Development and Design of Hot Spring Filter and Sterilization Device

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Abstract. Hot springs are not easy to generate, how to deal with the used hot spring water and make it recycled has become a very important topic in this industry. The purpose of this study was to develop a hot spring filtration and sterilization device, to provide hot spring industry in hot spring water quality management has good results. The problem to be solved in this research and design was to use Titanium dioxide nano silver Antibacterial cloth for antibacterial dyeing and finishing powder the filter sterilization device was made of filter material structure, aiming at the spring quality of Carbonated spring or Sodium bicarbonate spring), The hot spring pool water is filtered and sterilized and re-introduced, so that the hot spring water could be reused without the doubt of hygienic safety. In order to solve the above problems, this research and development designed department discloses a hot spring pool water filtration and sterilization device, applicable to carbonated spring or sodium bicarbonate spring. Its structure included: 1. barrel 2. central filter 3. filter material structure.

1. Introduction

The content of hot springs is not infinite. Water intake, water use, water storage, water delivery, and even digging wells to open up the source of hot springs. The source of hot springs should be as strictly protected as the water source control area, otherwise it will be damaged by human culture. The quality of hot springs will be affected by changes in the quality of hot springs, pollution of the quality of hot springs, and drop in water temperature [1]. The study indicates that more than 80% of the respondents are worried about bacterial infection [2]. The number of bacteria in hot spring water and E. coli can be used as one of the indicators of whether the water quality is hygienic [3]. If the water source is contaminated, it may cause excessive bacteria breeding in the water. The turbidity of the water quality of the hot spring pool is related to the amount of pollutants generated [4]. Therefore, whether the water quality of hot springs is safe or not is the focus of people's concern when soaking in soup. Circulating water is disgusting, but it helps to save resources and conforms to the concept of environmental protection [5]. In order to solve the problem of water quality variation caused by ground oxidation and injection of pollution sources, it is necessary to deeply analyze and explore its related influencing factors and explore the level of hot spring water quality management technology.Hot spring water quality and sanitation related problems are also emerging. In order to reach the standard value of health and safety, it is necessary to actively develop antimicrobial agents for hot spring water at this stage. However, no matter whether it is sterilization or inhibition, under the premise of its
development, hot spring water needs to "not improve its redox potential", "not change the quality of hot spring", "low cost" and "have high-efficiency antibacterial effect" as one of the factors to be considered. Therefore, based on the above background and motivation, the purpose of this study is to develop the hot spring filtration and sterilization device, hoping to provide the hot spring industry with good performance in hot spring water quality management.

2. Development of hot spring filtration sterilization device

2.1 Technical field
The R & D design is related to filtration and sterilization device; more specifically, it is a filtration and sterilization device for hot spring pool water.

2.2 Prior technology
In hot springs, "water" is the most important component, and the contents are divided into mineral springs and non-mineral springs according to the amount of mineral components. Taiwan can be called the world's hot spring museum because there are not only a lot of quality from cold springs to hot springs, but also a variety of hot springs, including: Solar spring, Simple spring, Salt spring, Carbon spring and Carbonic acid sodium bicarbonate spring Etc. spring type. However, the formation of hot springs is formed by infiltration of rainwater into the center of the earth, physical and chemical changes after a long time of precipitation, and then through human drilling wells to get groundwater, oil or squeezing the stratum due to seismic activities, so that the underground water can find a way out, and then eject from the earth to the surface. Because hot springs need to be generated for a long time, but today's industrial utilization environment has been consuming hot spring water, hot spring industry cannot effectively reuse hot spring resources, so hot spring water must be discharged and collected new hot spring water when it is used to a certain extent. Therefore, how to deal with the used hot spring water to make it recycled has become a very important topic in this industry. At present, the filter materials of the pool water re filtration are quartz sand, diatomite, sand and stone, and the sterilization methods are: Chlorine (CL) series, Trioxygen (O3), Chlorine dioxide (ClO2), Electrolysis, Ultraviolet (UV), Silver (Ag) ions (Ag), etc. [6] [7] [8].

2.3 Research design description
The problem to be solved in this research and development was to use the antibacterial cloth of Titanium dioxide nano silver antibacterial dyeing and finishing powder to make a filter and sterilization device with filter material structure, filter and sterilize the hot spring pool water with Carbonated spring or Sodium bicarbonate spring, and then re import it for use, so that the hot spring water could be used without any doubt of health and safety next reuse. To solve the above problems, the R & D and design department disclosed a hot spring pool water filtration and sterilization device, which was applicable to the hot spring water circulating filtration and sterilization of Carbonated spring and Sodium bicarbonate spring. Its structure includes:

- The barrel body included a barrel body and a holding space covered by the barrel body. The barrel body had a base and a top cover, and a hot spring water input pipe and a hot spring water output pipe connected with the holding space and the outside. The hot spring water input pipe was arranged near the bottom of the barrel body, and connected with the hot spring pool to lead in the hot spring water. The hot spring water output pipe was connected to the hot spring pool through the top cover.
- The central filter pipe was axially arranged in the holding space with the can body, through the base of the could body to the top cover, and connected with the hot spring water outlet pipe in the top cover. The pipe wall of the central filter pipe is provided with a plurality of filter holes.
- The filter material structure, which was detachable, was arranged in the holding space with the same axis as the central filter tube and is wrapped around the periphery of the central filter
tube. The filter material structure includes three filter material layers arranged concentrically, the structure included three layers from the outside to the inside: the first filter material layer was a cylindrical cloth layer; the second filter material layer was an antibacterial cloth using titanium dioxide nano silver antibacterial dyeing powder; and the third filter material layer was a cylindrical cloth layer. In the embodiment, the backwashing system was further included. Two ends of the backwashing pipeline were respectively connected with the hot spring water input pipe and the hot spring water output pipe, and the hot spring water input pipe and the hot spring water output pipe are respectively connected with a water stop valve for switching the water path. In the above embodiment, the pressure gauge is set on the can body to display the pressure of the water flow inside the can body as the basis for switching the water stop valve for back washing.

2.4 Design of hot spring filtration and sterilization device

In this design, the antibacterial cloth of titanium dioxide nano silver (Ag) antibacterial dye and finishing powder was used as the filter material structure of the filter material layer. It was aimed at the spring hot spring of the solid bicarbonate distributed in Guguan, Tai'an, Sizhongxi and other places, as well as the carbonic acid hot spring quality distributed in Guguan, Tai'an and Sichongxi. The antibacterial cloth of titanium dioxide (TiO2) nano silver (Ag) antibacterial dye and finishing powder is the combination of (TiO2) nano ceramic powder and silver (Ag) to form the adsorption and antibacterial material titanium dioxide (TiO2) nano silver (Ag) powder. Because of the high specific surface area of titanium dioxide (TiO2) powder, it could adsorb chemical poisons and a large number of negative ions on the surface. Therefore, the titanium dioxide (TiO2) nano silver (Ag) powder, which could be used in impregnation industry and anti-bacterial protection, is a kind of material with toxic and antibacterial properties. After 24 hours of cultivation, the inhibition zone of titanium dioxide nano silver powder and silver loaded titanium dioxide complex was about 20-26 mm. However, the inhibition zone of titanium dioxide (TiO2) powder was about 20-26 mm. The results showed that titanium dioxide (TiO2) nano silver (Ag) powder "complex had the effect of anti-microbial. As shown in Figure 1, the filter and sterilization device for hot spring pool water disclosed in the R & D design was applicable to the circulating filter and sterilization of hot spring water of carbon spring and soda bicarbonate spring water quality. Its structure includes: can body 11, which includes can body 111 and the containing space 112 covered by the can body 111. The can body 111 has base 1111 and top cover 1112, and connects the containing space 112 and the outside. A hot spring water input pipe 1113 and a hot spring water output pipe 1114 are arranged near the bottom of the barrel body 111 to connect the hot spring pool to lead in hot spring water, and the hot spring water output pipe 1114 is connected to the hot spring pool through the top cover 1112; the central filter pipe 12, which is axially arranged with the barrel body 11 in the capacity space 112, passes through the base 1111 of the barrel body 11 to the top cover 1112, and the top cover 1112 is connected with the hot spring water output pipe 1114, and the pipe wall of the central filter pipe 12 is provided with a plurality of filter holes 121; and the filter material structure 13, which is detachable, is arranged on the containing space 112 with the same axis as the central filter pipe 12, and is wrapped around the periphery of the central filter pipe 12. The filter material structure 13 includes three filter material layers which are arranged concentrically, and the structure includes from the outside to the inside: the first filter material layer 131 was a cylindrical cloth layer; a second filter material layer 132, which is an antibacterial cloth using titanium dioxide nano silver antibacterial dyeing and finishing powder; and a third filter material layer 133, which is a cylindrical cloth layer.

In the second embodiment, the filter sterilization device (Figure 2) was arranged on the central filter tube 12 in the holding space 112 of the barrel body 111, the top part of which was provided with two protruding screw structures 122a, the top cover 1112 is provided with two corresponding combination holes 11121, and the screw structures 122a pass through the combination holes 11121 and then use the screw cap 122b structure for locking, wherein, the pipe wall of the central filter tube 12 A plurality of filter holes 121 are arranged to circulate the imported hot spring water.
The application of the filter sterilization device in the third embodiment further includes: the backwash system 14 was respectively connected with the hot spring water input pipe 1113 (as shown in Figure. 1) connected with the can body 11 and the hot spring water output pipe 1114 (as shown in Figure. 1) connected with the central filter pipe 12 by two ends of the backwash pipe 141, and the hot spring water input pipe 1113 and the hot spring water output pipe 1114 were respectively connected with cutting positions A plurality of water stop valves 142 of the water change path. (Figure. 5) in order to represent the backwash pipeline 141 blocked by the can body 11, the cut-off pipeline end a would be connected to the pipeline end B to circulate and introduce the hot spring water filtered and sterilized or to backwash and empty the hot spring water. In the embodiments of (Figure. 3) and (Figure. 4), the filter sterilization device 1D further included a pressure gauge 15, which is arranged on the can body 11 to display the pressure of the water flow inside the can body 11, as the basis for switching the water stop valve 142 to backwash the system 14.

The application of the filter sterilization device (Figure. 5) in the third embodiment further includes: the backwash system 14 was respectively connected with the hot spring water input pipe 1113 (as shown in Fig. 1) connected with the can body 11 and the hot spring water output pipe 1114 (as shown in Fig. 1) connected with the central filter pipe 12 by two ends of the backwash pipe 141, and the hot spring water input pipe 1113 and the hot spring water output pipe 1114 were respectively connected with cutting positions A plurality of water stop valves 142 of the water change path. (Figure. 5) in order to represented the backwash pipeline 141 blocked by the can body 11, the cut-off pipeline end a will be connected to the pipeline end B to circulate and introduced the hot spring water filtered and sterilized or to backwash and empty the hot spring water. In the embodiments of (Figure. 3) and (Figure. 4), the filter sterilization device 1D further includes a pressure gauge 15, which was arranged on the can body 11 to display the pressure of the water flow inside the can body 11, as the basis for switching the water stop valve 142 to backwash the system 14.

In the embodiment of Figure 3, when the water stop valve 142 of the hot spring water input pipe 1113 connecting the hot spring pool water and the water stop valve 142 of the hot spring water output pipe 1114 connected to the top of the can body 11 are opened (on), the hot spring water is led into the can body 11 through the hot spring water input pipe 1113, and is discharged from the can body 11 from the outside to the inside, from the bottom to the top through the filter material structure 13 and the central filter pipe 12 as shown in Figure 1. And return the hot spring water to the hot spring pool. In this process, the release time and concentration of silver ion silver (Ag) ion of titanium dioxide Nano silver powder composite showed that 1g of silver loaded Titanium Dioxide Nano silver (Ag) composite was placed in 2-liter in water environment, silver ion could be released for a long time (more than 70 hours), and the release concentration of silver ion reaches the highest level in about 48 hours, and then gradually decreased. This result was mainly affected by the physical changes of complex and water diffusion.

In the embodiment of (Figure. 4), the open (on) water stop valve in (Figure. 3) was switched to off, and the closed water stop valve 142 in (Fig. 3) was switched to open, so that the hot spring water is directly led into the back washing system 14, connected to the pipeline end B through the pipe end a, and then flushed out the impurities stuck in the filter material structure 13 (Figure. 1) and discharged from the can body 11 from the inside out, up and down through the central filter pipe 12. (Figure 6) and (Figure 7) are different types of filter material structure. In the embodiment (as shown in Fig. 6), the second filter material layer of the filter material structure 13a was a star structure 132a, wherein the first filter material layer 131 was made of non-woven material and was wrapped on the outside of the second filter material layer of the star structure 132a, while the third filter material layer 133 was made of non-woven material and fixed on the inside of the second filter material layer. In the (Figure. 7) embodiment, the second filter material layer of the filter material structure 13b is a cylindrical structure 132b; wherein, the first filter material layer 131 was made of non-woven fabric, which was wrapped on the outside of the second filter material layer of the cylindrical structure 132b, and the third filter material layer 133 was made of non-woven fabric, which was fixed on the inside of the second filter material layer. In the embodiment, the water pump motor is arranged between the hot spring water input pipe 1113 (Figure. 1) and the hot spring pool to pump the hot spring water from the hot spring pool into the hot spring water input pipe 1113 and pressurize the water to drain back to the
hot spring pool through the hot spring water output pipe 1114 (Figure. 1). In the above embodiment, a hair remover was more included, which was arranged between the water pump motor and the hot spring water input pipe 1113 (Figure. 1). It was a filtering structure with mesh to filter impurities with larger volume in the hot spring water.

**Figure 1.** Filtration sterilization device exploded view

**Figure 2.** Filtration sterilization device Structure diagram
3. Conclusion
The main features of this R & D design are:
The current hot spring industry only filters the used hot spring water, but there may be many viruses or bacteria that cannot be eliminated through filtration. Therefore, through this research and development design, the antibacterial fabric of titanium dioxide Nano silver (Ag) antibacterial dye powder is used as the filter material structure of the filter material layer, which can be effectively applied to the hot spring water. Carry out sterilization to achieve the effect of sterilization and filtration.

In the embodiment, the second filter material layer designed with star structure can greatly increase the sterilization area and achieve the high-efficiency sterilization effect on hot spring water.

The embodiment includes a backwashing system. When the pressure gauge senses that the pressure of the water flow inside the tank is too high, that is, the pores representing the filter material structure have been highly stuck to the impurities in the hot spring water. Therefore, the water stop valve can be switched to backwash the filter sterilization device of the invention, to backwash the water flow in the reverse direction of the hot spring water filtration sterilization, and to flush the impurities stuck in the filter material structure Discharge to extend the service life of the filter material structure.

After repeated filtration, sterilization and backwashing of the filter material structure, when the filtration and sterilization effect begins to decline, good filtration and sterilization effect can be recovered by replacing the new filter material structure, without replacing the filtration and sterilization equipment, which can greatly reduce the cost in use and maintenance.

4. References
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