Analysis on the Characteristics of Dissolved Organic Matter in Receiving River Water in Wastewater Treatment Plant

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Abstract. In this paper, Nash's reagent luminosity and other methods were used to quantitatively and qualitatively study the content of ammonia nitrogen and other substances in the tailwater of urban sewage treatment plant, and to analyze the characteristics of organic matter by fluorescence spectrometry, focusing on different sampling points of rivers by three-dimensional fluorescence spectroscopy. The change in dissolved organic matter in the water sample was characterized. The results show that the dissolved organic matter in the upstream of the river channel is the tryptophan in the protein. After the tail water of the sewage treatment plant is discharged, the dissolved organic matter from the tail water discharge outlet to the downstream river channel is protein, sewage treatment. After the tail water is discharged, there is basically no influence on the composition and transformation of dissolved organic matter in the receiving river channel.

1. Introduction
The amount of urban sewage generated increases with the expansion of the city and the population.[1-3] The sewage treatment plant has become one of the important infrastructures in the urban development process.[4-8] The sewage treated by the sewage treatment plant, the content of the pollutants is greatly reduced, but whether the tail water discharged from the sewage treatment plant will affect the river water environment after being discharged into the receiving river becomes a problem worthy of attention and consideration.[9] Based on the background of sewage treatment plant, this paper quantitatively and qualitatively analyzes the changes of the content of organic matter and the characteristics of dissolved organic matter in the river channel after the tail water is discharged into the receiving river.

2. Experimental method
The research object of this paper is the water in the tailwater of the sewage treatment plant, receiving the upstream (I), the tailwater discharge (II) of the sewage treatment plant, the upper reaches of the river (III), and the lower reaches of the river. (IV) Four sampling points.

After the water sample was pretreated by 0.45μm filter, the water quality was as follows: pH 8.68-9.09, ammonia nitrogen 0.127~0.237 mg/L, total nitrogen 2.83~12.39mg/L, nitrate nitrogen 4.511~10.733 mg / L, nitrite nitrogen is 2.337 ~ 5.383 mg / L, UV254 is 0.090 ~ 0.097, TOC is 7.86 ~ 10.33 mg / L.
Table 1. Experimental indicators and methods

| index                          | method                                      |
|-------------------------------|---------------------------------------------|
| pH                            | Portable pH meter                           |
| Ammonia nitrogen              | Nessler reagent spectrophotometry           |
| NO$_2^-$-N                   | N-(1-naphthyl)-ethylenediamine luminosity   |
| NO$_3^-$-N                   | UV spectrophotometry                        |
| Total nitrogen and TOC        | Total organic carbon/total nitrogen analyzer |
| UV$_{254}$                    | UV spectrophotometry                        |

Table 2. Main instrument of experiment

| equipment name                              | model     | factory                                      |
|---------------------------------------------|-----------|----------------------------------------------|
| Total organic carbon/total nitrogen analyzer| MultiN/C3100 | Jena Analytical Instruments AG               |
| UV-visible spectrophotometer                | Lambda365 | Perkin Elmer Management Co., Ltd.            |
| Fluorescence spectrometer                   | F-4600    | Hitachi High-Tech Company                    |

3. Analysis of UV$_{254}$ content

The UV$_{254}$ value is the absorbance of some organic matter in water at 254 nm ultraviolet light, reflecting the amount of naturally occurring humic macromolecules in water and aromatic compounds containing C=C double bonds and C=O double bonds. It can be seen from Fig. 1 that the UV$_{254}$ content in the upper reaches of the river is 0.093, and the content in the tail water discharge of the sewage plant increases, and the pollution zone is formed in the upper part of the downstream, which leads to an increase in the content of the lower reaches of the river. The self-purification effect showed a significant downward trend.

![Figure 1. UV$_{254}$ value of water samples at different sampling points](image)

4. Analysis of TOC content

The decomposition of microorganisms such as algae and bacteria in river water and domestic garbage caused the highest TOC content in the upper reaches of the Nahe River, and the TOC content from the upstream to the downstream decreased. The TOC of the tail water discharge of the sewage treatment plant was 8.86 mg/L. With the drainage of the sewage treatment plant and the self-purification of the river, the TOC content is gradually reduced.
5. Analysis of Ammonia Nitrogen, Nitrate Nitrogen and Total Nitrogen Content

The content of ammonia nitrogen and total nitrogen in the upper reaches of the river is relatively low. Due to the drainage of the sewage treatment plant, it is easy to form a pollution zone between the outlet and the upper reaches of the river. From the downstream, the content of both increases is obvious. The ammonia nitrogen content gradually decreases with the downstream river to reach the water quality standard. The total nitrogen value increased significantly at the downstream, but the total nitrogen content decreased to the lower self-purification capacity of the downstream river and the degradation of the pollutant itself. The content of nitrate nitrogen increased, and the river water flowed from the upstream to the outlet of the sewage treatment plant. The decomposition of pollutants caused the nitrate nitrogen content to drop drastically. The content of the downstream upper reaches was increased due to the discharge of pollutants, and then the water was self-cleaned. And decomposition, the nitrate nitrogen in the river water gradually decreased.

6. Three-dimensional fluorescence spectroscopy

Three-dimensional fluorescence spectroscopy is a fluorescence analysis technology developed in recent years. At present, more and more applications are in the study of the types and contents of dissolved organic substances. The technology can simultaneously obtain the excitation wavelength, the emission wavelength and the corresponding fluorescence intensity information when the two changes, and analyze the organic pollutant characteristics according to different dissolved organic matter corresponding to different peaks and fluorescence centers. The three-dimensional fluorescence spectrum has the advantages of high sensitivity, good selectivity, no damage to the sample, simple and rapid measurement method, and can provide relatively complete fluorescence spectrum information.

The three-dimensional fluorescence spectrum characteristics of the dissolved organic matter were analyzed by a F-4600 fluorescence spectrophotometer, the light source was a xenon arc lamp, and the water sample was placed in a 1 cm quartz fluorescence sample cell, and the blank was used as a
control. The excitation light wavelength scanning range is 220-480 nm, the interval is 5 nm, the emission light wavelength scanning range is 240-550 nm, the interval is 1 nm, the excitation and emission slit width is 5 nm, the response time is 0.004 ns, and the scanning speed is 1200 nm/min.

Three-dimensional fluorescence spectroscopy can reveal the types of organic matter and their content information, and can spectrally identify and characterize objects with overlapping fluorescence spectra in multi-component complex systems. Different DOM components contain different fluorophores, and the positions of the fluorescent peaks are different. The corresponding different DOM components have characteristic fluorescence spectra, which are represented by the characteristic positions of the DOM components on the three-dimensional fluorescence spectrum contour map. Excitation/emission (ex/em) fluorescence center. In general, the ex/em fluorescence centers of various components of DOM in natural waters can be mainly divided into three categories: humic substances (ex/em: 237-260 nm/400-500 nm and 300-370 nm/400-500 nm); Acids: (ex/em: 235 to 240/340 to 355 nm); proteins (ex/em: 235 to 240/340 to 355 nm and 280 to 285/320 to 335 nm).

| Fluorescent peak designation | Fluorescent substance type | Excitation wavelength (nm) | Emission wavelength (nm) |
|-----------------------------|---------------------------|----------------------------|--------------------------|
| A                           | Fulvic acid               | 237–260                    | 400–500                  |
| C                           | Humic acid                | 300–370                    | 400–500                  |
| C₁                          | Humic acid                | 320–340                    | 410–430                  |
| C₂                          | Humic acid                | 370–390                    | 460–480                  |
| D                           | Soil fulvic acid          | 390                        | 509                      |
| E                           | Soil fulvic acid          | 455                        | 521                      |
| M                           | Marine humus              | 290–310                    | 370–410                  |
| T₁                          | Tryptophan                | 275                        | 340                      |
| T₂                          | Tryptophan                | 225–237                    | 340–381                  |
| B₁                          | Lysine                    | 275                        | 310                      |
| B₂                          | Lysine                    | 225–237                    | 309–321                  |
| N                           | Phytoplankton productivity| 280                        | 370                      |

It can be seen from Figure 4 that there is a distinct peak in the water sample upstream of the receiving river. The fluorescence center position of the peak is Ex/Em=285 nm / 340 nm, which belongs to a low excitation wavelength tryptophan peak. Figure 5 shows the fluorescence spectrum of the water sample at the outlet of the sewage treatment plant. The fluorescence center of the peak is at Ex/Em=285nm / 320nm, which is a protein-like fluorescent peak.
Fig. 4 and Fig. 5 show the three-dimensional fluorescence spectrum of the water samples at the two downstream sampling points, both of which have a peak, and the fluorescence center position of the peak is $E_x/E_m=285$ nm/$320$ nm, which belongs to the protein-like fluorescent peak. There is no obvious change in the position of the fluorescent peaks in the upper and lower reaches of the river, indicating that the self-purification of the downstream river itself mainly removes microorganisms and suspended matter, and has no effect on the composition and transformation of dissolved organic matter.

Fig. 6 and Fig. 7 show the three-dimensional fluorescence spectrum of the water samples at the two downstream sampling points, both of which have a peak, and the fluorescence center position of the peak is $E_x/E_m=285$ nm/$320$ nm, which belongs to the protein-like fluorescent peak. There is no obvious change in the position of the fluorescent peaks in the upper and lower reaches of the river, indicating that the self-purification of the downstream river itself mainly removes microorganisms and suspended matter, and has no effect on the composition and transformation of dissolved organic matter.

7. Summary
After the water treated by the sewage treatment plant is discharged, the contents of ammonia nitrogen, total nitrogen and UV254 increase, and then along the direction of the flow of the receiving river, the index values are gradually reduced due to the decomposition of pollutants and the self-purification of river water. Meet the surface water quality standards. Using three-dimensional fluorescence technology to analyze the characteristics of dissolved organic matter in the water of the receiving river, effective fluorescence spectrum information can be obtained. Spectral analysis showed that the dissolved organic matter in the upstream of the river channel is the tryptophan in the protein, and after
the tail water of the sewage treatment plant is discharged, it has no effect on the composition and conversion decomposition of the dissolved organic matter in the receiving river channel. The dissolved organic matter in the river is a protein.

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