



## The application of three-level filtration system and chlorine dioxide disinfection on hospital sewage treatment

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### ABSTRACT

Hospital sewage treatment and disinfection has become a public problem that often directly affects the public security and environment health. The economical and applicable technology including combined technology for hospital sewage treatment has become research hotspot. In this paper, pipeline-disinfection for hospital sewage treatment was proposed to replace contact disinfecting tank, the practical difficulty of no space to build contact disinfecting tank can be solved. It also can ensure the most optimal retention time. The combined process for hospital sewage treatment of three-stage filtration system and chlorine dioxide disinfection, which is suitable for the disinfection for hospital sewage of small or township hospital was adopted. The results showed that the three-level filtration system can effectively remove suspended solids, COD and BOD, and the preparation of chlorine dioxide on the spot can achieve better disinfection effect, also won't produce large quantities of disinfection by-products. The study will provide scientific reference and basis to improve the design parameter of treatment technology for the engineering application of disinfection system for treating hospital sewage.

**Key words:** Hospital sewage; disinfection; three-level filtration system; chlorine dioxide generator; combined process; small or township hospital

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### INTRODUCTION

The virus and germs in hospital sewage do harm to human health. It become a public problem that often threatens the public security and environment health. So greater attention has been paid to the research on its treatment method, and the researches in this area has made some achievements. But there are large-scale investigations and researches on the disinfection effect for hospital sewage in various hospitals showed that the effluent quality of sewage can't meet the discharge standard[1-4], especially in some small or township hospitals.

With the improvement of Chinese discharge standard of water pollutants for medical organization, leading to a range of further studies on various sewage treatment technologies[5]. The economical and applicable technology of hospital sewage disinfection has become research hotspot[6]. To achieve better treatment effect, most of the researches are focused on new alternative technology and combined technology[7-10].

The combined process of hydrolysis acidification, contact oxidation, chlorine dioxide disinfection and filtration was used to treat general hospital sewage[11]. The joint applying of biological contact oxidation and ClO<sub>2</sub> disinfection[12,13](①bio-contact oxidation, MBR and ClO<sub>2</sub>; ②bio-contact oxidation, sand filtration, active carbon filtration and ClO<sub>2</sub>) were applied on hospital sewage treatment. Advanced treatment processes such as flocculation-suspended packed bed, flowing sand micro-filtration and chlorine dioxide synergetic disinfection are used for the treatment of chemical biological flocculation effluent[14]. The combined process of hydrolysis

acidification, biological contact oxidation, fibrous filtration and NaClO disinfection is used to treat domestic sewage from a hospital[15,16]. Some scholar also concluded that it is feasible to treat hospital wastewater from a hospital by the A/O biochemistry tank-sedimentation tank-disinfection process[17].

The study on the combined process for hospital sewage treatment has become a hotspot research in recent years. But up to now, not only the treatment effect of different combination mode cannot achieve the desired effect, and design standards, but the suitable treatment process for the wastewater disinfection in small or township hospitals is rare proposed and studied. There are also few reports about the combined process for hospital sewage treatment, especially in small or township hospitals. According to the current management situation of medical sewage and its pollution in township hospitals, pipeline-disinfection for hospital sewage treatment was proposed. The combined process for hospital sewage treatment of three-stage filtration system and chlorine dioxide generator disinfection is adopted to treat hospital sewage. The study will provide scientific reference and basis to improve treatment and disinfection methods and parameter' determination for the engineering application of disinfection system for treating hospital sewage.

## EXPERIMENTAL SECTION

### 1.1 TECHNOLOGICAL PROCESS

The hospital sewage treatment system includes three parts, the experimental equipment for preparing chlorine dioxide(chlorine dioxide generator1, control valve2, water pipe3, water valve4, water ejector5, regulating valve for dosage 6, chemical dosing pipeline7), three-level filtration system (coarse filter 10, sand filter 11 and Fine filter 12), and disinfection system (mixed well 14 and disinfecting pipeline 16) [18]. The technological process is showed as follows:

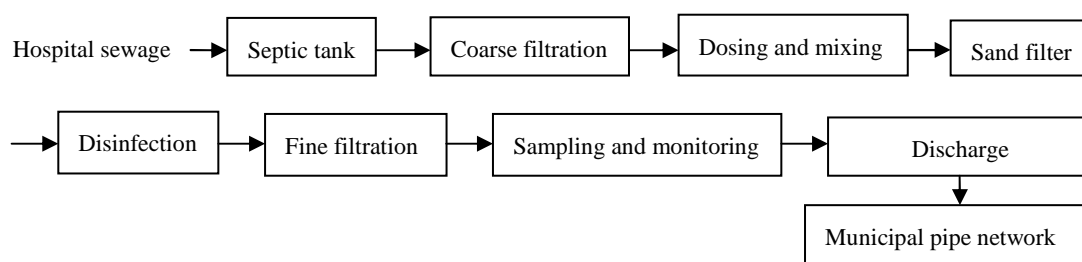
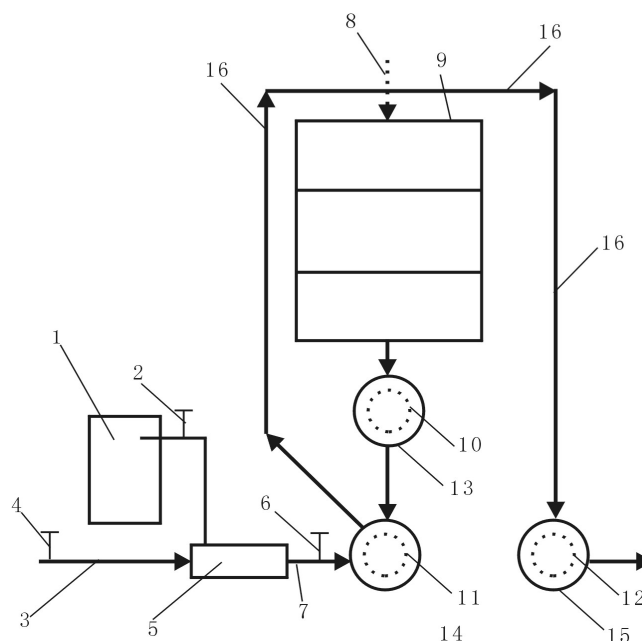


Fig.1 Flow chart of three-level filtration system for hospital sewage



Note: 1. chlorine dioxide generator; 2. control valve; 3. water pipe; 4. water valve; 5. water ejector; 6. regulating valve for dosage; 7. chemical dosing pipeline; 8. hospital sewage; 9. septic tank; 10. coarse filter; 11. sand filter; 12. fine filter; 13. prefiltration well; 14. mixed well; 15. sampling Well; 16. disinfecting pipeline.

Fig.2 The schematic diagram of simple treatment system for hospital sewage

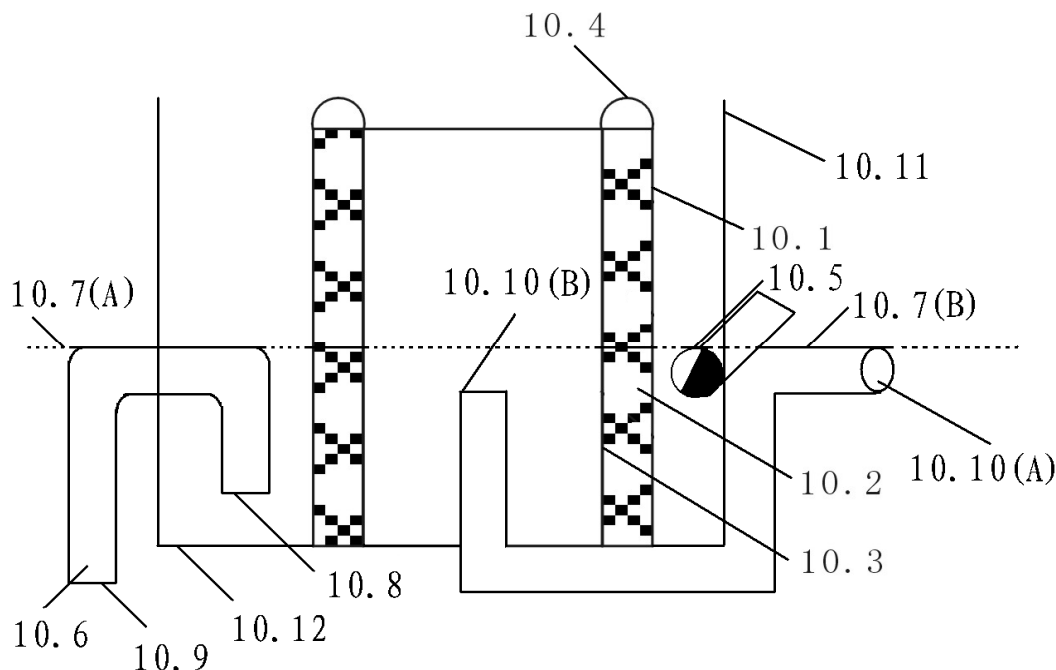
## 1.2 PROCESS FLOW DIAGRAM

The hospital sewage treatment system is mainly composed of chlorine dioxide generator, control valve, water ejector, septic tank, coarse filter, sand filter, fine filter, mixed well, disinfecting pipeline, sampling well, including the experimental equipment for preparing chlorine dioxide, three-level filtration system and disinfection system (figure 2).

## 2. KEY TECHNOLOGY ANALYSIS

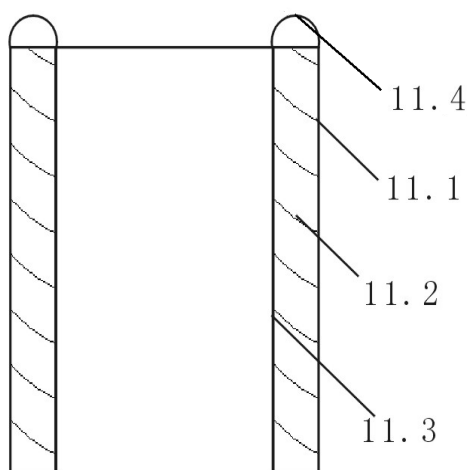
### 2.1 THREE-LEVEL FILTRATION SYSTEM

The three-level filtration system is consist of coarse filter (10), sand filter (11) and fine filter (12).



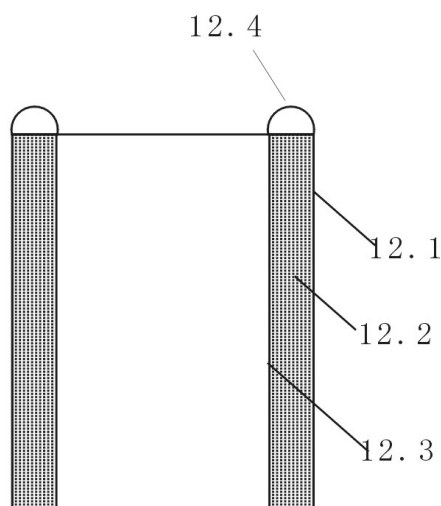
Note: 10.1 outer barrel of filter mesh; 10.2 scree filtering medium; 10.3 inner barrel of filter mesh; 10.4 simple handle; 10.5 tangential inlet pipe; 10.6 automatic deslagging tube; 10.7(A,B) datum line; 10.8 bottom of tube; 10.9 dregs-outlet; 10.10 U-shaped tube; 10.11 sidewall of the pool; 10.12 bottom of the pool.

**Fig.3** The schematic diagram of coarse filter of disinfection system



Note: 11.1 outer barrel of filter mesh; 11.2 coarse sand filtering medium; 11.3 inner barrel of filter mesh; 11.4 simple handle.

**Fig.4** The schematic diagram of sand filter of disinfection system



Note: 12.1 outer barrel of filter mesh; 12.2 Activated carbon filter material; 12.3 inner barrel of filter mesh; 12.4 simple handle.

**Fig.5 The schematic diagram of fine filter of disinfection system**

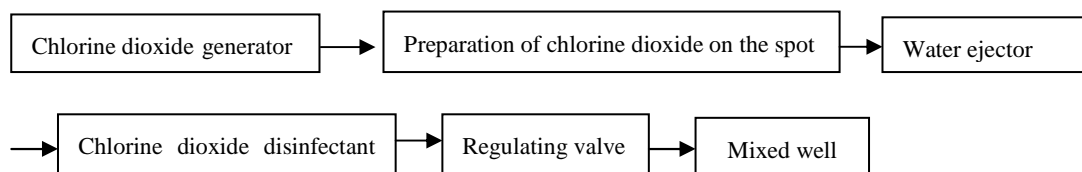
The coarse filter, sand filter and fine filter are filled with the manual filter material that is made by different size of pebbles, sand and activated carbon. And they are installed in prefiltration well, mixed well and sampling well in proper order.

The coarse filter is to remove the big size of suspended particulate matter of sewage after anaerobic treatment in septic tank. Then the sewage was mixed up with liquid chlorine dioxide disinfectant in mixed well, the mixed liquor flowed into the disinfecting pipeline after filtration and adsorption in sand filter. It concludes that enough hydraulic retention time (HRT) are the keys to ensure the disinfect effect. Finally, the sewage was monitored in sampling well and discharged into the municipal pipe network after second filtration and adsorption in fine filter.

## 2.2 CHLORINE DIOXIDE GENERATOR

Chlorine dioxide disinfectant is prepared on the spot, the experimental equipment is composed of chlorine dioxide generator(1), control valve(2), water pipe(3), water valve(4), water ejector (5), regulating valve for dosage (6), chemical dosing pipeline(7)(figure 2).

The equipment running cost for the preparation of chlorine dioxide on the spot by electrolysis is low, safe and reliable[19]. The technical process (figure 6) is simple.



**Fig.6 Flow chart of three-level filtration system for hospital sewage**

## 2.3 SAMPLING AND MONITORING

Hospital sewage flowed into mixed well through tangential inlet to become rotational flow, to increase mixing effect of mixture of sewage and chlorine dioxide disinfectant. The residual chlorine of samples collected from fine filter of sampling well was detected by colorimetric method to adjust the doses of disinfectant, to make the content of residual chlorine comply with relevant standards.

## 3. EFFECT ANALYSIS OF PRACTICAL APPLICATION

The hospital sewage treatment system has been used successfully in some hospitals of Chengdu City, Zizhong City and Yibin City in Sichuan Province, China. It concludes that the sewage treatment technology is simple, reliable, has a good system operating results. This system has gotten the perfect operation efficiency and good practicability by test operation and field validation in a hospital in Zizhong City. When the treatment effect is stable, the effluent quality of the sewage was monitored at every stage of the process. The monitoring results were showed as follows (Table 1).

Table 1 the effluent quality of the sewage at every stage of the process

Indexes Stages of process	Influent	Contact oxidation	Filtration	disinfection
COD <sub>Cr</sub> (mg·L <sup>-1</sup> )	220~286	36~74	26~54	24~46
BOD <sub>5</sub> (mg·L <sup>-1</sup> )	52~123	15~32	12~18	9~16
SS (mg·L <sup>-1</sup> )	42~124	34~64	4~10	5~12
pH	6.9~7.2	6.6~7.1	6.8~7.1	6.8~7.2
Fecal coliforms	2.6×10 <sup>6</sup>	2.1×10 <sup>4</sup>	1.5×10 <sup>4</sup>	80~340
Total residual chlorine(mg·L <sup>-1</sup> )	—	—	—	0.2~0.7

As shown in table 1, the hospital sewage treatment system has perfect treatment efficiency on sewage. In addition to the total residual chlorine, other pollutant indexes of the effluent have reached *Chinese discharge standard of water pollutants for medical organization* (GB 18466-2005), has good promoted application prospect. But, the content of total residual chlorine could not meet the emission limits, the dechlorination agent was required to reduce the residual chlorine concentration.

### CONCLUSION

1) Disinfecting pipeline surrounding the septic tank or outpatient building is adopted to replace contact disinfecting tank, the practical difficulty of no space to build contact disinfecting tank can be solved. It also can ensure the most optimal retention time between hospital sewage and disinfectant.

2) The coarse filter is to remove the big size of suspended particulate matter of sewage after anaerobic treatment in septic tank. And then after second filtration and adsorption in sand filter and fine filter, the three-level filtration system can effectively remove suspended solids, COD and BOD, is suitable for the disinfection for hospital sewage of township hospital.

3) Chloride dioxide is a kind of safe and high efficiency disinfectant, the preparation of chlorine dioxide on the spot can achieve better disinfection effect, also won't produce large quantities of disinfection by-products and carcinogens (like THMs), and the falling range of COD is big.

4) Owing to the special characteristic of small hospital sewage is complex quality, small water volume and large change in scope, its treatment method is also different with generally domestic wastewater. So it's not easy to achieve the desired effect and design standards by some one kind of treatment method or some combined process, and there is also some difference from the practical application, and it still should be studied in the future.

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