

Water treatment from swimming pool, piscine and swimming basins

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Abstract: The paper analyzed, in terms of technical, economic and ecological current technologies used to treat water in swimming pools, piscine and swimming basins with the public circuit and sport, for maintenance, recovery, recreation and for sport of performance. They are highlighted water treatment technologies in swimming pools, piscines and swimming basins through: use of membranes and slow filters with biological membrane without chemical disinfectants; use of ascendente filtering with multiple layers of effluent disinfection with hypochlorite of sodium, ozone, chlorine dioxide and other chemicals in solid, liquid or gaseous forms. The current system of treating water in swimming pools, piscine and swimming basins can be improved by using the following technologies: slow filtration without prior or subsequent disinfection; rapid filtration through single layer or multiple layers combined with a slow filtration; multiple layers upward by rapid filtration and disinfection with sodium hypochlorite, pre ozonation and sodium hypochlorite safe dose; membrane filters with or without disinfection with sodium hypochlorite.

Keywords: swimming pools, water treatment

1. GENERAL CONSIDERATIONS

Swimming pools, piscine and swimming basins are construction and installation arranged in closed indoor or outdoor intended for maintenance, recovery and recreation and for sport of performance. The quality of water in these pools is influenced by the number of users, how are met, the provisions of hygienic - sanitary used, and the way they are operated and maintained constructions and installations.

Urine and sweat destroying action role disinfectant substances introduced into the water. In addition, even chlorine disinfectant that can be a source of disease of people who attend the swimming pools, the piscine and swimming basins. Dermatological diseases that can be contracted from water of these arrangements are encountered as urticaria allergic to chlorine in water, papillomavirus, dermatomycosis and yeasts.

These disorders are more common in summer and are due to perspiration, skin maceration, microtraumas and dust and sediments [7], [12].

Contamination virus causes warts, granuloma, herpes or abscess. Dermatomycoses are contagious diseases that occur due to parasitic fungi through direct contact with infected surfaces. The most common are superficial mycoses are located in the legs: interdigital zemuinde epidermomycose, vesicular plantar epidermomycose, hyperkeratosis epidermomycose. These mycoses are located preferentially in the legs, interdigital and plantar, and in the inguinal fold, too. If measures are not taken in time required to treat such disorders, they can spread to the nail being called onychomycosis. Of yeast meet pityriasis versicolor, a condition that occurs mainly in people with seborrheic sweating and skin, which is manifested by the appearance, back, arms, chest, abdomen or neck, yellowish or brown patches in. After sun exposure pityriasis stains lose their brown color, fading and then turn white, while neighboring skin non parasitized are normal skin pigmentation [7], [12], [13], [16].

The water in swimming pools, piscine and swimming basins can be the source of contracting and eye infections, microbial or viral in nature. Redness, excessive tearing and purulent secretions are symptoms of conjunctivitis or corneal infection that occur several hours after exposure to the bacteria.

The water entering the ear canal can cause mycotic otitis, pathology manifested by inflammation and pain. Otitis pool can occur a few days after the bath, the signs of which is the sensation of blocked ears and itching - especially when pressing the tragus or below the earlobe [4], [5], [6], [8].

Prevention of these diseases can be done by: choosing units that hygiene rules are respected; making showering before and after the bath in the pool; avoiding swallowing pool water; use of slippers outside the pool; loungers coverage bath towels; disinfecting hands and feet with betadine or any other solution containing iodine; use rubber helmet, goggles and swimming ear plugs special.

Disease risk can be reduced not only by the instructions for use of swimming pools, but also by an appropriate treatment of water in these premises, through the use of performance rinse and disinfection equipment, in order to prevent degradation the quality of the water, the growth of algae, bacteria and

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pathogenic microorganisms that can affect the health of users.

2. CLARIFICATION OF WATER FROM SWIMMING POOLS, PISCINE AND SWIMMING BAZINS

Swimming pools, piscine and swimming basins are systematic construction, which depending on the purpose and intended use, have the following dimensions: 25 (16.60 to 12.5) x 50 (25) m where swimming pools are for sports and variable for maintenance and recreation. It is recommended that the height of the water to be $H = 1.5 - 2.5$ m, and the jumping basins it can be up to 5 m. The optimum temperature of the water is $T = 26 - 28$ ° C.

The water required to fill pools and to complete loss of water provides from the public network of the village through underground drilling of cold water or geothermal water [11], [12], [16].

The recirculating system of water in these pools being closed circuit involves, necessarily, a proper treatment, consisting of a good rinse combined with disinfection by physical, chemical or biological, in order to prevent the growth of pathogenic microbes that can be the source of many infectious diseases [5], [7], [12].

Schemes treatment plants water pools and swimming pools is up to the nature and characteristics of water recirculation and conditions as required by sanitary institutions, pursuing the solutions applied to be economical, simple and safe to work [6], [7], [8], [13].

Physical treatment consists of suspensions retaining from water of swimming pools by: slow filters; quick filters, upward and downward, monolayer (quartz sand) or multi-layer / multi-layer (gravel, sand, coal); membrane filters / filtration membranes [3], [8], [9].

Chemical treatment with aluminum sulfate and sodium carbonate are applicable only in case of non-upgraded installations, before rapid filtration in order to favor the formation of agglomerates in order to retain fine and very fine suspension in the filter mass. [6].

Water treatment with copper sulphate is recommended to do in basins where water waiting longer than 5-7 days after reheating water in a substation in order to destroy algae which color green water in these pools.

Chemical treatment with various chemical agents applied to neutralize pathogens transmitters of infectious diseases [1], [2], [4], [5].

Biological treatment consists of membrane filters retain pathogens slow filtration layer forms on the surface, after 1-3 days of the commissioning of the plant, filtered water is free of pathogens not require a subsequent disinfection. For all other rinse installations it requires further disinfection for the safety health of users.

Clarified water, before being reintroduced in swimming pools, will undergo a disinfection process, which must be given special attention to prevent the transmission of contagious diseases.

3. WATER DISINFECTION OF SWIMMING POOLS, PISCINE AND SWIMMING BAZINS

In the process of treating water in swimming pools, disinfection is an operation of paramount importance, which is applied in order to prevent the transmission of contagious diseases among different users and preventing the development of microscopic algae which turns green water rays solar [4], [5], [7], [8], [9], [12], [13].

To avoid contamination of the water in swimming pools, disinfecting procedures are recommended with chlorine gas; chlorine dioxide; sodium hypochlorite; calcium hypochlorite; bleach; bromine; ozone; UV, disinfection tablets supplied by various manufacturers and newly TwinOxide [11], [12], [13].

Disinfectant used must meet the following requirements: to destroy in a short time existing pathogens in water; have a high stability; It can be easily controlled; do not cause harmful side effects; do not alter the organoleptic qualities of the pool water and air quality in premises not covered vitiate of these facilities [14], [15], [16].

Chlorine gas is the chemical reagent with the most widely used for water disinfection of swimming pools.

Using chlorine involves, besides the many advantages and some shortcomings, safety risks and health can only be prevented by stopping the use of or applying a disinfectant with features completely different, but to be effective but also economically advantageous.

Excess chlorine in water may cause the formation of trihalomethanes disinfected (THM) and mutagens X (MX), substances known to be carcinogenic and at great risk to public health. In addition, excess chlorine from the water can vitiate the atmosphere inside and swimming pools arranged in enclosed spaces [5], [6], [7], [14], [16].

Chlorine dioxide is known as an excellent disinfectant for drinking water treatment, food industry waters, pools and swimming basins. The pretreatment processes, chlorine dioxide, effectively remove manganese and iron in groundwater and promote flocculation. Also, remove unpleasant taste and odor, and precursors of secondary disinfection products that can lead to the formation of trihalomethanes and haloacetic acids [1], [2], [13].

Bromine as chlorine is the halogen family and is an oxidising agent with right disinfection and bactericidal activity particularly strong, sufficiently effective to avoid the development of microscopic and filamentous algae [13], [14].

Sodium hypochlorite is the chemical reagent with disinfecting particularly effective and is used to disinfect drinking water, piscine and swimming basins water and for areas related poultry units of industrial type [1], [2], [8] [10].

Sodium hypochlorite is the result of the electrolysis of a saline solution (salt and water), which runs in an electrolytic cell. The general solution has a pH of 8-8.5 and a maximum chlorine concentration

equivalent of 6-8 g/l, with a duty cycle of prolonged storage.

The advantages of using the method of disinfection with sodium hypochlorite are: handling safe and easy to store; efficient production of the disinfectant agent; low operating and production costs; simple installation with low investment costs; do not cause dangerous side products; the product is cheap and easy to handle.

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Inputs specific to a charge of hypochlorite solution (16 hours / charge for 3 - 4 days / charge) are: 200 l water / charge; 6 kg salt / charge; electricity consumption of 7.2 kWh / charge and treated water to 1.0 m: 1.05 g salt / mc water; 1.25 Wh / m³ water.

The main drawback of this reagent is the fact that, after approx. 10-14 days after disinfection with the product, the pH of the water rises to above 8.2, resulting in slowing down the coagulation of alumina. Sodium hypochlorite is only administered regeneration circuit after the heat exchanger, rather than directly in the basin to avoid the removal of the disinfectant in the atmosphere or in the enclosure.

Ultraviolet rays with wavelengths of 100-300 nm show a particularly effective bactericidal action. Using ultraviolet light to destroy bacteria and viruses has been promoted disinfecting pool water and swimming pools, since it does not interfere in any way with the chemicals in the water supply structure. Ultraviolet rays are produced by mercury-vapor lamps, placed in balloons quartz.

Ozone is a highly effective disinfectant with powerful and rapid oxidizing the organic matter and micropollutants algae, bacteria and viruses from contaminated waters, while improving color, taste and smell of water.

Ozone is produced in special plants, by blind electrical discharge of high voltage alternating current (V 10000-20000). Consumption of ozone disinfection is 0.5- 5mmg / dm³ water and electricity consumption to produce a gram of ozone is 20-30 Wh [4], [7].

TwinOxide is a solution of chlorine dioxide, substance produced by the Institute of the University of Duisburg IWW (Germany) - internationally approved and recommended for disinfecting water in swimming pools, piscine and swimming basins. TwinOxide totally destroy microorganisms present in water, viruses and pathogens, removes biofilm, do not cause allergic reactions and generates no odor typical of pool, does not favor the formation of trihalomethanes (THM) and other byproducts, is not corrosive and overdosing does not resulting in an immediate risk to swimmers and does not generate chlorite, chlorine or chlorine free, thereby avoiding unwanted limitations of chlorine disinfectants [7], [10].

TwinOxide is recommended to use after a preliminary disinfection with ozone or ultraviolet. The chemical reagent is recommended for disinfecting monthly sand filters or activated carbon filters used in technological schemes, after ozone disinfection. [7], [10].

Appropriate dosage TwinOxide in covered basins must be at least 0.2 ppm and 1.0 ppm maximum solution with a concentration of 0.3%.

In case of covered basins without automatic dosing / metering is recommended that weekly, evening, apply a dose of 0.2 ppm TwinOxide, corresponding to water (Co = 6.67 TwinOxide l / 100 m³ water) and climatic conditions, sun and high heat dose of 0.2 ppm will apply twice a week in the evening.

Natural **biological membranes** from membrane of slow filters the artificial, are able to retain not only fine mineral suspensions, but also pathogenic microorganisms, carrying microbes and virus. High technologies are effective but very expensive, which is why they have not found wide application in drinking water treatment technologies and those in swimming pools, piscine and swimming basins.

4. STUDIES AND EXPERIMENTAL RESEARCH

Studies and experimental research conducted at four swimming pools were designed to eliminate the negative effects of chlorine and its derivatives, with risks to health and safety for users, the use of sodium hypochlorite, ultraviolet light and those of solution TwinOxide .

Figure 1 highlighted the constructions and installations after refurbishment from T₁ basin, where disinfection is made with TwinOxide in doses of 0.2 ppm.



Figure 1 - Construction and installation of swimming pool rehabilitated T₁

In Figure 2 is shown T₂ swimming pool, water in the disinfection solution is of TwinOxid the mean doses used are 0.2 - 0.4 ppm in a 0.3% solution, from which the equivalent concentration TwinOxide is 6.67 l / 100 m³ water, harmless effect on the quality of facilities and construction.

The results of bacteriological analyzes the water samples from chlorinated swimming pools show that the content of free residual chlorine of 0.3 - 0.4 mg / dm³, faecal germs are neutralized, and at doses of 0.6 - 0.8 mg / dm³ staphylococci and viruses are inactive at doses of chlorine of 0.8 mg / dm³ for 30 minutes. The main drawback is that at higher doses irritate mucous membranes in combination with nitrogenous

materials of human origin, which causes an unpleasant odor in the pool.

The elimination of the drawbacks of chlorine can be given by using ultraviolet light alone or in combination with sodium hypochlorite, or with TwinOxide solution, disinfectants residence time in the regeneration circuit of the water in swimming pools, piscine and swimming basins.



Figure 2 - Water quality and construction of swimming pool T²

In Figure 3 is evidence of harmless disinfection with sodium hypochlorite, the buildings and facilities at the sports complex of T³.



Figure 3 - Water quality and construction of swimming pool T³

In Figures 4 and 5 are highlighted T_{4,1} and T_{4,2} swimming pools where water is ultraviolet disinfection solution and CTX. Dosage CTX solution is recommended as a safety effect, to ensure residual chlorine in swimming pool water and ultraviolet rays to disinfect basic water supply circuit.



Fig. 4 - Water quality and construction of the swimming pool T_{4,1}

If Outdoor Swimming Pool / outdoor played in Figure 5, used only in the warm season, water disinfection is ensured by the simultaneous action of UV for disinfection base, and a disinfectant solution of CTX, in order to ensure residual chlorine concentration of 0.5 to 0.6 mg / dm³, required by technical rules [14], [15], [16].



Figure 5 – Outdoor Swimming Pool T_{4,2}

In figures 6 and 7 presents T_{5,1} and T_{5,2} swimming pools, in which water is provided disinfection with sodium hypochlorite at a dose of 0.5 - 1 mg / l to a pH of - 7.8.

Water supply to these pools is through a drilling geothermal water (H = 1200 m. Depth) at a temperature of 45 ° C and the drilling of cold water (H = 100 m. Depth) to cool the geothermal water or power outdoor pools during summer.

Analysis reports have revealed that the physical and biological pool water is clear / limpid, no viruses and no germs.



Figure 6 – Indoor swimming pool T_{5,1}



Figure 7 – Outdoor swimming pool T_{5,2}

5. CONCLUSIONS

Water treatment in swimming pools is done in order to ensure clean water and sanitary physically, able to avoid the transmission of contagious diseases among swimmers or persons who practice recreational swimming. To ensure a disinfection simple, inexpensive and safe to use in an ambient environment as pleasant inside the basin is recommended sodium hypochlorite.

Water quality in swimming pools, can be provided by the combined effect of ultraviolet rays TwinOxide solutions, or CTX, effective procedures outstanding, but more expensive than hypochlorite disinfection current treating sodiu.

The current system of water treatment for swimming pools, piscine and swimming basins can be improved by using the following technologies: slow filtration without prior or subsequent disinfection; rapid filtration through single layer or multiple layers combined with a slow filtration; multiple layers upward by rapid filtration and disinfection with sodium hypochlorite, pre ozonation and sodium hypochlorite as safe dose; membrane filters with or without disinfection with sodium hypochlorite.

These procedures are fully insured, optimal hygienic conditions, health and comfort for all users who practice swimming performance, or maintenance, recovery and recreation.

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