Study on optimal pollutant control screening in benxi section of taizi river

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Abstract. In view of the pollution problem of toxic and harmful sewage discharge from enterprises in benxi section of the upper reaches of taizi river, the typical pollution sources of benxi section were investigated and the pollutants in benxi section were measured. The comprehensive scoring method based on the potential hazard method was used to select 8 factors suitable for the selection of benxi section of taizi river and assign weights to them. Screen out 13 kinds of poisonous and harmful pollutants for benxi section of the optimal control of pollutants. It provides the index basis for monitoring the water quality of the benxi section of taizi river and water risk accidents.

1. Introduction
At present, the prominent feature of water pollution in China's river basin is the complexity and diversification of environmental pollution, and the impact of water pollution accidents on the water environment is increasingly intensified [1]. For river pollution index, most of the conventional pollutants are COD, nitrogen and phosphorus. These indicators are very one-sided in the assessment of river pollution. It can not objectively reflect the degree of river pollution. Different screening methods are applied to the selection of optimal control pollutants for many pollutants and potential pollutants in the water. On the basis of the screening principle, according to the general situation of pollution sources around the river, the pollutants with great harm to human health in this section of river are selected as the priority monitoring and control objects [2].

There are many domestic studies on optimal pollutant control, including the screening of pollutants in rivers and groundwater. The national "12th five-year plan" water project has completed the research on optimal pollutant control screening for typical industries in Liaohe river basin. Based on the method of potential hazard, the pollutants in the polluted river sections of five key industries in Liaohe river basin were screened, and the optimal control pollutants in corresponding regions of metallurgy, petrochemical, printing and dyeing, pharmaceutical and chemical industries were obtained [3]. Taking liaohe river filtering method based on optimal control pollutants, application based on the method of potential hazards of comprehensive evaluation method, starting from the toxicity of pollution discharge of waste water, the key to identify typical industry wastewater toxic substances, combined with the water quality monitoring results, it is concluded that the benxi section of taizi river basin optimal control pollutant list, this method can not only reflect the characteristics of the river water quality, and can reflect the pollution industry layout and its dynamic change characteristics. It makes up the gap of optimal pollution control in the upper reaches of taizi river in benxi section, and provides support for the optimal pollutant control screening of liaohe river basin control unit and the integration of treatment technology in taizi river basin in the 13th five-year plan water basin [4].
2. Overview of Benxi Section of Taizi river

Taizi river is an important tributary of Liaohai river, which is mainly absorbed by Benxi, Anshan and Liaoyang[5]. Along the Taizi river, there are iron and steel metallurgy, chemical fiber, printing and dyeing and other heavy chemical enterprises. Compared with other tributaries of Liaohai river, Taizi river pollution is caused by the common pollutants from agricultural or domestic sources as well as industrial pollutants from metal products and chemical industries. The pollution types are organic pollution with COD as the index and compound pollution of volatile phenol, nitrobenzene and other toxic organic compounds. The centralized treatment rate of wastewater is not high. The Benxi section of Taizi river is the upstream section of Taizi river. Benxi city, as a heavy industry city with large enterprises such as Benxi steel and Beiyin iron & steel (group) co., LTD., Benxi Beita iron & steel group, the industrial wastewater in Benxi section is discharged directly into the surface water, and only 5% into the sewage plant. In the list of key sewage discharge in Liaoning province to be released in 2019, there are 31 units located in Benxi section, including 6 major industries of metallurgy, petrochemical, chemical, food, pharmaceutical and sewage treatment plants, as shown in FIG. 1. Among them chemical industry blowdown unit has 11. There are 7 food manufacturing industries and 2 petrochemical units. Statistics of potential pollutants in these industries pollutants mainly relate to raw materials and intermediates involved in the manufacturing process, as well as existing pollutants in the discharged sewage. Taking Benxi large enterprises: Benxi Beiyin iron and steel, Benxi Haida pharmaceutical factory, Benxi Di textile co., LTD., and other risk enterprises as the object, the data were searched and analyzed. The types of potentially toxic and harmful pollutants in the enterprise were statistically analyzed, as shown in table 1. It is found that volatile phenol and cyanide are the main toxic pollutants in Taizihe industry. These are not among the usual indicators for sewage monitoring. At the same time, it has irreversible harm to human health and water quality environment for a long time[6].

![Figure 1. Pollution sources in Benxi section of Taizi river](image-url)
Table 1. A list of potential pollutants of risk enterprises in this section

| Enterprise Name                  | Industry Categories          | Sewage Type                      | Potential Pollutant Type                                                                 |
|---------------------------------|-----------------------------|---------------------------------|-----------------------------------------------------------------------------------------|
| Beiying steel (group) co., LTD  | Metal smelting              | Black smelting slag water        | Heavy metals, petroleum, pahs                                                           |
| Benxi haida pharmaceutical co., LTD | Manufacture of chemicals | Other pharmaceutical manufacturing wastewater | API (kanamycin sulfate, kanamycin sulfate, kanamycin base), phenol |
| Benxi first textile co., LTD    | Chemical production         | Product processing wastewater    | Replace alkanes, ketones, alcohols, replace benzene, phthalates, containing nitrogen heterocyclic, polycyclic aromatic hydrocarbons |
| Benxi Beiying steel (Group) Co., Ltd. rolling mill | Metal processing | Ferrous metal rolling processing wastewater | Heavy metals, petroleum, pahs |
| Benxi Beiying iron and steel (Group) Co., Ltd. ironmaking plant (zone 3) | Metal smelting | Black smelting cooling water    | Heavy metals, petroleum, pahs                                                           |

3. Optimal pollutant control screening in Benxi section of Taizi river

3.1 Optimal control of pollutant screening path

According to the statistics of pollution sources in Benxi section of Taizi river, the potential pollutants of typical risk industries in Benxi section are summarized, and the water quality of Benxi section of Taizi river is tested for many times to summarize the data. According to the principle of optimal pollutant control, the pollutants in Benxi section of Taizi river were screened. The filter path is as follows:

1. Determine the typical pollutants of risk enterprises and industries in this section
2. Multiple monitoring and analysis of major pollutants in this section of the river basin
3. Determine the initial screening list of pollutants under optimal control
4. Calculate the potential hazard index of each pollutant in the initial screening list
5. Determine the selection factors and weight of comprehensive scoring method
6. Calculate the comprehensive score of pollutants and determine the list of pollutants under optimal control

3.2 Comprehensive scoring method based on potential hazard method

The comprehensive scoring method based on the potential hazard method in the existing potential hazard method and the comprehensive scoring method system, the quantitative screening method is established based on the environmental exposure index and environmental effect index. Suitable for the Benxi section of Taizi river in this study, the concentration and detection rate of pollutants in the section were studied by comprehensively considering the toxicity of pollutants, and whether the pollutants were selected as screening factors for China's optimal control list and American EPA optimal control pollutants. Different screening factors are given different screening weights according to the influence degree of the screening factors involved. It has the advantages of comprehensive consideration, objective continuity and targeted optimal pollutant control screening.

Comprehensive evaluation method based on potential hazards method to potential hazard index (A), concentration of Benxi section of pollutants detection (B), Benxi section of pollutant detection rate (C), whether it is poisonous chemicals (D), whether to belong to the environmental hormone (E), (F) for persistent pollutants, whether for the U.S. EPA optimal control of pollutants (G), whether for China's
priority pollutants (H) eight factors as screening index, the taizi river at the beginning of benxi section scores screen list of poisonous and harmful pollutants.

Firstly, determine the potential hazard index of pollutants in the initial screening list of benxi section of taizi river, and calculate the screening factor A according to the formula of potential hazard index (N): 

\[
N = 2aA + 4bB
\]

where,

A - the value of the AMEGAH of A chemical
B - the value of the AMEGAC of the potential "trisolectic" chemical;

(1) estimation of air environment target value (AMEGAH)
The AMEGAH value of the chemical was estimated by LD50. The LD50 was given to rats by oral administration.

As the basis. The formula of AMEGAH calculated by LD50: 

\[
AMEGAH() = 0.107 \times LD50
\]

(2) estimation of AMEGAC of "trisaccharide" substance

According to the estimation of the threshold value of carcinogens or suspected carcinogens in this screening, the calculation formula is as follows:

\[
AMEGAC() = \text{threshold value} / 420 \times 10^3
\]

The determination method of B value is shown in the table.

| Of a common chemical substance | A value | Of a potential trisolectic substance | B value |
|--------------------------------|---------|-------------------------------------|---------|
| AMEGAH (μg/m³)                | A value | AMEGAC (μg/m³)                      | B value |
| >200                           | 1       | >20                                 | 1       |
| <200                           | 2       | <20                                 | 2       |
| <40                            | 3       | <2                                  | 3       |
| <2                             | 4       | <0.2                                | 4       |
| <0.02                          | 5       | <0.02                               | 5       |

Where a, a' and b are constants. The determination principle of a, a' and b is as follows: when b value can be found, a=1; when no b value is found, a=2; When a chemical substance has accumulative or chronic toxicity, a'=1.25, and when only acute toxicity, a'=1; If you can find A value, b is 1, and if you can't find A value, b is 1.5. The potential hazard index of pollutants in the initial screening list of benxi section of taizi river was calculated.

Determination method of screening factor B: the detected concentration was determined by geometric classification, with five intervals of 1 ~ 5. The maximum detection concentration was taken as the peak value, and the minimum detection concentration was 1. The average span of the maximum and minimum detection concentration was divided into five parts, and the corresponding values of the corresponding detection concentration were selected. The detection rate of screening factor C defined 0% ~ 100% as five equal parts, and assigned 1 ~ 5 points respectively.

| index code | indicators                              | Index weight | annotation                                           |
|------------|-----------------------------------------|--------------|------------------------------------------------------|
| A          | Potential hazard index                  | 1            | Determined by the calculation method of USEPA        |
| B          | Pollutant concentration was detected in benxi section | 3            | Determined by water quality monitoring               |
| C          | Detection rate of pollutants in this section | 3            | Determined by water quality monitoring               |
| D          | Whether it is a toxic chemical           | 6            | International register of potentially toxic chemicals |
| E          | Whether it is an environmental hormone   | 10           |                                                      |
| F          | Whether it is a persistent pollutant     | 8            |                                                      |
Finally, the calculation formula of the improved comprehensive scoring method is determined as follows:

Comprehensive score = A + B × 3 + C × 3 + D × 6 + E × 10 + F × 8 + G × 6 + H × 12. The total score is 100, and the score of each substance is shown in Table 4. Pollutants with a score of more than 50 points were selected as the optimal control pollutants in the Benxi section of Taizi river.

Table 4. Comprehensive score calculation score table

| Number | Pollutant name                  | A  | B  | C  | D  | E  | F  | G  | H  | Total |
|--------|---------------------------------|----|----|----|----|----|----|----|----|-------|
| 1      | Diisobutyl phthalate            | 15 | 15 | 12 | 6  | 10 | 0  | 6  | 12 | 76    |
| 2      | Dibutyl phthalate               | 10 | 12 | 12 | 6  | 0  | 0  | 12 | 12 | 62    |
| 3      | Diethyl hexyl phthalate         | 6  | 15 | 12 | 6  | 10 | 0  | 0  | 12 | 61    |
| 4      | Naphthalene                     | 16 | 9  | 15 | 6  | 0  | 0  | 0  | 12 | 58    |
| 5      | Fluorene                        | 28 | 6  | 15 | 6  | 0  | 0  | 0  | 55 |       |
| 6      | 3-Nitrotoluene                  | 16 | 12 | 9  | 6  | 0  | 0  | 12 | 55 |       |
| 7      | 2, 6-Dimethyl phenol            | 20 | 12 | 15 | 6  | 0  | 0  | 0  | 53 |       |
| 8      | Benzo (a) anthracene            | 26 | 3  | 12 | 6  | 0  | 0  | 6  | 53 |       |
| 9      | Diethyl phthalate               | 10 | 9  | 12 | 0  | 10 | 0  | 0  | 53 |       |
| 10     | o-Cresol                        | 22 | 9  | 15 | 6  | 0  | 0  | 0  | 52 |       |
| 11     | 2-Methyl naphthalene            | 22 | 9  | 15 | 6  | 0  | 0  | 0  | 52 |       |
| 12     | 2-Nitrotoluene                  | 16 | 15 | 15 | 6  | 0  | 0  | 0  | 52 |       |
| 13     | Butyl benzyl phthalate          | 10 | 3  | 9  | 6  | 10 | 0  | 0  | 50 |       |
| 14     | 1, 4-Dinitrobenzene             | 22 | 9  | 12 | 6  | 0  | 0  | 0  | 49 |       |
| 15     | 2, 6-Tert-Butyl Parcresol       | 16 | 12 | 15 | 6  | 0  | 0  | 0  | 49 |       |
| 16     | 2-Naphthylamine                 | 16 | 15 | 12 | 6  | 0  | 0  | 0  | 49 |       |
| 17     | M-Methyl Phenol                 | 18 | 12 | 12 | 6  | 0  | 0  | 0  | 48 |       |
| 18     | Benzyl benzoate                 | 16 | 12 | 12 | 6  | 0  | 0  | 0  | 46 |       |
| 19     | Guaiacol                        | 16 | 9  | 15 | 6  | 0  | 0  | 0  | 46 |       |
| 20     | Acenaphthylene                  | 16 | 9  | 15 | 6  | 0  | 0  | 0  | 46 |       |
| 21     | 1-Methyl naphthalene            | 16 | 9  | 15 | 6  | 0  | 0  | 0  | 46 |       |
| 22     | P-Methyl styrene                | 10 | 15 | 15 | 6  | 0  | 0  | 0  | 46 |       |
| 23     | 2-Ethylhexanol                  | 10 | 15 | 15 | 6  | 0  | 0  | 0  | 46 |       |
| 24     | 2, 4-Tert-Butyl Phenol          | 10 | 15 | 15 | 6  | 0  | 0  | 0  | 46 |       |
| 25     | 1,3, 5-Trimethylbenzene         | 10 | 15 | 15 | 6  | 0  | 0  | 0  | 46 |       |
| 26     | 1, 3-Diethyl benzene            | 10 | 15 | 15 | 6  | 0  | 0  | 0  | 46 |       |
| 27     | Fluoranthene                    | 10 | 3  | 15 | 6  | 0  | 0  | 0  | 46 |       |

3.3 Screening results
According to Table 4, toxic pollutants with scores of more than 50 points were selected as the optimal control pollutants in the Benxi section of Taizi river. Be able to get 13 species, phthalate butyl ester, phthalic acid, dibutyl phthalate (2-ethyl hexyl ester, naphthalene, fluorene, 3-nitrotoluene, 2, 6-dimethyl phenol and benzene and (a) anthracene, diethyl phthalate, o-cresol, 2-methyl naphthalene, 2-nitrotoluene, phthalic acid butyl benzyl ester as Taizi river Benxi section of the optimal control of pollutants.

4. Conclusion
It can be seen from the results of the study that, Taizi river Benxi section of 13 kinds of optimal control of pollutants from Liaohe optimal control of pollutants have bigger difference, comparing to other
reach optimum control of pollutants, more can reflect taizi river benxi section of chemical industry of point source pollution characteristics, fill in the taizi river benxi section of optimal control of pollutants, the blank of taizi river section of benxi water quality monitoring and management to provide a more powerful solutions. The management applicability of liaohe river water environment standard is improved, which provides a strong support for the development of water environment quality supervision level in our country.

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