage treatment plant

The centralized treatment rate of sewage treatment plant refers to the ratio between the amount of sewage treated by the sewage treatment plant and the total amount of sewage discharged during the research period. The higher the centralized treatment rate, the less the damage to the environment. See table 4.2 for details of centralized treatment rate of sewage treatment plants in Beijing Tianjin Hebei Urban Agglomeration.

Tab. 3 Concentration rate of sewage treatment plant of Beijing-Tianjin-Hebei (%)

|                | 2013   | 2014   | 2015   | 2016   | 2017   |
|----------------|--------|--------|--------|--------|--------|
| Beijing        | 84.60  | 86.10  | 87.90  | 88.13  | 90.90  |
| Tianjin        | 89.20  | 100.00 | 99.00  | 100.00 | 99.85  |
| Shijiazhuang   | 95.17  | 95.85  | 95.42  | 95.68  | 96.47  |
| Tangshan       | 95.05  | 95.00  | 95.00  | 95.00  | 96.00  |
| Qinhuangdao    | 95.59  | 98.38  | 96.17  | 96.78  | 97.23  |
| Handan         | 97.52  | 97.56  | 97.62  | 97.78  | 97.86  |
| Xingtai        | 91.18  | 93.28  | 96.35  | 97.63  | 98.56  |
| Baoding        | 92.00  | 91.39  | 81.76  | 87.66  | 91.23  |
| Zhangjiakou    | 100.00 | 91.60  | 94.42  | 92.33  | 96.00  |
| Chengde        | 88.11  | 92.34  | 91.56  | 92.22  | 94.21  |
| Cangzhou       | 97.99  | 99.04  | 100.00 | 100.00 | 100.00 |
| Langfang       | 91.12  | 93.50  | 92.01  | 92.56  | 93.45  |
| Hengshui       | 88.00  | 81.20  | 80.00  | 81.33  | 81.00  |
From table 3, it can be seen that the centralized treatment rate of sewage treatment plants in Beijing Tianjin Hebei Urban Agglomeration is generally high, except for the low level of Chengde, other cities are in high value, and there have been many times of centralized treatment rate of sewage treatment plants reaching 100% in five years, which shows that the sewage treatment level in Beijing Tianjin Hebei area is relatively high, and the subsequent treatment of sewage is good. In Zhangjiakou, Baoding and Hengshui, the wastewater treatment rates fluctuated greatly, and decreased; in other cities, the wastewater treatment rates basically increased, or basically remained the same, with Tianjin, Xingtai, Qinhuangdao and Chengde as the most obvious ones. In Cangzhou, Handan, Shijiazhuang and Tangshan, the centralized treatment rate of sewage treatment plants is always high.

4.3. Current situation of harmless treatment rate of domestic waste

The harmless treatment rate of domestic waste refers to the ratio of harmless treatment amount of domestic waste to the amount of domestic waste generated in a certain period, which reflects the treatment capacity of a city for domestic waste. See table 4 for the harmless treatment rate of domestic waste in Beijing Tianjin Hebei Urban Agglomeration.

| Tab.4 Harmless treatment rate of domestic waste of Beijing-Tianjin-Hebei (%) |
|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
|                     | 2013               | 2014               | 2015               | 2016               | 2017               |
| Beijing             | 99.30              | 99.59              | 99.80              | 99.67              | 100.00             |
| Tianjin             | 96.80              | 96.23              | 99.00              | 99.22              | 100.00             |
| Shijiazhuang        | 73.54              | 71.98              | 95.41              | 83.45              | 90.23              |
| Tangshan            | 88.34              | 100.00             | 100.00             | 98.00              | 100.00             |
| Qinhuangdao         | 90.22              | 157.94             | 100.00             | 100.00             | 100.00             |
| Handan              | 100.00             | 100.00             | 100.00             | 100.00             | 100.00             |
| Xingtai             | 99.86              | 99.02              | 100.00             | 99.64              | 99.88              |
| Baoding             | 68.91              | 82.37              | 99.99              | 100.00             | 99.00              |
| Zhangjiakou         | 87.58              | 88.00              | 95.00              | 90.00              | 93.38              |
| Chengde             | 85.86              | 88.41              | 89.02              | 91.23              | 89.76              |
| Cangzhou            | 74.44              | 93.55              | 100.00             | 100.00             | 100.00             |
| Langfang            | 27.16              | 29.41              | 58.95              | 45.67              | 40.21              |
| Hengshui            | 65.52              | 100.00             | 100.00             | 98.00              | 100.00             |

From table 4, it can be seen that the development linkage degree of each city in Beijing Tianjin Hebei Urban Agglomeration is good. The harmless treatment rate of domestic waste in most cities is concentrated in 80% ~ 100%, and the harmless treatment rate of domestic waste is generally high. In three special cities, Qinhuangdao's domestic waste harmless treatment rate in 2014 reached 157.94%, and the domestic waste treatment capacity in that year was higher than the production capacity; Hengshui's domestic waste harmless treatment rate in 2013 was relatively low, but it directly increased to 100% in 2014 and 2015, and the improvement was faster; Langfang showed a downward trend, the domestic waste harmless treatment rate in 2015 was higher, but 2016 was higher From to 2017, the decline was large, and it was reduced to the lowest level in the urban agglomeration.

5. Conclusion

The proportion of industrial pollution control investment in industrial GDP in Beijing, Tianjin and Hebei region has been changing continuously, and no reasonable investment plan has been made according to the severity of pollution [4]. As a whole of industrial pollution control, Beijing, Tianjin and Hebei are actively transforming in the new era, transferring some enterprises with more serious pollution to Hebei Province. In addition, they do not have the advantages of technology and supervision, resulting in more serious pollution while the industrial economic growth of Hebei Province [5]. In terms of the overall
treatment of Beijing, Tianjin and Hebei, the discharge of "three wastes" will increase, the treatment
effect will not be improved in the short term, and the pollution will not be well and quickly prevented
in the near future [6]. Therefore, we should increase the scale and proportion of investment in industrial
pollution control, focus on strengthening the investment in industrial pollution control in Hebei Province,
and increase the investment in the research and development and promotion of pollution control
ecological technology.

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