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An Overview of the Water Disinfection with Ultraviolet Radiation Nowadays: New Approaches

Burhan Davarcioglu

Department of Physics, Aksaray University,
Aksaray, 68100, Turkey

Abstract

Water is one of our most precious natural resources and micro-organisms are found everywhere on earth, including water. This causes many disease germs and must be free of water for disinfecting microbes. UV disinfection system is one of the technologies commonly used in the world for disinfection. UV disinfection has many advantages. There is no need for expensive chemicals that are toxic effects, rapid disinfection is provided, it does not require frequent maintenance and low operating costs. Ultraviolet disinfection, provide similar benefits, but the water beneficial minerals are separation by distillation. UV disinfects water with solar energy at high power. Unlike chemical, water does not leave unwanted residues or by-products. Because it is not a chemical reaction in the environment, UV water's taste, odor and clarity does not act. This article, we will briefly before the UV disinfection method, followed by the "New Design" and will focus on the advantages of UV technology to it.

Keywords: *Disinfection, Ultraviolet (UV), Physical methods, Chemical methods, Water, Treatment.*

1. Introduction

In the developed world the use of water supply disinfection as a public health measure has been responsible for a major reduction in people contracting illness from drinking water. However many of these disinfectant chemicals if over dosed or used inappropriately, as part of a water treatment process, can result in the formation of disinfection by-products. Disinfection by-products are formed when disinfection chemicals react with organic or inorganic compounds. Research shows that human exposure to these by-products may have adverse health effects [1-5].

At the end of nineteenth century, when the existence of bacteria and their relationship to disease was already known, work was done with pressures. Contaminated water was placed in hermetically sealed containers and submitted to pressure. After a few minutes' time, the pressure was suddenly brought down to normal and the result was pure, germ free water. Similar experiments using continuous and violent shaking over long periods of time apparently also resulted in disinfection. Certain ancient cultures placed their drinking water in silver jars. Without understanding why, they knew that after a period of contact with these containers, the water was safe to drink. The list is almost endless. Micro-organisms can be eliminated in a variety of ways. Obviously, however, only a few of these possibilities are viable. The power to annihilate is not sufficient, in itself. It must be accompanied by specific characteristics, such as simple equipment and ease of operation and maintenance. If chemicals are used, these must be easily available at the site of use [6, 7]. Disinfection must be accomplished rapidly and the inexpensiveness of the method is vital. Even though the bactericidal power of silver is important, it is not as quick as that of other disinfectants. It has also been found to be not a very good virucide. Besides, organic matter or other salts present in the water may hinder its activity. Finally, silver disinfection treatment costs can be tens or even hundreds of times more expensive than low cost disinfectants [8-10].

Many of these disinfectants are also employed as oxidation agents to improve the efficiency of coagulation/filtration, reduce iron and manganese, remove taste and odor and control algal growth. The possible cumulative effect of these oxidants on by-product formation in combination with their use for disinfection purposes also needs to be understood and risk assessed. The provision of drinking water free from harmful micro-organisms has traditionally been assured by monitoring the numbers of bacteria which are indicators of fecal contamination [11]. This monitoring is done on drinking water entering supply and at certain fixed and random locations within the distribution system.

Treatment upstream of disinfection is also crucial to the performance of any disinfection processes. If the bacteriological loading entering the disinfection stage is too great then disinfection will not be able to achieve the required reduction in numbers of bacteria and pathogens. In addition to this, conventional disinfection practices will require treated water to achieve certain standards in terms of turbidity, pH and other parameters prior to their application. There are also raw water characteristics that can exert a chlorine demand e.g. ammonia, iron and manganese [12]. Any upstream processes must be able to prepare the water so that disinfection is not compromised, for example in relation to turbidity removal. Upstream processes can also be critical to minimize the risk from disinfection by-products. Microbial and chemical characteristics are two major water quality factors that affect the UV unit performance. Microbial characteristics of water include type, source, age, and density. Chemical water characteristics include nitrites, sulfites, iron, hardness, and aromatic organic levels [13].

The object of disinfection is to kill disease-causing organisms present in the water. With regard to water treatment, disinfection refers to the destruction of most intestinal or fecal bacteria. Sometimes disinfection is not complete. Some viruses and especially some protozoa, such as Giardia or cryptosporidium, could survive the disinfection process. The only method of complete protection is to sterilize the water by boiling it for a period of 15 to 20 minutes. This process kills most living organisms, but it is only practical as an emergency measure for the individual users [1, 14].

Produced by the sun passing through a layer of the atmosphere at different wavelengths of UV-rays come up to our world. UV light and micro-organisms that are in direct lethal effects on a large proportion of UV radiation in the 230-280 nm range is filtered by the ozone layer in the atmosphere, thereby protecting life on earth. Ultraviolet 254 nm in length bacteria, viruses, spores, is the most effective UV radiation on living organisms such as parasites. 254 nm, the effect of UV-rays are explained as follows: 254 nm is slipped inside the cell membrane of UV light micro-organisms in the neck, makes changes in the DNA chain, DNA stops all cell activities, including proliferation live deteriorating and cell death occur [15].

Amongst disinfection technologies, UV has a distinctive mode of action as it does not necessarily kill all the target organisms. Instead, UV light is absorbed by the micro-organisms, damaging genetic nucleic acids (DNA, RNA) responsible for replicating or multiplying. Because the organisms cannot replicate, a human or animal host cannot be infected [5, 15].

2. The Basic Principle of Disinfection

Germ killing activity of sunlight is an indisputable fact. This is caused by the ultraviolet rays emitted by the sun. UV-rays emitted by the lamps are the most effective for short wavelength light up our world through the atmosphere to reach the micro-organisms come from the sun. Disinfection does not necessarily start and end at the inlet and outlet of a contact tank. Other parts of the treatment process may provide disinfection by removing micro-organisms as well as ensuring the water is suitable for disinfection with chlorine or other disinfectants.

Many water treatment works abstracting from surface waters, such as rivers and reservoirs, have long adopted the multi barrier approach to water treatment, where a number of treatment processes are employed to provide treatment and disinfection. Failure of an upstream process such as clarification or filtration may mean that the chlorination stage will not be able to achieve disinfection. Both chemical coagulation based treatment followed by rapid gravity filtration and slow sand filtration can provide effective removal of protozoan pathogens, bacteria and, sometimes to a lesser extent, viruses [16].

The practical term UV transmission is a percentage measure of the spectral transmissivity observed for a particular layer thickness. The latter has an exponential effect on the level of UV transmission [17]. Consequently, knowledge of the layer thickness (cuvette size) is essential. Frequently, the design of UV disinfection equipment is based on UV transmission at 254 nm instead of on the SSK (spectral attenuation coefficient) 254. The UV transmission rate is determined by means of a suitable spectrophotometer.

The use of UV light, defined as an attempt to mimic nature. Sunlight destroys certain bacteria present in water and water if exposed to UV light pathogens destroyed. This alone should be sure that the water turbidity and color in my treatment. Ultraviolet dosage microWatt.sec/cm^2 (μW.s/cm^2) is measured. MicroWatts value increases, the dose is increased, the contact time increases, the dose would be more effective. Therefore the beam energy and dose chamber volume used is very important.

An effective dose is measured as a product of the lamp's intensity (the rate at which photons are delivered to the target), including radiation concentration, proper wavelength, exposure time, water quality, flow rate, and the micro-organism's type, and source, as well as its distance from the light source. At a minimum, drinking water systems should install two UV units, which are both capable of carrying the amount of water the system was designed to handle. Having two units in place assures continuous disinfection when one unit is being serviced. Two units also can ensure operation during low flow demand periods [5, 18].

Typical UV disinfection systems involve the flow of water through a vessel containing a UV lamp as shown in Fig. 1.

As the water passes through this vessel, micro-organisms are exposed to intense ultraviolet light energy which causes damage to genetic molecules (i.e. nucleic acids: DNA or RNA) needed for reproductive functions. This damage prevents the micro-organism from multiplying or replicating in a human or animal host. Because the micro-organism cannot multiply, no infection can occur. Disinfection of water is achieved when UV light causes microbial inactivation.

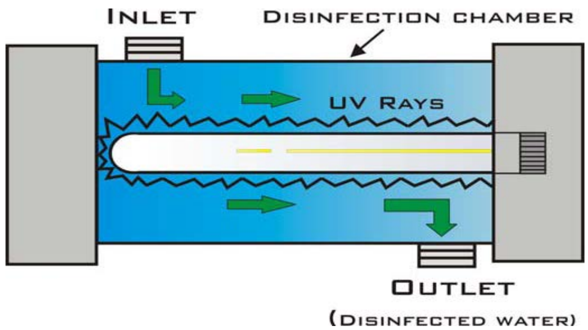

Fig.1 Basic schematic of UV unit with bulb [11]

2.1 How does UV Technology Work?

UV light is electromagnetic radiation traveling in wavelengths in all directions from its emitting source (bulb). It is found in the spectral range of light between X-rays and visible light; UV light occurs with a wavelength ranging from 200 to 390 nanometers. The most effective wavelength frequency, from the point of view to microbiological disinfection, is 254 nm as this is where the optimum energy intensity is found [11]. This relationship between microbiological disinfection effectiveness and the wavelength frequency as emitted from the UV bulb is shown in Fig. 2.

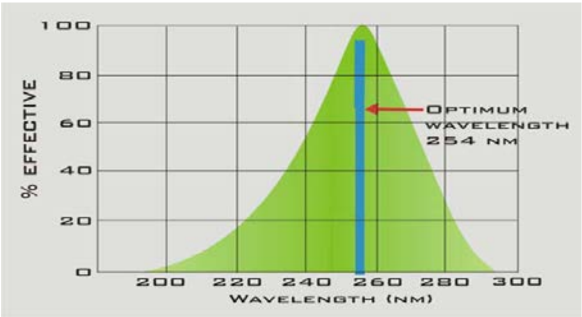

Fig. 2 % Effectiveness versus wavelength emitted from UV unit

Generally, a UV disinfection unit is composed of a lamp or bulb, power supply, and electronic ballast. An example of a typical unit is shown in Fig. 3. UV light, which continues to be a reliable means of disinfection, involves exposing contaminated water to radiation from UV light. The treatment works because UV light penetrates an organism's cell walls and disrupts the cell's genetic material, making reproduction impossible.

Fig. 3 Schematic of UV unit with cover removed [11]

Low pressure mercury discharge lamps (the most common type used in small scale systems are similar in design and construction to fluorescent lamps) emit a wavelength of 254 nm, which has been found to be a good source of UV radiation to perform the disinfection process. An electronic arc the length of the lamp is formed and travels through an inert gas containing mercury. The heat generated by the arc vaporizes some of the mercury, which becomes ionized in the electric arc and gives off UV radiation. The UV bulb is constructed using quartz glass, which easily allows the UV radiation to pass through it. This bulb is then encased by a protective quartz glass sleeve that allows the water to be exposed to the disinfecting UV radiation [19]. This protective quartz sleeve prevents the water from contacting the UV bulb, which would change the temperature of the bulb glass, therefore affecting the pressure of mercury in the lamp and, in turn the level of UV output.

Ballasts are used to control the power to the UV lamps. They should operate at a temperature cooler than 60 °C to prevent premature failure. Commonly used ballasts are electronic or electromagnetic. Electronic ballasts operate at a much higher frequency, resulting in lower lamp operating temperatures, less energy use, less heat production, and longer ballast life. Some types of electronic ballasts provide constant output to the lamp regardless of input voltage or frequency.

A special lamp generates the radiation that creates UV light by striking an electric arc through low pressure mercury vapor. This lamp emits a broad spectrum of radiation with intense peaks at UV wavelengths of 253.7 nm and a lesser peak at 184.9 nm. Research has shown that the optimum UV wavelength range to destroy bacteria is between 250 nm and 270 nm. At shorter wavelengths (e.g. 185 nm), UV light is powerful enough to produce ozone, hydroxyl, and other free radicals that destroy bacteria [20].

2.2 Factors Affecting UV Performance

A number of useful add on features are available for UV units. Features such as a UV lamp intensity monitor connected to visual and/or audible alarms, timers, digital displays, temperature sensors, electronic ballasts, and high output lamps can be quite valuable. Additional safety features can be incorporated into the design and layout of a system. In the event of a power outage, unit malfunction, or lamp failure, a solenoid valve can be used to prevent untreated water from entering the water distribution system. UV units have been incorporated into the disinfection process for various system designs and configurations (Fig. 4).

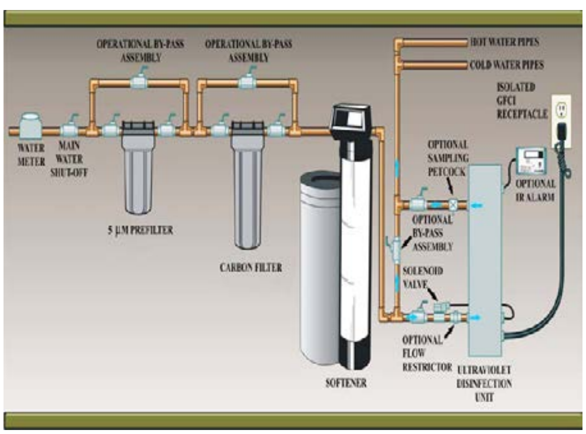

Fig. 4 Typical softening system with UV disinfection

Water treatment systems can incorporate UV as a useful method of disinfecting treated water for safe use. Many other applications of this technology are possible, depending on the desired outcome. For instance, UV disinfection used in conjunction with chlorination can be a very effective disinfection system. UV is a cost effective method for treating bacteria, viruses and protozoa, while chlorine provides a chemical residual offering additional protection in the event of contamination being introduced in the distribution system or plumbing. For surface water systems and ground water under the direct influence of surface water, filtration pre-treatment and other processes are required.

UV devices “real performance” determination, in other words “calculated UV dose of” correction/verification “Bio UV Dose Dosimetric Test” is carried out with. There are authorized private entities to do these tests in the world. UV devices are tested in real conditions in bio dosimetric test laboratory (Fig. 5). In these tests, the UV dose-related death curve is used predetermined resistant micro-organisms. Removal of micro-organisms in certain concentrations in the effluent water is fed into the UV equipment containing these micro-organisms are constantly monitored. UV device according to obtained test results into real and certified disinfection efficiency of the table.

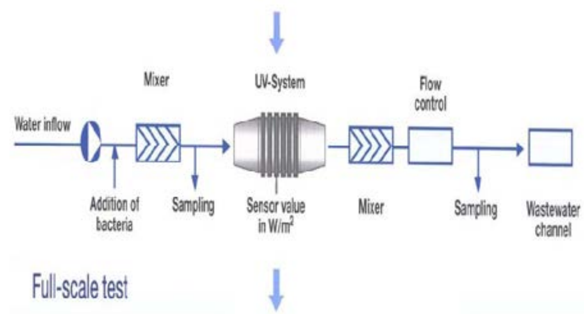

Fig. 5 Bio dosimetric UV dose test stand simple flow chart [6]

The main water quality parameter used to specify UV disinfection systems and by which their performance is governed is UV transmittance (UVT) which is defined as set out in Fig. 6 overleaf.

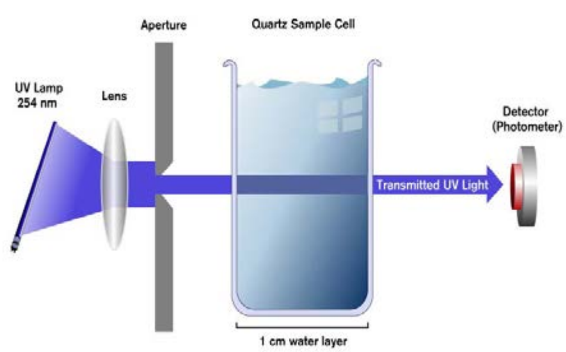

Fig. 6 Schematic of UV transmittance measurement [21]

UVT is the percentage of the light emitted which is transmitted through the fluid, for a path length of 1 cm.

Reduction in UVT is caused by the scattering and absorbance of UV in the water by natural organic matter in particulate or dissolved form or by inorganic chemical compounds such as iron and nitrates. UVT levels in excess of 85% are typically associated with treated surface waters from a treatment process following filtration. Good quality groundwater would typically have higher UVT [11, 21].

The importance of UVT levels in the water with respect to the sizing of UV disinfection systems is that the power requirements of a UV disinfection system required to achieve a desired UV dose is approximately doubled for every 5% decrease in the UVT of the water to be disinfected. The fouling of the quartz sleeves, which encapsulates the UV lamps, can occur, consequent to chemical parameters in water to be treated. This sleeve fouling can also result in the blocking of UV light and reduced UV transmission to the water. While variations in pH and temperature are not known to affect UVT, iron and hardness in water can cause accumulation of mineral deposition on the quartz sleeves.

There are published reports from laboratory tests of synergistic benefits from using two or more disinfectants, i.e. the overall inactivation is greater than the sum of the inactivation achieved for each disinfectant individually [20-23]. For example, one benefit from ozonation before UV treatment is that ozone can degrade natural organics which cause UV absorption thereby allowing the UV dose to be a more effective disinfectant and more energy efficient. Chlorine dioxide also shows a synergistic effect when combined with other disinfectants such as ozone, chlorine, and chloramines. Combination of disinfectants is known to lead to greater inactivation when the disinfectants are added in series rather than individually. However, this is rarely, if ever, taken into account for practical applications. Combination of disinfectants would need to take into account interactions between them.

If one considers the graphical representation of UV and chlorination dosage necessary to inactivate a range of common pathogens as set out in Fig. 7, it is clear that there is a benefit in the multi barrier use of both disinfection methods in the provision of full spectrum pathogen control.

When used as a final treatment stage, chlorination is unlikely to interact significantly with other processes. Chlorine is reduced by UV treatment. Although the extent of chlorine reduction is small (e.g. 0.1 to 0.2 mg/l at a dose 40 mJ/cm^2) it is best if chlorine is dosed after UV. Chlorine reacts with ozone to produce chlorate. However, it is unlikely that sufficiently large ozone residual would reach a final chlorination process, for such chlorate formation to be an issue. Chlorine also reacts with chlorine dioxide to produce chlorate, but it unlikely that these oxidants would be used in such a way as to allow this interaction to occur. Chlorine is the most widely used disinfectant for the inactivation of waterborne pathogens in drinking water supplies and historically has arguably made the greatest contribution to the public health protection of consumers. In addition to its use as a primary disinfectant post treatment, the residual level which remains in the distribution systems ensures that the microbiological compliance can be quality assured to the consumer tap as well as safeguarding against recontamination in the distribution system.

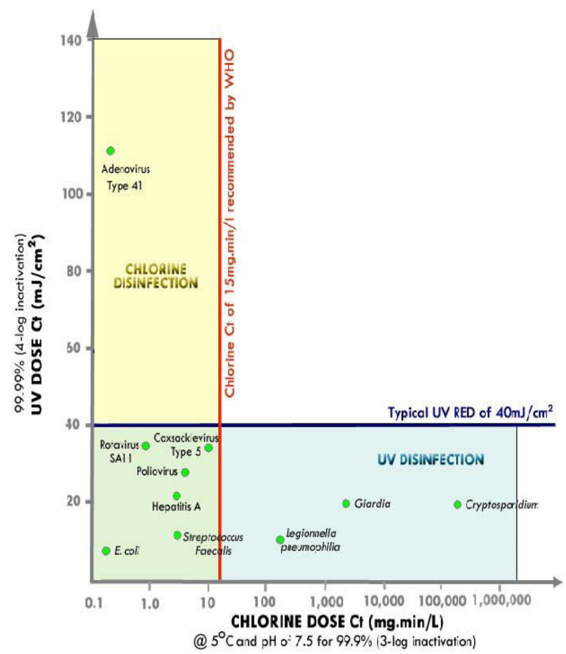

Fig. 7 Synergistic uses of UV and chlorination disinfection systems [21]

The selection and application of an appropriate disinfection technology should have regard to the following principles:

- The assessment of catchment and source risks with respect to the clarity, organic content, and the likely risk of pathogenic micro-organisms in the source water. The evaluation of particular source risk following analysis of raw water monitoring to determine the extent of pathogen removal/inactivation required of the disinfection system. The disinfection technology must be capable of removing or inactivating all pathogens potentially present in the final water.
- The determination of the pre-treatment processes, necessary to ensure the required pre-treatment of

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the water and/or inorganic chemical removal, upstream of the disinfection system to ensure it is capable of performing adequately. An assessment of the adequacy of contact time for chemical disinfection technologies and the necessity to ensure that minimum contact times required for disinfection are achieved. The verification of the efficiency of the disinfection treatment. Any disinfection technology used must be capable of being verified.

- An assessment of the requirement to ensure that a residual disinfectant is present in the distribution network for all but very small distribution networks. An assessment of the capital and operational cost of the disinfection technology. Where disinfection technologies achieve equally effective outcomes the water supplier should have regard to the financial implications from the capital and ongoing operational aspects to ensure that the most cost effective solution is selected.

2.3 Chlorination Practices

Chlorination has gained the most acceptances among the reagent techniques to date. The main reasons for this are the high reliability of the bactericidal effects, the possibility of rather simple monitoring of the residual chlorine, the simplicity of the corresponding equipment, and others. However, in the case where some organic substances remain in water, chlorine reacts with them forming carcinogenic substances. Among the latter are chloramines that induce the cancer. Because of this, drinking water should be carefully purified from organic compounds prior to chlorination.

Early chlorination practices were developed for the purpose of disinfection. Combined chlorine and ammonia treatment was introduced to limit the development of objectionable tastes and odors often associated with marginal chlorine disinfection. Super chlorination was developed for the additional purpose of destroying objectionable taste and odor producing substances often associated with chlorine containing compounds. The discovery of breakpoint chlorination, followed by the recognition that chlorine residuals can exist in two distinct forms, led to the establishment of the two methods for water chlorination used today [24, 25].

Use of Combined Residual Chlorination: Combined residual chlorination involves the addition of chlorine to water to produce, with natural ammonia present or with ammonia added, a combined available chlorine residual. Combined available chlorine forms have lower oxidation potentials than free available chlorine forms and are less effective as oxidants. They are also less effective as disinfectants. In fact, 25 times more combined available residual chlorine must be obtained to meet the same disinfectant level as a free available residual. The contact time has to be up to 100 times greater to obtain the same level of bacterial kill at the same pH and temperature conditions. These conditions may have to be considered:

- If the water contains sufficient ammonia to produce the desired level of combined residual, the application of sufficient chlorine alone is all that is needed.
- If the water contains too little or no ammonia, then addition of both chlorine and ammonia is required.
- If the water has a free available chlorine, the addition of ammonia alone is all that is required. A combined chlorine residual should contain little or no free available chlorine.

Use of Free Residual Chlorination: Free residual chlorination involves the application of chlorine to water to produce either directly or by first destroying any naturally present ammonia a free available chlorine residual and to maintain this residual through part or all of the water treatment plant and distribution system. Free available residual forms have higher oxidation potentials than combined available chlorine forms and are more effective as disinfectants. When free available chlorine residuals are desired, the characteristics of the water will determine how this will be accomplished. This may have to be considered:

- If the water contains no ammonia or other nitrogen compounds, any application of chlorine will yield a free residual once it has reacted with any bacteria, virus and the micro-organisms present in the water.
- If the water contains ammonia, it results in the formation of a combined residual, which must be destroyed by applying an excess of chlorine (Fig. 8; see the breakpoint-chlorination curve) [26].

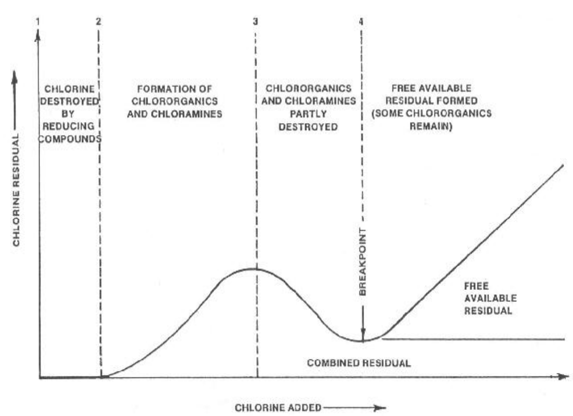

Fig. 8 Breakpoint chlorination

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Breakpoint Chlorination: Breakpoint chlorination is the name of the process of adding chlorine to water until the chlorine demand has been satisfied. Chlorine demand equals the amount of chlorine used up before a free available chlorine residual is produced. Further additions of chlorine will result in a chlorine residual that is directly proportional to the amount of chlorine added beyond the breakpoint. Public water supplies normally chlorinate past the breakpoint. When chlorine is initially added to water, the following may happen:

- If the water contains some iron, manganese, organic matter, and ammonia, the chlorine reacts with these materials and no residual is formed, meaning that no disinfection has taken place.
- If additional chlorine is added at this point, it will react with the organics and ammonia to form chloramines. The chloramines produce a combined chlorine residual. Combined residuals have poor disinfection power and may be the cause of taste and odor problems. As the chlorine is combined with other substances, it loses some of the disinfection strength.
- With a little more chlorine added, the chloramines and some of the chlororganics are destroyed.

Shock Chlorination Treatment: Gaseous chlorine is the least expensive form of chlorine for water supplies. In small water utility installations or for field emergency or other specialized uses, other chlorine containing compounds may be easier to use and more economical. Such materials are various hypochlorites or liquid bleach solutions, chlorinated lime, or chlorine dioxide. Unlike continuous chlorination, shock chlorination is a one time treatment designed to kill bacteria in the well and water system. Shock chlorination is the preferred disinfection treatment for private well systems because it is simple, cheap and effective for most situations. The amount of chlorine used in well treatment is determined by the well's diameter and depth of water. A 200 ppm solution of chlorine in the well and plumbing system for a period of at least 2 hours is desired preferably overnight. While it is common for public water supply providers to use chlorine gas for disinfection, gaseous chlorine is considered too dangerous for private use. Private systems most often use liquid chlorine (sodium hypochlorite) or dry chlorine (calcium hypochlorine). Unless you are confident about safely performing shock chlorination yourself, contact a licensed water well contractor to perform the procedure.

However, in developing countries use of these expensive methods is limited mainly due to lack of funds. With more advances in low cost technologies these methods may rove promising and can be an alternative to chorine in disinfection of water [8, 14, 21, 25].

2.4 Alternative Approach to UV Disinfection

Physical methods of disinfection mainly includes:

Solar-Boiling: This is the very basic and simplest method of disinfection. Temperature of water is raised to its boiling point and maintained for 15-20 minutes to kill all the bacteria [16]. This method is suitable for household purpose or in case of epidemics. The germicidal action of sunlight has long been recognized, but the ecological implications and the potentials for practical applications have to be researched more thoroughly [27]. Accordingly, simple prototype units were designed, and their effectiveness in decontaminating water by exposure to sunlight was assessed. The advantages of this method are no taste and odour is produced and complete destruction of micro-organism. The limitations of this method are required more space and uniform solar radiation thought day.

Titanium dioxide films and sunlight method, the efficiency of solar disinfection by heterogeneous photo catalysis with sol-gel immobilized titanium dioxide films over glass cylinders. The advantages of this method are it is more efficient than solar water disinfection, inactivating total as well as fecal coliform and keep water free of coliform at least for seven days after sun irradiation. The limitations of this method are, it is costly and uniform solar radiations are required.

Ultrasonic Sound: Ultrasonic is effective for water disinfection [28]. In water purification, ultrasonic waves have been used to effect disintegration by cavitations. These waves themselves have no germicidal effect. Ultrasonic waves of frequency 400 KHz have been demonstrated to provide complete sterilization in 60 minutes. Very large reduction in bacterial number is observed within 2 seconds.

Activated Carbon: Activated carbon can also be used for sterilization of water. It works on the principle of adsorption. Adsorption involves the interphase accumulation of concentration of substance at the surface of solid-liquid. A water filter medium consisting of activated carbon and silver coated activated carbon disinfects water. Similarly water passing through column containing activated carbon fibers impregnated with silver releases silver ion for disinfection of water. It assures minimum residual silver in disinfected water [29, 30].

Free Dipoles: A short analysis of the contemporary techniques of water disinfection as well as of the effects arising from the magnetic treatment of water has been carried out. The experimental results of water disinfection in constant magnetic and electric fields are presented. The maximum disinfection efficiency exceeds 99%. A theoretical model is developed that describes the effects arising in water after its treatment by constant magnetic and electric fields on the basis of free dipoles. The anomalous properties of water are shown to be retained more than two hours after its treatment. It is rather important that the expenditure of energy in the techniques considered is virtually nil. The energy consumption in the magnetic (with permanent magnets) and electric treatment of water is virtually nil. Thus, this method, used particularly for water disinfection, offer substantial advantages over any reagent less techniques [15, 31].

3. New Approaches in the UV Disinfection

There are many UV disinfection technologies to the developing world. The technology of water and wastewater for further research and testing to be used for disinfection is required. Developing certain technologies is discussed below.

Pulsed UV Systems: Pulsed UV systems, alternating current is converted into direct current and stored in a compact. This energy is then released with a high speed control mechanism to produce intense radiation pulse.

Broad Based Pulse Xenon: These lamps emit radiation at different wavelengths. Although only a small portion of the total emissions if the lethal radiation wavelength, in these studies, due to the high emission intensity pulses produced by Xenon lamp shows that it is useful for water and wastewater disinfection.

Narrow Band Excimer: Close to monochromatic emissions on producing low pressure UV system is continuing research on a variety of lamp types. These lamps, corona discharge are used to generate high energy dimers (A gas mixture of a gas discharge laser such as an excimer or molecular fluorine laser is stabilized).

Ozone or Peroxide UV: To develop a more efficient disinfection system used in conjunction with UV ozone or hydrogen peroxide. Thus, generated hydroxyl radicals are not very potent and selective oxidants. In fact, micro-contaminants in waters contaminated groundwater are being used to oxidize the chemical that technology is a promising one for water and wastewater disinfection.

Micro-Grid UV: This unit consists of two tanks each containing at least 2 μm thickness of the porous metal grid. On both sides of the grill are located three low pressure mercury lamps (254 nm theoretically minimum dose 14.6 $mW.s/cm^2$) [11]. The system is designed to keep the micro-organisms in water over the first grid. The first cycle is used to adjust the UV dose. By mechanical means (with valves) flow in the first tank, then turned back and kept micro-organisms second tank is sent back to the washing process. Here the micro-organisms are kept until the UV dose is reached [32]. The total is sufficient to inactivate the micro-organisms that system 8000 $mW.s/cm^2$, it is stated that reach the UV dose [33, 34]. A major disadvantage of this type of reactor, the grid 2 μm is very small openings occur due to loss of incoming load.

Another area of use is the widespread use in recent years in obtaining drinking water and wastewater treatment plants. For this purpose commercial UV unit it has been developed. UV light can pass through the thin quartz tubes or centers around the UV lamp can be sterilized are reported clear water was passing filter. Thus the taste and without the addition of any chemicals, process water can be passed through unchanged.

UV radiation production requires a considerable amount of electricity. UV treatment systems must be designed for continuous disinfection it is important as precautionary against power outages or malfunctions. Dual power system or standby generator for continuous operation is required. Each low pressure UV lamps require approximately 100 W standby powers. Another precaution is to supply all the UV system from the same motor control center.

3.1 Differeantial UV Spectroscopy

Developing formal kinetic or statistical models for disinfection by-products formation require substantial cost and effort of analyzing for disinfection by-products as trihalomethanes. Several people have tried to relate water quality parameters to disinfection by-products formation in an effort to find a useful surrogate parameter to better understand the chemical nature of disinfection by-products formation process. Surrogate parameters that have been used to estimate the formation of disinfection by-products include UV absorbance, specific UV absorbance which is ultraviole absorbance divided by dissolved organic carbon concentration. Since the aromatic functional groups are thought to be both the dominant chromophores in natural organic matter and the dominant sites of attack by chlorine on some molecule, UV absorbance at 254 nm has frequently proposed to predict disinfection by-products precursors. However, the use of UV spectroscopy to estimate for formation disinfection by-products such as trihalomethanes is thought to be problematic by many researches [15, 35-38].

Therefore, the potential use of differential UV absorbance at a wavelength of 272 nm to monitor the formation of trihalomethanes in drinking water has been investigated. This method is an excellent and practical technique for monitoring instantaneous and continuous the formation of trihalomethanes online. The magnitude of decrease in UV absorbance at a wavelength of 272 nm is an excellent technique of disinfection by-products formation from resulting chlorination [39].

All of differential UV spectra for different water sources including natural organic matter have a peak at 272 nm. The other important feature is related to the intensity of differential UV spectra. The intensity of differential UV spectra grows with increasing of chlorine dose and reaction time. The differential UV absorbance at a wavelength of 272 nm technique is used not only detect chronophers destroyed by the chlorination reactions but also to monitor the amount of formation of chlorinated by-products like trihalomethane. The trihalomethane and differential UV absorbance at a wavelength of 272 nm correlations may have practical value since they provide an alternative approach for monitoring the formation of trihalomethane online, and further, differential UV absorbance at a wavelength of 272 nm can be determined in a short period of time, using a small volume of sample and does not require sophisticated sample pretreatment.

3.2 New Design to UV Disinfection

In this new design, the water passes through the quartz tube in the water flow is no obstacle, pharmaceutical and food industry in undesirable "dead legs" are destroyed. Water passes through a large diameter quartz tube, produced by UV lamps is located outside the quartz tube UV light disinfects the water. Device in "dead legs" at the end of the washing process is not periodically participate on the quartz tube can be removed easily and completely; after rinsing there will be no chemicals on the quartz tube. "New Design" UV water disinfection device differs from the usual to come from a single UV device is not only that of the UV quartz tube reactor [40].

The device is designed for a very special washes. If desired all kinds of devices acid/caustic and washed with 144 °C steam. Pharmaceutical, food and beverage after a long position in the private sector for this type of washing done, "New Design" to be resistant to such radical cleaning of the UV device in the desired properties. UV lamps are broken out of the water and replacement of lamps is very easy. The device is equipped with UV lamps that UV light at high dosages. Observing that the acts of the UV lamp are located very special sensors.

4. Conclusions

UV radiation inactivates organisms by absorption of the light which causes a photochemical reaction that alters molecular components essential to cell function. UV is a stronger disinfectant than chlorine and chloramines, and also has a wide spectrum of inactivation. The most important disadvantages of UV disinfection can be listed as follows: low dosage may not effectively inactivate some spores and cysts; some micro-organisms sometimes may repair and reverse the destructive effects of UV through a repair mechanism known as "photo reactivation", or in the absence of light known as "dark repair", turbidity and total suspended solids in waters can render UV disinfection ineffective by decreasing UV transmission and harboring pathogens; and the need to dose post disinfectant in drinking water treatment before distribution systems to decrease the risk of microbial regrowth since UV does not leave residual. UV disinfection is user friendly for operators; UV disinfection has a shorter contact time when compared with other disinfectants. UV disinfection equipment requires less space than other methods. Experience is available both in drinking water and wastewater treatment. A further disadvantage with UV disinfection is that unlike other forms of chemical treatment it does not leave a persistent residual in the treated water, which can lead to problems of regrowth of organisms in some circumstances.

Disinfection of surface water supplies containing natural organic matter with chlorine leads to formation of disinfection by-products such as trihalomethane and haloasetic acids. These halogenic compounds have adverse health effects on human begin. Epidemiological studies indicated that there is a possible link between disinfection by-products and development of cancer [18]. Concerns regarding the potential health effects of disinfection by-products prompted several industrialized countries to develop a number of regulations. These regulations should provide the safety of drinking water through the elemination, or reduction to minimum concentration of the hazardous substances in water.

On the other hand European Union regulated trihalomethane limit at a 100 µg/L. Moreover, Turkish Government recently regulated 150 µg/L trihalomethane limit in drinking water to comply with European Union regulations. The relationship among chlorination conditions, pH, temperature, reaction time, chlorine dosage, natural organic matter concentration and the formation of disinfection by-products are highly complex.

The methods discussed in this paper appear to be attractive methods of disinfection in certain specific situations.

However, they have disadvantages like cost and no residual effect. As such chlorine is looked upon as a universal choice in the past and the present. Technological advances and development have shown the drawback in using chlorine as disinfectant and necessity of alternative disinfectant. Nowadays ozone and UV radiation are used in developed countries.

UV disinfection equipment has special lamps emitting UV lights. When water flows through the UV disinfection equipment, micro-organisms in water are affected by the UV light and loose all functions. A well designed and with the right capacity of UV disinfection equipment provides a reliable water disinfection without producing any bad side effects. Disinfection only takes places during the passage of water through the UV reactor. In order to ensure that the requisite dose to effect inactivation of the targeted waterborne pathogens are delivered, the Guidance Manual recommends that all UV systems used for the disinfection of drinking water should possess third party validation certification. This validation should be based on bio dosimetric testing for the particular reactor from an independent third party testing facility undertaken in accordance with international standards and their validation protocols.

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Dr.Burhan Davarcioglu, Hacettepe University, Ankara-Turkey, Faculty of Engineering in 1978, enters as the Engineer graduated from the Physics. Nuclear Medicine Department in the years 1984-1985 at Hacettepe University, Radiation Physics and Radioisotope Laboratories has participated in the creation work. Works as a Research Fellow (1985-1993) at Gazi University, Institute of Science and Technology, Department of Physics, in 1987, "Solid-State Lasers" with his M.Sc. thesis, and in 1992, "Some Complex and Clathrates Infra-red Spectroscopy Investigation" of the named Ph.D. thesis completed. Faculty Member appointed as he took active part in the founding, Nigde University in 1994. Faculty of Arts and Sciences Department of Physics and Institute of Science and Technology the establishment of many administrative tasks found. Aksaray University, was appointed in April of 2007 to the relay. Since the year 2000, industrial raw materials quality and quantity of clay, by means of the spectroscopic identification of the work operates. Papers presented at the international level to the majority and the broadcast Dr.Davarcioglu's many references were made to run. The interest related to the study of various summer schools participated. Turkish National Committee on Clay Science is member and New York Academy of Sciences is an active member and also other important members. Reviewer in European Commission projects and many articles in international scientific journals are refereeing.