Rev. Int. Contam. Ambie. 38 (Environmental Science and Policy for Sustainable Development) 21-32, 2022
https://doi.org/10.20937/RICA.54604

DESIGN OF A METHOD FOR WATER TREATMENT TECHNOLOGY OF AN INDOOR SWIMMING POOL BASED ON OZONE DISINFECTION METHOD

Diseño de un método para la tecnología de tratamiento de agua de una piscina cubierta con base en la desinfección por ozono

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(Received: October 2021; accepted: April 2022)

Key words: Ozone disinfection, indoor swimming pool, water quality treatment, water cycle, urea, particulate matter.

ABSTRACT

Aiming at the problem that most of the water treatment technology of swimming pools cannot effectively remove harmful substances, the design of a method for water treatment technology of indoor swimming pool based on ozone disinfection was proposed. Firstly, the organic composition of swimming pool water is analyzed, and the related evaluation indexes of swimming pool water are selected. Then, according to the disinfection performance of ozone disinfection, the appropriate ozone disinfection method is selected. Finally, according to the characteristics of the ozone disinfection method, the design of the water treatment cycle filtration system is completed to achieve the treatment of swimming pool water. The experimental results show that the method is superior to the conventional method by keeping urea at about 1.3 mg/L, the highest COD removal rate approaching 100%, and the lowest value only 59%. Moreover, the effect of particle reduction is obvious after the application, and the daily ozone consumption is always lower than 0.9, which fully verifies the feasibility and economic value of the method.

Palabras clave: desinfección por ozono, piscina cubierta, tratamiento de calidad del agua, ciclo del agua, urea, partículas.

RESUMEN

Considerando el problema de que la mayoría de las tecnologías para el tratamiento de agua de piscinas no puede eliminar eficazmente las sustancias nocivas, se propuso el diseño diseño de un método de tratamiento de agua para piscinas cubiertas basado en la desinfección por ozono. En primer lugar, se analiza la composición orgánica del agua de la piscina y se seleccionan los índices de evaluación relacionados con el agua. Luego, de acuerdo con el rendimiento de desinfección de ozono, se selecciona el método de desinfección por ozono adecuado. Finalmente, de acuerdo con las características del método de desinfección por ozono, se completa el diseño del sistema de filtración del ciclo de tratamiento. Los resultados experimentales muestran que el método es superior al método convencional al mantener la urea en aproximadamente 1.3 mg/L, la tasa de eliminación de DQO más alta se acerca al 100% y el valor más bajo a sólo el 59%. Además, el efecto de la reducción de partículas es evidente después de la aplicación, y el consumo diario de ozono es siempre inferior a 0.9 mg/L, lo que verifica plenamente la viabilidad y el valor económico del método.

INTRODUCTION

The debate over pool water disinfectants has raged in recent years. Various disinfectants may be recommended by health and quarantine authorities, sports authorities, environmental protection authorities or higher authorities (Gunten 2018, Luklema 2018, Feng et al. 2020), generally chlorine water, chlorine tablets, bleach powder, bleach powder two-in-one or three-in-one, sodium dichloroisocyanate, sodium trichloroispolyurea, etc. Recommended disinfection equipment includes: sodium hypochlorite generators, chlorine dichloride generators, electromagnetic disinfectors, ultraviolet disinfectors, etc. These disinfectants are all good, as well as the equipment, but each has its own place of use, and most are not suitable for disinfection of swimming pool water (Hodges et al. 2018, Mcguire and Pearthree 2018). At present, the majority of swimming pools still use chlorine oxidation disinfection method for disinfection. Liquid chlorine was used in the past, but the storage and use of liquid chlorine are relatively dangerous. Now, sodium hypochlorite solution is used, taking advantage of the oxidation of sodium hypochlorite to achieve disinfection effect, but this disinfectant will often form a lot of harmful substances in the water, such as chloroform. High chlorine species can adversely affect swimmers' skin, hair and eyes. Therefore, no or little use of chlorine has been the development direction of swimming pools (He et al. 2018a).

In addition to water disinfection, there are also corresponding methods in swimming pool water filtration. The recycling of swimming pool water is a reflection of sewage recycling, and is an effective way to alleviate the water shortage. Because swimming pool water is directly related to human health and safety, people pay more and more attention to the water quality of swimming pools (Maleki et al. 2018). At present, the research on swimming pool water treatment technology has been basically mature at home and abroad. Many water treatment equipment plants have been developing more suitable equipment for swimming pool water treatment in view of the existing problems. The pressure filter tank is mostly used in the circulating filtration system of swimming pools around the world. According to the tank type, there are two types of pressure filter tanks: vertical and horizontal. According to the filter materials, there are natural sand and stone filter materials and artificial synthetic filter materials. It has many advantages, such as the tank can bear pressure, high filtration rate and small volume, so it is a typical product (Ozkok et al. 2019), but its application in swimming pools is not ideal. The outstanding feature of the pressure tank is that the filtered water can be transported to a certain height or a far place. Therefore, it is especially suitable for water supply treatment of factories, mining enterprises and small residential areas. It can directly supply water to the pipe network, making the system simpler. The natatorium pool and its circulating water treatment system are an integral whole, which requires a small faucet. The advantages of long-distance transmission of filtered water by pressure filter tank cannot be fully utilized in the circulating water treatment system of swimming pools (Abadikhah et al. 2019, Liu et al. 2021).

At present, there is not a relatively complete swimming pool water treatment and circulation system for disinfection and filtration of the pool water. Based on this, this paper designs a swimming pool water treatment technology based on ozone disinfection method. In this paper, the organic composition of swimming pool water was analyzed and the evaluation indexes were selected. Then, the appropriate ozone disinfection method was selected to design the training system of swimming pool water treatment. Finally, the swimming pool water was tested to prove the feasibility of this method, in order to provide reference for the research of swimming pool water treatment method.

METHODOLOGY

The swimming pool water indicators

The organic matter in the water in swimming places mainly includes the natural organic matter (NOM) in the source water and the organic matter carried by the human body. The components of natural organic matter in natural waters are relatively complex. According to the different hydrophilic properties of the components, the components in NOM can be divided into three categories: hydrophobic components, hydrophilic components and intermediate components (Yazdani et al. 2019).

Total organic carbon (TOC) refers to the amount of carbon contained in all organic substances in a water body, and is a comprehensive indicator that can fully reflect the pollution level of organic matter to the water body (Liu et al. 2019). Chemical oxygen demand (COD) refers to the amount of oxygen required to oxidize and decompose organic matter, nitrite, ferrous salt, sulfide and other oxidizable compounds in water using strong oxidizing agents such as potassium dichromate and permanganate. It is calculated based on the consumption of oxidants, and chemical oxygen demand is an important parameter to measure the degree of organic pollution in water (Raeiszadeh and Taghipour 2019, Skiba and Vorobyova 2019). Therefore, this study selected TOC, COD, and urea as the indicators of organic matter in swimming pool water, which can better reflect the pollution of organic matter in the water body.

In order to compare the change of water quality of the swimming pool before and after treatment, the reference standard should be given. **Table I** shows the limit values of turbidity, oxygen consumption, microorganisms, disinfection by-products and other indicators in the "swimming pool water quality standard" (CJ244-2007).

Design method of water quality treatment process for indoor swimming pool based on ozone disinfection method

The "Swimming Pool Water Supply and Drainage Design Specification" (CECS14:89) only mentions that swimming pool water can be disinfected with ozone, but it does not specify the design of the ozone disinfection system. This article mainly focuses on how to use ozone to disinfect swimming pool water (Yan et al. 2019).

Ozone disinfection performance analysis

International competition swimming pools and high-standard swimming pools require the use of ozone for disinfection. Ozone is an irritating and toxic gas with strong oxidizing ability and is suitable for sterilization and disinfection of water bodies (He et al. 2018b). Ozone has the functions of decolorization, deodorization, and air purification, as well as coagulation aid, which can improve the filtering effect of the filter (Arunkumar et al. 2019). **Table II** is a comparison table of various indicators of conventional chlorine disinfection and ozone disinfection.

The analysis of **Table II** shows that ozone disinfection has obvious advantages over conventional chlorine disinfection. Therefore, it is feasible to apply ozone disinfection to water treatment in indoor swimming pools.

Ozone disinfection methods

There are two main methods of ozone disinfection: full-flow disinfection and split-flow disinfection.

TABLE I. WATER QUALITY STANDARD OF SWIMMING POOL

Serial number	Name	Numerical value	Remarks
1	Turbidity (NTU)	≤ 1	Swimming pool water quality standards
2	Oxygen consumption	Urea ≤ 3.5 mg/L Oxygen consumption is not regulated	Swimming pool water quality standards
3	Microorganism	Total number of bacteria ≤ 200 cfu/ml Total E. coli shall not be detected per 100 ml	Swimming pool water quality standards
4	Trihalomethane	≤ 0.2 mg/L	Swimming pool water quality standards
5	Pool water temperature/ ºC	22-26	Water quality standards for artificial swimming pools
6	pH value	6.5-8.5	Water quality standards for artificial swimming pools

TABLE II. COMPARISON TABLE OF VARIOUS INDICATORS OF CONVENTIONAL CHLORINE DISINFECTION AND OZONE DISINFECTION

	Specific project	Routine chlorine disinfection	Ozone disinfection
Disinfection effect	Sterilization speed	General	300-3000 times faster than chlorine
	Pathogen	Invalid	Excellent
	Deodorize	Invalid	Better effect
	Remove iron	Invalid	Removal rate 100%
	Remove manganese ions	Invalid	Removal rate 100%
	Remove organic matter	Invalid	Removal rate 97%
	Oxidizing ability	Oxidation potential 1.36	Oxidation potential2.07
	Remove urea	A small amount	Removal rate 95%
Safety	Swimming environment	Some organic compounds will be produced after disinfection, such as chloroform, etc.	No secondary pollution
	Irritating	Will irritate the skin, cause pink eye, etc.	No
	Crowd influence	When the flow of people is large, it is easily affected	No
	Air quality	Will produce a pungent smell	Odorless
Operating parameters	Disinfectant consumption	Big	Small
	Energy used	Lower	General

Full flow disinfection adds ozone to the entire circulating water flow, and the dosage of ozone for full flow disinfection is 0.8 mg/L. Split flow disinfection refers to only adding ozone to a part of the circulating water flow and mixing it with the part of the flow without ozone after the mixing reaction. The circulating water flow of adding ozone is generally not less than 30-50% of the circulating water flow. The dosage of ozone for disinfection in full flow is 0.4-0.6 mg/L. Ozone is generally added with negative pressure from a water jet, and after being mixed with pool water through a static mixer, it is sent to the reaction tank for contact reaction, and the reaction time is not less than 2 min (Atallah et al. 2019). The full-flow ozone disinfection system pool water should be adsorbed by activated carbon adsorption tank before entering the pool to remove excess ozone. Comparing the two methods, the effect of full-flow disinfection is better than that of shunt disinfection. Since this project uses ozone as an instant disinfectant in diving pools, competition pools and warm-up pools, full-flow disinfection is used for disinfection.

Figure 1 shows that the make-up water in the swimming pool water recycling system is municipal tap water. Because ozone is extremely unstable in a gaseous state, it will automatically decompose into oxygen at room temperature (Zhang and Wang 2019, Han et al. 2020). Therefore, ozone cannot be stored and must be prepared on site when used. The equipment for preparing ozone is an ozone generator, and the ozone generator is selected according to the amount of ozone required in the design. When the ozone generator is working, it generates a lot of heat and needs to be cooled by circulating cooling water.

Design of water treatment circulating filtration system

Based on the advantages of the ozone disinfection method, the water treatment circulating filtration system is designed to optimize the water quality of the indoor swimming pool. The specific process is as follows.

Pipe

Considering that the equipment room of this project is underground, the service life and safety of the

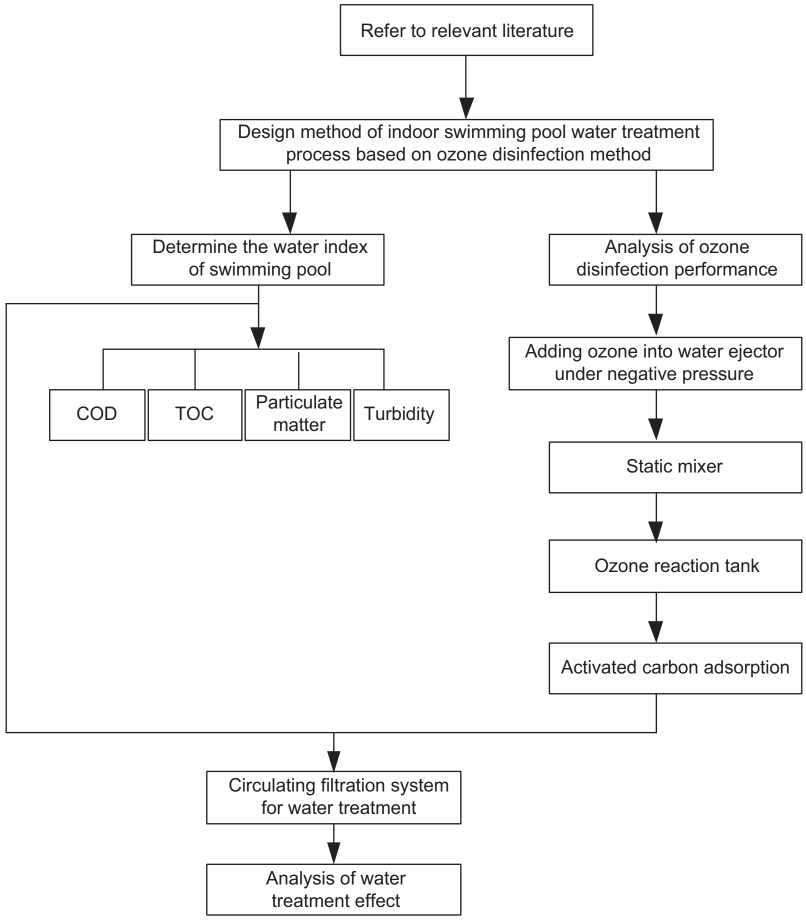

Fig. 1. Technical roadmap.

equipment must be fully guaranteed. Therefore, all pressure filter tanks, ozone reaction tanks and static mixers are made of chlorine-resistant 316 L stainless steel, all pipes are made of ABS, and valves are made of stainless steel (Thani et al. 2020).

Selection of disinfection method

Since the swimming pool is open to the public, the water quality requirements are very high, so it is absolutely necessary for the water treatment system to design a full-flow ozone disinfection system. Diving pools are usually only used for competitions and training, while competition pools are required to be open to the public in addition to competitions and training. The main functions of leisure, training pools and children's paddling pools are open to the public. They have the following characteristics: leisure and training pools are mostly used for juvenile training and adult fitness, and children's wading pools have a fairly short cycle. It is obvious that there is no need for each circulation system to be equipped with a full flow ozone disinfection system. After analyzing the competition schedule of swimming events, it is determined that the diving pool and the competition pool share a set of full flow ozone disinfection system intermittently, and leisure, training pool and children's pool share a set of full flow ozone disinfection system intermittently and equipped with special ozone concentration detection device.

Selection of circulating water pump

For the swimming pool water treatment system, the circulating flow is relatively stable, and the head loss of the piping system is only due to the increase in the local head loss of the filter sand tank and activated carbon filter tank after a period of cyclic treatment. The selection of circulating water pump has certain particularity: it should work in the working area of high efficiency section as far as possible. The product of the flow of single pump and the number of selected pumps should be greater than the circulating flow. The head of single pump should not be lower than the actual calculated head loss of pipeline system. In this way, no matter whether the pump needs single operation or several parallel operations, the cycle period will not be lengthened due to the decrease of parallel flow, and the shaft power will not be too high due to the excessive working flow of single water pump, which will cause the water pump to heat up and not work normally (Gadekar and Ahammed 2019, Jarvis et al. 2019). In the water treatment project of swimming pool, the imported Berkeley "B" series water pump is selected as the circulating water pump of all systems. The pump has the characteristics of silicon bronze impeller, flange connection, closed coupling structure, open waterproof motor, mechanical shaft seal, etc.

Design of inlet and outlet of swimming pool

The purpose of the study on the inlet and outlet of swimming pool is to simplify the requirements for connecting pipes, and assign the task of uniform flow distribution to the water inlet and outlet. The water distribution at the inlet should be uniform to make the whole pool water advance evenly. The flow velocity at the outlet should be reduced to the minimum to prevent eddy current and backflow in the pool. The head loss should be minimized. The water outlet should act as the grid of treatment system net function. No corrosion, no damage, no leakage, and the ceramic tile into one, beautiful and generous.

In the past, small metal water inlets ≤ DN50 contradicted the above requirements. Therefore, DN100 white plastic shaped product water inlets are used. The mouth is a 300 bell mouth, and there are several anti-seepage rings on the outside of the product, which are poured directly into the concrete of the pool wall. The mouth is equipped with a flow regulator, which is a cube of 300 × 300 × 25 (thickness) mm, which is attached to the pool wall tiles at the same time.

Work process of water treatment circulating filtration system

Usually, ozone is introduced into the water with an ejector installed on the bypass pipe. In order to ensure the water inlet pressure of the ejector, a pipeline pump is installed on the bypass pipe to increase pressure. The mixed liquid of water and ozone after the jet enters the reaction tank from the upper side to fully contact, and the water discharged from the lower side is connected to the main pipe of the circulating water of the swimming pool. The water in the bypass pipe is disinfected under high ozone concentration and then mixed with the water in the main pipe to produce an oxidation reaction. The swimming pool water circulation cycle is 6 h, and the water flow of the bypass pipe is 15% to 25% of the flow of the circulating water main pipe, which can ensure that the ozone has sufficient mass transfer efficiency and sufficient contact time before entering the main line. The size of the jet can be calculated and determined according to the bypass water flow, the inlet and outlet water pressure and the air flow required by the ozone generator (Ramprasad and Philip 2018).

According to the different requirements of the use function, circulation mode, circulation period, design water temperature and disinfection mode of each pool, different water treatment systems are set up. **Figure 2** shows the specific process flow.

EXPERIMENTAL RESEARCH

In order to control the pollution of indoor swimming pools and reduce the chance of disease transmission (Liu et al. 2020), an indoor swimming pool water treatment method was designed based on the ozone disinfection method, and then the treated water quality was tested. (Liu et al. 2020). After an indoor swimming pool water treatment process design method based on the ozone disinfection method was used to treat an indoor swimming pool, and the treated water quality was tested.

Subjects

The function of indoor swimming and diving hall in the experiment includes professional competition, professional training and amateur training, as well as water fitness and entertainment for the masses. It can hold national and international individual competitions of swimming, diving, synchronized swimming and water polo. There are 3000 spectator seats, which are class a sports building. There are six pools in the museum. The plane dimensions, design parameters and design requirements of each pool are as follows:

Diving pool: 25 m × 21 m × 5.5 m, countercurrent circulation, cycle time 8 h, design water temperature 27 ºC, ozone disinfection.

Competition pool: 25 m × 50 m × 3.0 m, countercurrent circulation, cycle time 6 h, design water temperature 27 ºC, ozone disinfection.

Warm up pool: 25 m × 50 m × 1.6 m, countercurrent circulation, cycle time 6 h, design water temperature 28 ºC, ozone disinfection.

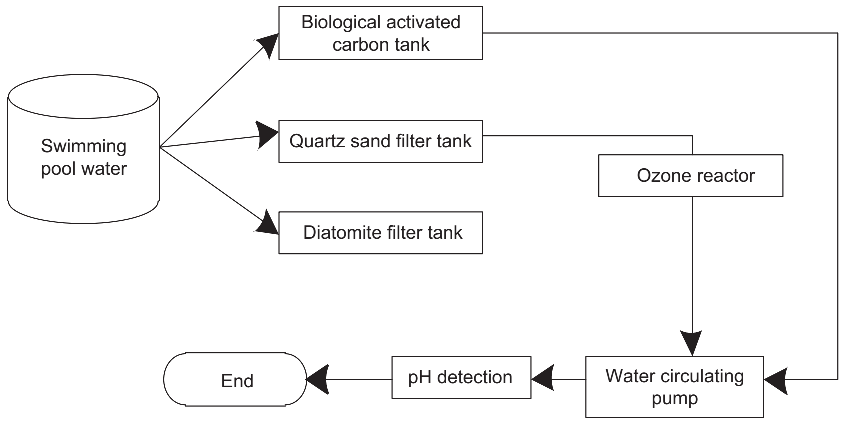

Fig. 2. Process flow of water treatment system.

Children's training pool: 12.5 m × 25 m × 0.8 m, downstream circulation, cycle time 2 h, design water temperature 30 ºC, sodium hypochlorite disinfection.

Surf pool (2 sets): 100 m^2 × 0.50 m, downstream circulation, cycle 2 h, design water temperature 30 ºC, sodium hypochlorite disinfection.

The pool water heating source is the high temperature hot water provided by the boiler room, and the supply/return water temperature is 95/70 ºC (Zuo et al. 2020).

Data and methods

The indoor swimming pool was selected as the investigation object. The water samples were collected in the shallow water area, the pool area and the deep water area according to the diagonal line, and the water samples were collected 30 cm below the water surface (Yang et al. 2020). A total of 72 water samples were tested in the natatorium, and the sampling method was carried out according to the national standard (GB/T18204-2000).

Experimental instruments and equipment

The main experimental instruments and equipment used in the process of index detection in this paper are shown in **Table III**.

Swimming pool water quality before treatment

Table IV shows the water quality status of the swimming pool before any treatment. Using the data in **Table IV** as comparison data, the water quality after treatment with the designed method is compared with the water quality without treatment. According to the different functions of each pool in the venue, the disinfection and filtration process is designed, and the water outlet of each pool is connected to the system presented in this article. The diving pool and the competition pool are designed to share a full-flow ozone disinfection system, and the leisure, training

TABLE III. EXPERIMENTAL INSTRUMENTS AND EQUIPMENT.

Serial number	Name	Specification/Model	Manufacturer
1	Turbidity meter	CT12 crystal plate	Wuxi Guangming Turbidity Meter Factory
2	Peristaltic pump	BE00-600 M	Constant Flow Pump Co., Ltd.
3	TOC meter	Multi N/C3100	Jena, Germany
4	Particle counter	HACH2200 PCX	United States Metone
5	High power microscope	Axioskop 40	Zeiss
6	Photometer	7500	Hash
7	UV branch photometer	UNICOTM7205	Hash
8	Written test pH meter	pH100	Jiangsu Shenglan Instrument Manufacturing Co., Ltd.
9	Thermometer	Conventional	Kejian

TABLE IV. RAW WATER QUALITY PARAMETERS OF SWIMMING POOL

Serial number	Name	Accurate value
1	COD (mg/L)	1.03-2.91
2	TOC (mg/L)	1.89-5.59
3	Urea (mg/L)	0.49-7.02
4	pH	7.7
5	Turbidity (NTU)	0.12-0.63
6	Water temperature (ºC)	16-23
7	Residual chlorine content (mg/L)	0.13-0.49

pool and children's pool share a set full flow ozone disinfection system. The water pass through the quartz sand filter tank, complete disinfection in the ozone reactor, equipped with a special ozone concentration detection device to detect the ozone concentration, conduct pH detection on it, and heat it to a suitable temperature after passing the test. Comparing the processing results of the two methods, the results are analyzed as follows.

EXPERIMENTAL RESULTS

Figure 3 shows the comparison of urea removal when the conventional chlorine disinfection method and the designed method are used for swimming pool water treatment. The swimming pool water quality sanitation standards are shown in **table I**.

It can be seen from the analysis in **figure 3** that when the conventional chlorine disinfection method is used for swimming pool water treatment, with the increase of the number of days, the urea content in the water generally shows a continuous upward

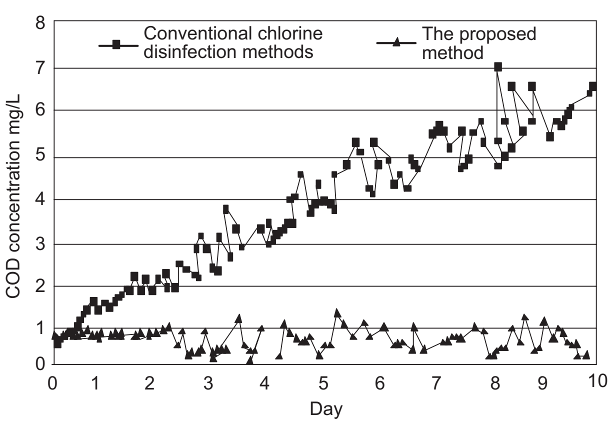

Fig. 3. Urea content.

trend, and the highest value can reach 7 mg/L. After using the ozone disinfection process design method, the urea content in the indoor swimming pool water remains at a low level, and its concentration is less than 1.3 mg/L, which is significantly lower than the urea content when this method is not used. The results show that the method can effectively filter the urea in the swimming pool water, and the purification effect is good.

Figure 4 shows the removal effect of COD. When the traditional water treatment method is used for indoor swimming pool water treatment, the COD removal rate basically shows a downward trend starting from the third day, the highest removal rate is 64%, and the lowest removal rate is 12%. In comparison, the COD removal rate of the proposed method is significantly higher than that of the traditional method. The highest removal rate is close to 100% and the lowest value is only 59%, indicating that the proposed method has a better removal effect on COD in water bodies. This is because this method uses sampling as a disinfectant. Ozone has a high oxidizing ability, which can quickly kill bacteria, fungi, large bacteria, viruses and other pathogenic microorganisms in the water, and can completely oxidize organic matter to achieve decolorization and deodorization. The effect of reducing turbidity can make the water quality after treatment reach the standard of recycling.

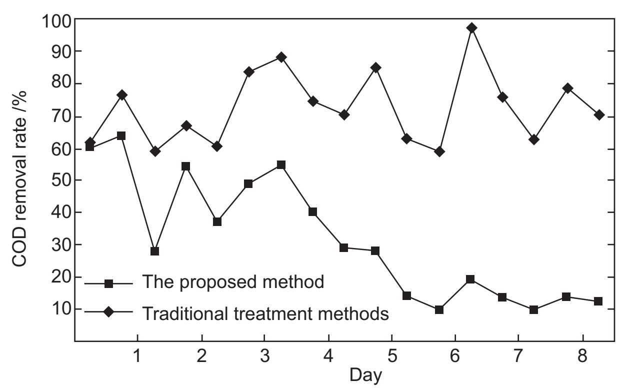

Fig 4. COD removal effect.

Figure 5 shows the linear relationship between COD and TOC. Here, it can be seen that the linear relationship between COD and TOC is poor. This is because the TOC measurement uses the traditional treatment method. The measurement process oxidizes all the organic matter in the water. The COD measure-

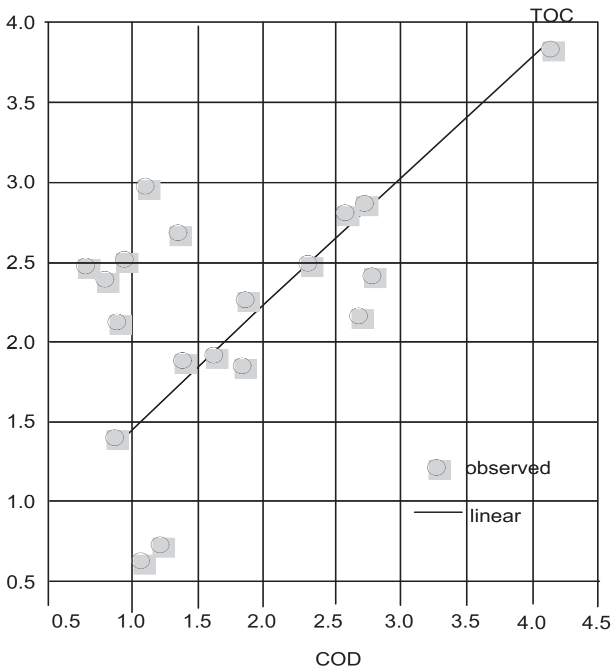

Fig 5. COD and TOC linear relationship diagram.

ment uses the proposed method. During this process, the organic matter is oxidized to carbon dioxide and water. The chemical oxygen demand only represents the sum of the oxygen demand of the substances that can be oxidized in the water under the specified conditions. The difficulty of chemical oxidation reaction of various organic substances in the water is different. In the actual measurement, not only the soluble organic components are expressed as COD, but the soluble reducing inorganic ions (such as Cl-, S^{2-}, Fe^{2+}, etc.) will also be oxidized and expressed as a certain COD value.

Compared with drinking water, the natural and human organic components in swimming pool water are more complex. Some organic compounds that are difficult to be oxidized, such as aromatic compounds, lead to lower measured values during COD measurement. In addition, the volatilization of organic matter in water has a certain effect on the measurement of COD and TOC. For the determination of COD, organic matter may volatilize before and after the oxidation reaction. Research has found that organic components can volatilize directly from the solution before COD measurement, which affects the actual measured value of COD. Some non-volatile organic components are oxidized into a volatile intermediate product and volatilized, so volatility may have a significant impact on the correlation between COD and TOC. At the same time, some reducing organics in water can form stable complexes with metal ions, thereby reducing the actual measured value of COD.

Particulate matter is a water quality indicator that characterizes the content of insoluble particulate matter in water. It is the most common important indicator in water treatment processes and detects particulate matter in water quality. Therefore, the particle content is used as an experimental indicator to compare the changes in water quality before and after the water treatment process for indoor swimming pools based on the ozone disinfection method. **Figure 6** shows the distribution of the number of particles of different particle sizes in the swimming pool before filtration. From this figure, it can be seen that under the channel setting condition, there are more particles in the water body of the swimming pool in the first three days. That is, the particles in the water are mainly 2-20 µm, among which, the particles in water inlet 1 and water inlet 2 are more. It can be seen that the particles of 2-10 µm in the low turbidity swimming pool water are dominant.

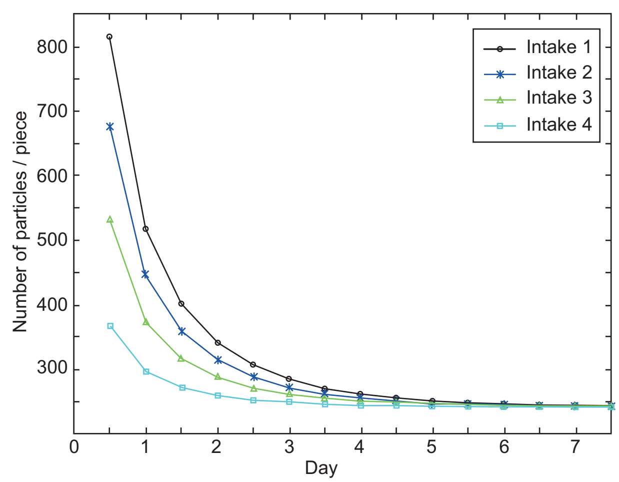

Fig 6. The distribution of the number of particles of different sizes in the water before filtration in the swimming pool.

After the swimming pool water was treated by the designed method, the particle number distribution of different particle sizes in the water was obtained, as shown in **Figure 7**. This figure shows that after the proposed method is used to treat the swimming pool water body, the content of particulate matter in different inlets has been greatly reduced, indicating that the method can effectively remove particulate

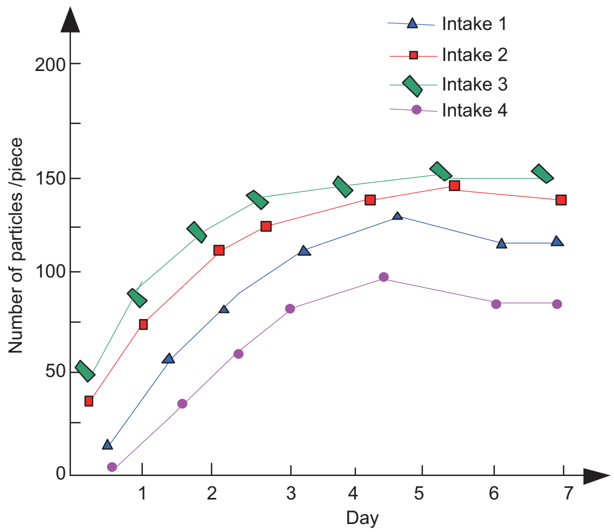

Fig 7. Distribution of particle number with different particle sizes in filtered water of swimming pool.

matter in the water body and has a better water quality treatment effect.

In addition to the above indicators that can verify the effect of the designed method, in order to further verify the feasibility of the method, the economic value of the conventional chlorine disinfection method and the ozone disinfection method is compared with the consumption of disinfectant as an indicator. The results are shown in **figure 8**. From the analysis of this figure, it can be seen that when the swimming pool water is treated by the ozone disinfection method, the ozone consumption is always lower than 0.9 mg/L, while the consumption of the conventional method is higher than 0.9 mg/L. Although the ozone consumption increased significantly in the first two days, this is due to the fact that the water pollution is more serious, therefore, a large amount of disinfectant is needed. When the disinfectant reaches a certain amount, there is no need to increase the dose of the disinfectant. The comparison **in table II** shows that the content of chlorine disinfectant used in the conventional chlorine disinfection method is significantly higher than the proposed method, which matches the conclusion that the conventional chlorine disinfectant consumes a large amount and the ozone disinfectant consumes a small amount. This means that the ozone disinfection method is less expensive.

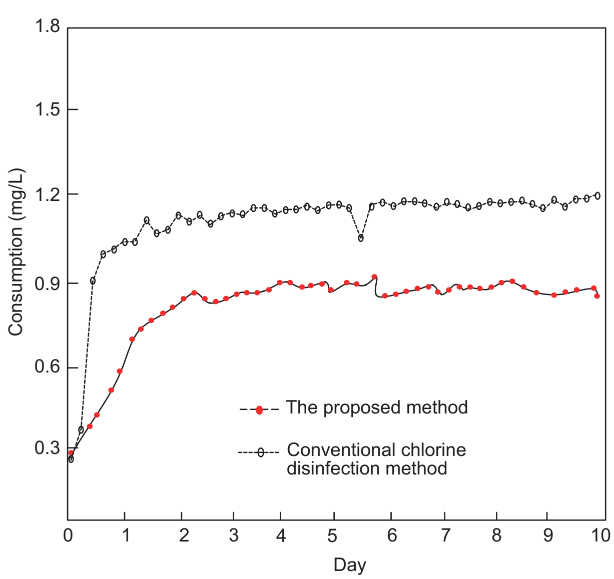

Fig. 8. Comparison of disinfectant consumption by different methods.

DISCUSSION

According to the "Water Quality Standards for Swimming Pools" (CJ244-2007), the swimming pool circulating water purification system mainly includes three parts: pool water filtration (clarification), disinfection and heating. After treatment, it is required to keep the pool water clear, transparent and sanitary, and meet the water temperature requirements. Swimming pool water is always in direct contact with human skin during use. If the water quality is not up to standard, it is very easy to cause harmful substances in the water to enter the human body through the skin, breathing or mouth, endangering human health. Insufficient disinfection will cause outbreaks or epidemics of acute infectious conjunctivitis, viral gastroenteritis, infectious skin diseases and other diseases. Therefore, it is necessary to ensure that the pool water does not pose a threat to human health due to toxic and harmful substances through efficient purification, and to ensure that the pool water does not cause disease infection and spread through effective disinfection technology. In order to ensure the safety of swimming pool water, a design method of indoor swimming pool water quality treatment process based on ozone disinfection was proposed. The method adopts ozone as a disinfection method, and designs a water circulation system at the same time, and combines the two organically to achieve effective purification of swimming pool water.

In order to further improve the water quality of the swimming pool, in addition to disinfection by the method proposed in this paper, it can also be purified and distributed, such as pre-processing the swimming pool water before it enters the disinfection system, and setting up a hair collector to prevent a large amount of debris from entering the circulation system. Attention must be paid to the filtration function, and set up more filter tanks to intercept the small suspended particles and some microorganisms in the water, so as to improve the filtration effect. When carrying out disinfection and purification, attention should be paid to the amount of ozone content, so as to avoid that too little input will affect the sterilization effect, and too much will cause costs rise. In addition, in summer, pay attention to the algae removal of the pool water, rewash the filter repeatedly, increase the input of disinfectant, ventilate the swimming pool, use low-temperature water to wash the algae, and eliminate the environmental factors of algae reproduction. Through the above measures, the water quality of the swimming pool can be improved on the basis of the method put forward in this paper.

CONCLUSION

Since most of the current swimming pool water treatment processes are not good enough, there are often problems such as excessive particulate matter, high COD and excessive urea content in the water. The method in this paper makes full use of the advantages of ozone disinfection, and is designed for the disinfection and filtration of swimming pool water. The experimental results show that after the application of this method, the urea content in the water is kept at about 1 mg/L, the highest COD removal rate is close to 100%, and the lowest value is only 59%. Below 0.9 mg/L, it has certain economic practicability and can be applied to actual use scenarios. Although this paper has achieved certain results, the system is not perfect and lacks real-time monitoring of swimming pool water, which needs to be further improved in the future.

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