# Ultraviolet Light as a Sterilization Method in Flotation Tanks

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**Flotation tanks are widely used in laboratories, clinical settings, commercial facilities, and private homes; they have multiple applications in research, therapy, self-improvement, and recreation. Since the warm saline solution used in tanks is favorable for the proliferation of microorganisms, disinfection/sterilization is an important concern. Evaluations of various techniques for achieving acceptable levels of sterilization have not yet been published. This article describes early results using ultraviolet light and filtration in a laboratory flotation tank.**

**Index Under: Flotation; Tanks, Flotation; REST; Sterilization; Sterilization, Ultraviolet.**

## INTRODUCTION

Flotation tanks are devices for achieving profound reductions in environmental stimulation. At first used primarily for basic research in cognition, affect, perception, psychophysiology, and other processes (Zubek, 1969), they have more recently been employed in a variety of recreational, self-improvement, and therapeutic settings (Fine, 1982; Jacobs, in press; Lilly, 1977; Suedfeld, 1980, 1983). The tank is one of the major tools used in work on *Restricted Environmental Stimulation Techniques* (REST), with about a dozen tank manufacturers in North America and Europe.

Most tanks are made of fiberglass and resemble large covered bathtubs. The individual floats in a warm solution of Epsom or other salts, with the face and the ventral parts of the body out of the water. The environment is dark, silent, warm, and soothing; the subjective effects of gravity are minimal. Data have shown that the experience is pleasant and extremely relaxing for most participants. As a result, many privately-owned tanks are now being used, and even more are available on an hourly rental basis in commercial tanking facilities. Two organizations which have been established to disseminate information and generate safety guidelines, are the **Floatation Tank Association**, drawing its membership primarily from private and commercial users, and the **International REST Investigators Society**, which emphasizes research and clinical contexts.

## DISCUSSION

One major concern of users has been the problem of eliminating bacteria, fungi, and other organisms that might proliferate in the warm saline solution. Originally, filtration techniques developed in microbiology were used; however, because of the time lag between the introduction of bacteria into the water and their removal by the filter (McCulloch, 1945), this was considered to be inadequate. Chemical disinfection methods are, therefore, used to supplement filtration.

Commonly used disinfectants have been chlorine ($Cl_2$), bromine ($Br_2$), and iodine ($I_2$). The most common disinfectant at this time is a one percent solution of $I_2$ in alcohol. $I_2$ combines with cell protein and an active germicidal agent with moderate effectiveness against spores. In the authors' laboratory, 5 mL of one percent $I_2$ solution was added to the 828 L of water in the tank approximately 30 minutes before each subject was run; in the interim, the solution was filtered. The filter allows

 

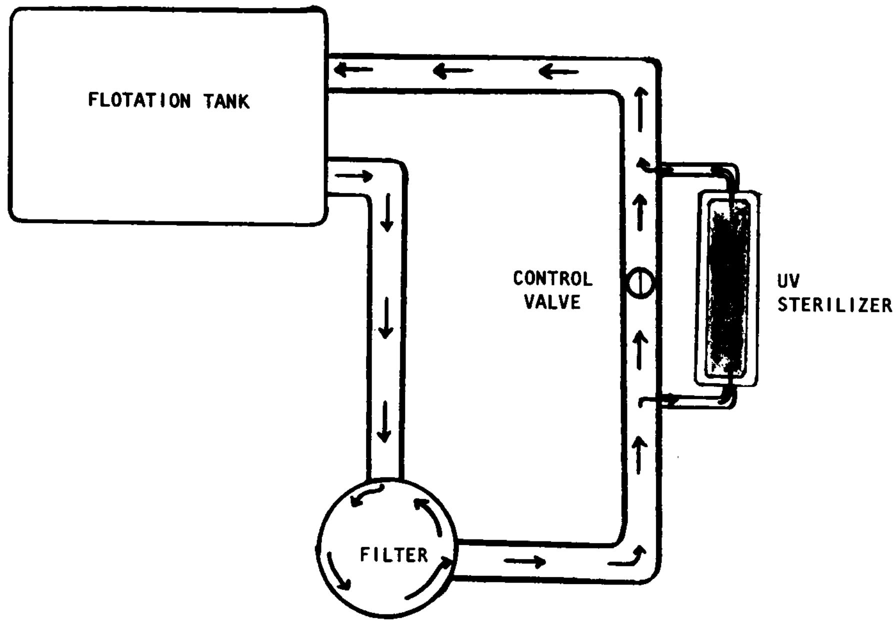


**Figure 1**
Ultraviolet Light Water Sterilizer Incorporated into Flotation Tank Setup. (Direction of arrows indicates flow of water.)

the passage of particles smaller than 16 microns and, thus, has no effect on bacterial counts in the solution.

Although this method was acceptable, the authors wanted to achieve *sterilization* (killing all microorganisms), rather than merely *disinfection* (destroying pathogenic microorganisms that may cause infection [Breach, 1968]). Accordingly, an *ultraviolet* (UV) system was installed. This apparatus relies on a mercury vapor sterilizing lamp, which efficiently converts approximately 17 percent of its total electrical energy into the mercury resonance radiation of 2537 Å (1 Å = $10^{-8}$ m). Microorganisms absorb this radiation through DNA molecules in the nucleus, which disrupts molecular bonding and kills the organism by interrupting normal metabolic processes.

Approximately one and one-half hours before and after each subject, and again at the end of each research day, water is pumped out of the tank, filtered through a reusable single-element reinforced polyester filter cartridge, passed once through the UV sterilizer (Figures 1 and 2), and finally returned through an inlet pipe. Recirculation through the pump provides a high degree of water clarity. A control valve adjusts the flow of solution through the UV source. The sterilizer delivers a dose (total energy absorbed by the microorganism) of 20,000 microwatt/sec/cm$^2$ at a flow rate of 245 mL/min/cm of chamber length. In a recent report on UV sterilizers, Health and Welfare Canada, a government agency, indicated that the necessary end-point dosage to destroy pathogenic microorganisms was only 16,000 microwatt/sec/cm$^2$.

A comparison of the effectiveness of the two techniques was conducted by deliberately introducing coliform bacteria into the saline medium and leaving the tank untouched for 24 hours. At that point, either $I_2$ disinfection or UV sterilization was applied. A test sample of the solution was taken from the tank immediately thereafter by aseptically filling a sterile 500 mL container, which was sent to a commercial laboratory. Table IA shows the results of this test.

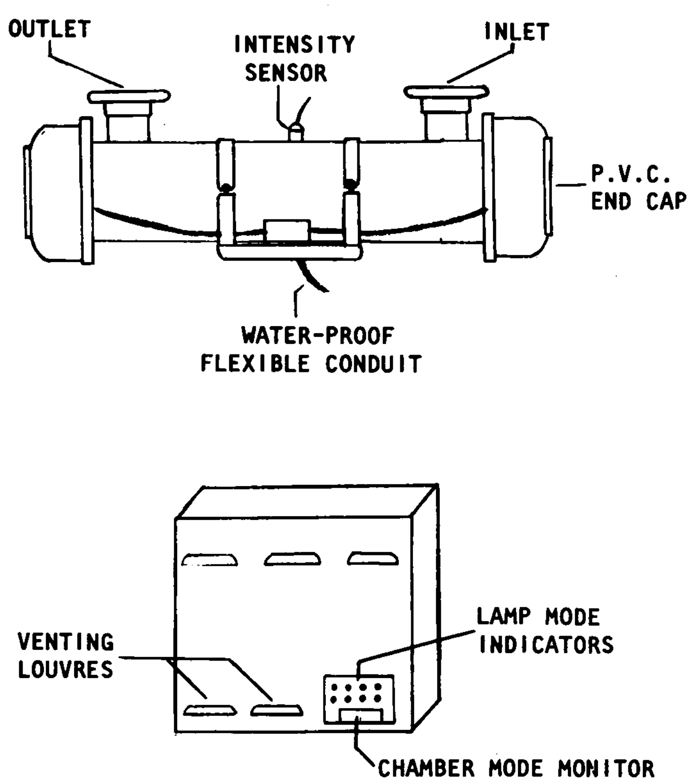


**Figure 2**
Model JMC-1-b-FS Ultraviolet Light Sterilizer and Remote Electrical Enclosure.

**TABLE IA**
**Bacterial Measurement of Water Test Samples Treated Chemically or by UV**

| TREATMENT | STANDARD PLATE COUNT (# Bacteria/mL @ 35°C) | COLIFORMS (MPN/100 mL) | |
|---|---|---|---|
| | | TOTAL | FECAL |
| None | 15,500 | 2,400 | 23 |
| $I_2$ | 6,500 | 350 | <2 |
| UV | 1,900 | 350 | <2 |

**TABLE IB**
**Bacterial Measurement of Water Test Samples Treated Chemically or by UV With No Bacteria Introduced**

| TREATMENT | STANDARD PLATE COUNT (# Bacteria/mL @ 35°C) | COLIFORMS (MPN/100 mL) | |
|---|---|---|---|
| | | TOTAL | FECAL |
| UV | 10 | 0 | 0 |
| $Br_2$/UV | 8 | <2 | <2 |

*Coliform counts* (number of *types* of viable microorganisms) were much lower after either treatment than in the untreated sample, and were equal to each other. However, the total number of bacteria/mL was reduced by 88 percent after UV, compared with only 58 percent reduction after $I_2$ treatment.

In the next phase, UV was used for 30 minutes between float sessions and for one and one-half hours at the end of the day. Test samples were taken at the end of each research day (usually two subjects/day). Mean results for three independent tests performed by a commercial laboratory are presented in Table IB. In the last phase of the study, a fresh supply of the solution was treated with 48 mL of $Br_2$ salts plus activator. For the subsequent two months, the UV treatment described above was administered. The results of the combined treatment, with the analysis replicated, are also presented in Table IB. The data presented in Table IB should be more representative of the use of UV in everyday tank operation than the more stringent test based on microorganisms actually added to the solution (Table IA); the effectiveness of UV sterilization in this context was very high.

Both the Floatation Tank Association and an increasing number of municipal, state, and provincial health agencies have begun to set standards for flotation tank water sterilization. FTA's provisional guideline is no more than 10 bacteria/mL and a coliform count of 1/100 mL. The authors' samples of UV sterilization and the combined $Br_2$/UV treatment are both well within those limits.

## CONCLUSIONS

If more extensive tests, preferably with a variety of tank designs and configurations, confirm the authors' results, UV has advantages aside from its effectiveness. The intensity of bactericidal action can be maintained at reasonably constant levels over time, and overtreatment is impossible. Materials dissolved or suspended in the water (e.g., the Epsom salts) are unchanged by exposure to UV light. Most importantly, no toxic effects are possible upon the equipment operator or the subject, and no damage can be incurred by the tank and associated equipment. Injuries and damage are quite possible when chemical disinfectants are used, since the substances involved are toxic at some levels and in some combinations.

Since UV cannot penetrate water in which there is a heavy solution of organic compounds, it must be used in conjunction with a filter system. There is a potential maintenance problem—iron dissolved in the saline solution may pass through the sterilizer, adhere to the quartz sleeve of the UV lamp, and reduce UV light transmission. The sleeve must be checked regularly, which is easily done by simply removing the PVC end cap and lifting the sleeve out of the unit. Any iron deposit or film can be removed with nonabrasive soap and warm water.

Tanks should be designed so that the solution flows to all areas, since pools of microbial flora can grow in places where the water is not recirculated. The flow rate across the quartz sleeve will affect the area reached. Since UV reaches only those microorganisms that are suspended in the solution, the walls of the tank must be wiped down between uses to remove microorganisms clinging to them.

This UV filter system has been in use for nine months, during which time approximately 130 flotation sessions have been run. No problems of any sort have been encountered. Obviously, these data are restricted—the authors have a limited number of laboratory analyses, and used only one particular UV system, tank, and set of related equipment. Thus, the generalizability of the findings should be evaluated through further tests. If these are consistent with the authors' results, REST researchers as well as flotation tank operators and owners should consider this type of system as an alternative to chemical disinfection. The bromine/UV combination clearly merits further testing as well. So may other chemicals (such as iodine, chlorine, hydrogen peroxide), possibly in combination with UV; but UV does have some unique advantages.


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## REFERENCES


**Breach**, M.R. (1968), *Sterilization: Methods and Control*, Butterworth, London, UK.

**Fine**, T.H., and Turner, J.W. (1982), The effects of brief restricted environmental stimulation therapy in the treatment of essential hypertension, *Behaviour Research and Therapy*, 20:567-570.

**Jacobs**, G.D., Kemp, J.C., and Belden, A.D. (In Press), A preliminary clinical outcome study on a hospital-based stress management program utilizing flotation REST and biofeedback, *REST and Self-Regulation*, T.H. Fine, K. Johnson, and J.M. Stanley (Eds.), Ohio Medical College, Toledo, OH.

**Lilly**, J.C. (1977), *The Deep Self*, Simon & Schuster, New York, NY.

**McCulloch**, E.C. (1945), *Disinfection and Sterilization*, Lea & Febiger, Philadelphia, PA.

**Suedfeld**, P. (1980), *Restricted Environmental Stimulation: Research and Clinical Applications*, Wiley & Sons, New York, NY.

**Suedfeld**, P., Ballard, E.J., and Murphy, M. (1983), Water immersion and flotation: from stress experiment to stress treatment, *Journal of Environmental Psychology*, 3:147-155.

**Zubek**, J.P. (Ed.) (1969), *Sensory Deprivation: Fifteen Years of Research*, Appleton-Century-Crofts, New York, NY.


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