Study on The Relationship Between Silt Density Index and Turbidity in Wastewater Membrane Treatment

Zhibin Guo, Xiaolin Du
Changzhi Industrial Informatization Research Center

Full postal address: No.40 Zijin West Street, Luzhou District, Changzhi City, Shanxi Province, P.R.China
E-mail address: guozhibin@iirc.changzhi.com

Abstract
With the development of the city, the problem of wastewater is becoming more and more serious. In wastewater treatment, membrane treatment technology is becoming more and more mature. In membrane treatment technology, the SDI value of filtered water is a key indicator to show the treatment capacity, which has a great relationship with the turbidity of sewage. In this paper, the relationship between turbidity and SDI of effluent was studied in the same membrane treatment.

1. Introduction
At present, in the development of the city, the problem of urban wastewater pollution is becoming more and more serious, which has a great impact on the urban ecosystem. But in the wastewater treatment, membrane treatment is a common method, which can purify the sewage and has a wide range of applications. In the process of membrane treatment, water quality is often characterized by pollution index or turbidity. Pollution index is also called silt density index (SDI), and it's a technical index representing the content of pollutants such as particles, bacteria and colloids in water. The SDI was calculated by sample water blocking 0.45um microporous membrane. It is of great significance to carry out the research on SDI test method of ultrafiltration membrane effluent for real-time and accurate detection of SDI in engineering application. By measuring the SDI value, the corresponding water purification technology or equipment can be selected. In the process of reverse osmosis water treatment, SDI value is one of the important marks to determine the influent of reverse osmosis system, and it is the main means to check whether the effluent of pretreatment system meets the requirements of reverse osmosis influent. Its size is very important for the operation life of reverse osmosis system.

Turbidity is a measure of the decrease in transparency of a liquid due to the presence of substances that scatter light in water. The colloidal particles of suspending agent in water will scatter and absorb the light passing through the sample, and the scattering phenomenon of light produces turbidity. The turbidity is characterized by the scattering characteristics of the particles in the sample. The unit of it is NTU. Turbidity is usually suitable for the determination of natural water, drinking water and some industrial water. The water sample for turbidity measurement should be determined as soon as possible. Before determination, the water sample should be shaken violently and returned to room temperature. The water contains soil, silt, fine organic matter, inorganic matter, plankton and other suspended solids and colloidal matter, which can make the water become turbid and present a certain turbidity. According to the water quality analysis, the turbidity of 1L water containing 1mg SiO₂ is a standard turbidity unit, referred to as 1 degree. Generally, the higher the turbidity, the more turbid the solution.
On the basis of the experiment, the relationship between turbidity before filtration and SDI after filtration is studied in detail.

2. Materials and Methods

2.1 Instrument and Reagents
Ultrafiltration membrane, Ultrafiltration membrane performance detector, a stopwatch, a scale

2.2 Experimental Steps

2.2.1 0.0, 0.1, 0.2, 0.3 NTU demonized water: Standardized deionized water with turbidity of 0.0, 0.1, 0.2, 0.3 NTU.

2.2.2 According to GB / T 32360-2015[6] test methods for ultrafiltration membrane, the ultrafiltration membrane sheet was installed on the ultrafiltration membrane performance tester and pretreated;

2.2.3 SDI5, SDI10, or SDI15: The ultrafiltration water sample taken from the initial filtration 500 ml and the time of filtering 500 ml of the same water sample after 5, 10, and 15min. The SDI of the water sample was calculated as follows:

$$SDI_\tau = \left(1 - \frac{\tau_0}{\tau_1}\right) \times 100/\tau$$ (1)

Where

$SDI_\tau$ denotes the SDI value at time $\tau$;

$\tau$ denotes the interval between the collection of two water samples; it can be 5, 10, or 15 min;

$\tau_0$ denotes the initial collection time of 500 mL of filtered water, s;

$\tau_1$ denotes the time spent in collecting 500 mL of filtered water after times, s;

3. Results
After filtration, different volumes of filtered water are collected. The corresponding data of SDI5, SDI10 and SDI15 are shown in Table 1, Table 2, Table 3 and Table 4. (Note: it is noted that the calculation cannot be carried out because the corresponding filtered water cannot be obtained.)

| Table 1 | SDI of different volumes of filtered water for NTU=0.0 Sample |
|---------|-------------------------------------------------------------|
| NTU=0.0 | 100mL | 250mL | 500mL |
| ST0     | 6.06  | 14.77 | 29.58 |
| ST5     | 7.64  | 16.92 | 33.14 |
| ST10    | 8.02  | 18.14 | 35.80 |
| ST15    | 8.20  | 19.39 | 36.24 |
| SDI5    | 4.14  | 2.54  | 2.15  |
| SDI10   | 2.44  | 1.86  | 1.74  |
| SDI15   | 1.74  | 1.59  | 1.23  |
Table 2 SDI of different volumes of filtered water for NTU=0.1 Sample

| NTU=0.1 | 100mL   | 250mL   | 500mL   |
|---------|---------|---------|---------|
| ST0     | 14.05   | 41.92   | 113.77  |
| ST5     | 65.45   | 193.70  | /       |
| ST10    | 111.41  | /       | /       |
| ST15    | 145.11  | /       | /       |
| SDI5    | 15.46   | 15.67   | /       |
| SDI10   | 8.69    | /       | /       |
| SDI15   | 5.99    | /       | /       |

Table 3 SDI of different volumes of filtered water for NTU=0.2 Sample

| NTU=0.2 | 100mL   | 250mL   | 500mL   |
|---------|---------|---------|---------|
| ST0     | 35.30   | 165.31  | /       |
| ST5     | 170.84  | /       | /       |
| ST10    | 288.99  | /       | /       |
| ST15    | 378.30  | /       | /       |
| SDI5    | 15.71   | /       | /       |
| SDI10   | 8.74    | /       | /       |
| SDI15   | 6.02    | /       | /       |

Table 4 SDI of different volumes of filtered water for NTU=0.3 Sample

| NTU=0.3 | 100mL   | 250mL   | 500mL   |
|---------|---------|---------|---------|
| ST0     | 38.81   | 144.49  | /       |
| ST5     | 171.96  | /       | /       |
| ST10    | 295.97  | /       | /       |
| ST15    | 381.03  | /       | /       |
| SDI5    | 15.89   | /       | /       |
| SDI10   | 8.78    | /       | /       |
| SDI15   | 6.04    | /       | /       |

4. Conclusions
By comparing the data in Table 1 to Table 4, it can be seen that:

4.1 The water with the same turbidity is treated by membrane and the same volume of filtered water is collected. The SDI5, SDI10 and SDI15 gradually decrease;

4.2 The water with the same turbidity is treated by membrane and filtered for the same time. The collected volume is larger and the SDI value is the lower;

4.3 The water with different turbidity is treated by membrane and the same volume of filtered water is
collected after the same time. The original turbidity is higher and the SDI after filtration is larger;

4.4 It cannot be concluded that the greater the turbidity of raw water, the larger the SDI after filtration. It is necessary to indicate the corresponding filtering time in SDI. For example, for collecting 100mL filtered water, SDI5 is 15.46 for NTU = 0.1, but SDI15 is 6.04 for NTU = 0.3. Therefore, the turbidity of the sample should not be equal to the SDI after filtration.

Acknowledgments
Supported by the Changzhi Luzhou District 14th Five Year Industrial High Quality Development Planning Project.

References
[1] Huang YL, (2020) Problems and Countermeasures of sewage treatment in urban environmental protection, Resource conservation and environmental protection, 1: 11;
[2] DL/T 588-2015, (2015) Water quality-Determination of fouling index;
[3] Wang XL, Zhang YP, Pan XH, (2013) Study on the measurement method of ultrafiltration membrane effluent pollution density index, Journal of Filtration and Separation, 23:1-3
[4] Wang XL, Zhang YP, Pan XH, (2012) Research on Testing Method of Silt Density Index, 2012 Qingdao International desalination Conference, 272-275
[5] HJ 1075-2019, (2019) Water quality-Determination of turbidity-Nephelometry;
[6] GB / T 32360-2015, (2015) Test methods for ultrafiltration membranes.