Ultraviolet (UV) Info Sheet and studies

In nature, the sun produces UV rays which have a germicidal effect on disease causing pathogens in water. When these contaminants are exposed to UV light, they are rendered harmless and the output water is considered disinfected.

Ultra Violet Sterilizing Water Purification & Water Filtration System --
Ultra-violet (UV) light kills disease-causing micro-organisms such as Ecoli with a 99.9% effectiveness. UV sterilization adds nothing to, and removes nothing from the water and is extremely cost effective by volume. UV Water Sterilization technology seeks to use the same process as nature to provide drinking water that is completely safe.

By exposing contaminated water to high intensity UV light, disease causing micro-organisms are rendered harmless and the water produced is safe, clean and fresh.
http://www.cetsolar.com/uvwaterm.htm

UV light is not only effective, but also very efficient. It can **disinfect water at about one-tenth the cost of other treatment** methods ... in part because the equipment is so small.

Ultraviolet rays have shorter wavelengths than visible light. A wavelength, the distance between the crests of two waves, is often measured in units called nanometers. A nanometer (nm) is a billionth of a meter, or about 1/25,000,000 inch. Wavelengths of visible light range from about 400 to 700 nm. Ultraviolet wavelengths range from about 1 to 400 nm and are beyond the range of visible light.

Ultraviolet rays with wavelengths shorter than 300 nm are extremely effective in killing microorganisms. The most effective sterilizing range for UV is within the C bandwidth (UVC). This range is called the germicidal bandwidth. UVC has been used in hospitals for decades to sterilize surgical instruments, water, and the air in operating rooms. Many food and drug companies use germicidal lamps to disinfect various types of products and their containers.

The cleansing mechanism of UV is a photochemical process. The contaminants that pollute the indoor environment are almost entirely based upon organic or carbon-based compounds. These compounds breakdown when exposed to high intensity UV at 240 to 280 nm. Short-wave ultraviolet light can destroy DNA in living microorganisms and breakdown organic material found in indoor air. UVC's effectiveness is directly related to intensity and exposure time.

UV rays must strike the contaminants directly in order to penetrate the microorganism and breakdown its molecular bonds. This bond breakage translates into cellular or genetic damage with the germs rendered harmless by robbing them of the ability to reproduce.

UV Health Facts

Why is UV-B harmful while UV-C (germicidal UV) is not? - The difference has to do with the ability of UV rays to penetrate body surfaces. UVC has an extremely low penetrating ability. It is nearly completely absorbed by the outer, dead layer of the skin (stratum corneum) where it does little harm. It does reach the most superficial layer of the eye where overexposure can cause irritation, but it does not penetrate to the top of the lens of the eye and can not cause cataracts. UVC is completely stopped by the ordinary eye glasses and by ordinary clothing.

How much UV exposure is considered safe? The National Institute for Occupational Safety and Health (NIOSH) has established safe exposure levels for each type of UV. These safe exposure limits are set below the levels found to cause eye irritation, eye being the body part most sensitive to UV. For germicidal UV (253.7nm) the exposure limit is less than 0.2µW/cm² over 8 hours.

How can people be certain they are not overexposed to UV? When upper room UV is first installed it must be checked with a sensitive UV meter to make sure reflected UV is less than 0.2µW/cm² at eye level. UV air cleaners must be installed well above eye level - usually 7 feet above the floor. UV tubes (lamps) within the air cleaners should not be directly visible from within 30 feet. Safety is assured if UV measurements at eye level meet NIOSH standards.

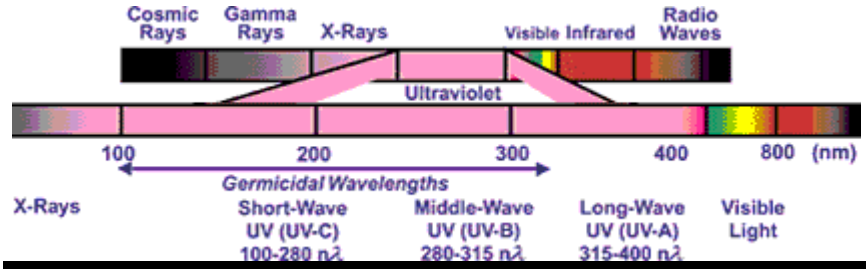
What are the symptoms and signs of UV overexposure? UV overexposure causes an eye inflammatory condition known as photokeratitis. For 6 to 12 hours after an accidental overexposure the individual may feel nothing unusual, followed by the abrupt sensation of foreign body or "sand" in the eyes, redness of the skin around the eyes, some light sensitivity, tearing, and eye pain. The acute symptoms last 6 to 24 hours and resolve completely without long-term effects. Overexposure of the skin resembles sunburn but does not result in tanning.

What precautions are needed with overhead germicidal UV? Fixtures must be turned OFF when cleaning, inspecting or changing the lamps. Persons hypersensitive to sunlight may need to wear protective glasses, clothing or use sunscreen on exposed skin. No special protection is needed for most people.

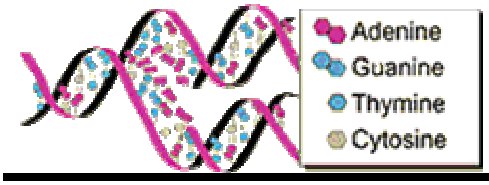
Ultraviolet light is used extensively in purified water and water for injection water systems to prevent microbiological contamination and growth. UV is also used for residual ozone destruction in pure water loops where ozone is employed as a "system sanitizer" to purify pipe and tank surfaces.

An important area of use of ultraviolet technology is in the production of purified water for Semiconductors. Hydrocarbon compounds (TOC) in water can be reduced by a combination of using ultraviolet light with a 185 nm wavelength and other processes. This particularly high degree of purity is essential in the electronics industry and specifically manufacturing of semiconductors.
http://www.americanairandwater.com/uv-water-applications.htm

What is ultraviolet?
Ultraviolet light is part of the light spectrum, which is classified into three wavelength ranges:
- UV-C, from 100 nanometers (nm) to 280 nm
- UV-B, from 280 nm to 315 nm
- UV-A, from 315 nm to 400 nm



What is germicidal ultraviolet?
UV-C light is germicidal - i.e., it deactivates the DNA of bacteria, viruses and other pathogens and thus destroys their ability to multiply and cause disease. Specifically, UV-C light causes damage to the nucleic acid of microorganisms by forming covalent bonds between certain adjacent bases in the DNA. The formation of such bonds prevent the DNA from being unzipped for replication, and the organism is unable to reproduce. In fact, when the organism tries to replicate, it dies.



What are the beneficial uses of germicidal uv?
Ultraviolet technology is a non-chemical approach to disinfection. In this method of disinfection, nothing is added which makes this process simple, inexpensive and requires very low maintenance. Ultraviolet purifiers utilize germicidal lamps that are designed and calculated to produce a certain dosage of ultraviolet (usually at least 16,000 microwatt seconds per square centimeter but many units actually have a much higher dosage.) The principle of design is based on a product of time and intensity - you must have a certain amount of both for a successful design.

Here are just a few of the applications...

Drinking Water
- under sink installs & water vending machines
- aircraft, boats & recreational vehicles
- water wells & water cisterns
- swimming pool & hot tubs
- farms, ranches & trailer parks
- schools & hotels
- aquarium, hatcheries and nurseries
- ice making

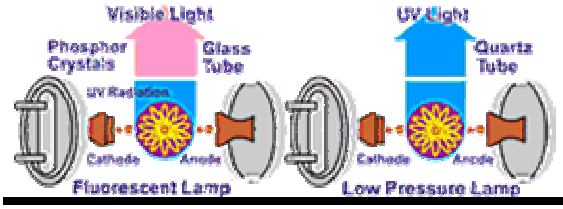
Food Processing
- brewery & winery
- soft drinks, fruit drinks and juices
- bottling facilities
- diary processing
- liquid sugars, sweeteners and edible oils
- water based lubricants
- pure wash water

Medical
- pharmaceutical production
- laboratories, hospitals and clinics
- maternity labor and delivery areas
- pathology labs, kidney dialysis
- animal husbandry

Industries
- cosmetics and electronic production
- pond & lake reclamation
- laundry water

How do ultraviolet purifiers work?
Atlantic Ultraviolet Corporation's purifier units contain one or more germicidal ultraviolet lamps. The **Ster-L-Ray™** germicidal lamp produced by Atlantic Ultraviolet Corporation is a short wave low pressure mercury vapor tubes that produces ultraviolet wavelengths that are lethal to micro-organisms. Approximately 95% of the ultraviolet energy emitted is at the mercury resonance line of

254 nanometers. This wavelength is in the region of maximum germicidal effectiveness and is highly lethal to virus, bacteria and mold spores. Therefore, the water or air that passes through the chamber is exposed to the germicidal uv light and the genetic material of the micro-organism is deactivated, which prevents them from reproducing and renders them harmless.



http://ultraviolet.com/whatis.htm

What microorganisms are deactivated by germicidal ultraviolet light?			
Bacteria	**UV Dose**	**Bacteria**	**UV Dose**
Agrobacterium lumefaciens 5	8,500	*Pseudomonas aeruginosa* (Environ.Strain) 1,2,3,4,5,9	10,500
Bacillus anthracis 1,4,5,7,9 (anthrax veg.)	8,700	*Pseudomonas aeruginosa* (Lab. Strain) 5,7	3,900
Bacillus anthracis Spores (anthrax spores)*	46,200	*Pseudomonas fluorescens* 4,9	6,600
Bacillus megatherium Sp. (veg) 4,5,9	2,500	*Rhodospirillum rubrum* 5	6,200
Bacillus megatherium Sp. (spores) 4,9	5,200	*Salmonella enteritidis* 3,4,5,9	7,600
Bacillus paratyphosus 4,9	6,100	*Salmonella paratyphi* (Enteric Fever) 5,7	6,100
Bacillus subtilis 3,4,5,6,9	11,000	*Salmonella Species* 4,7,9	15,200
Bacillus subtilis Spores 2,3,4,6,9	22,000	*Salmonella typhimurium* 4,5,9	15,200
Clostridium tetani	23,100	*Salmonella typhi* (Typhoid Fever) 7	7,000
Clostridium botulinum	11,200	Salmonella	10,500
Corynebacterium diphtheriae 1,4,5,7,8,9	6,500	*Sarcina lutea* 1,4,5,6,9	26,400
Dysentery bacilli 3,4,7,9	4,200	*Serratia marcescens* 1,4,6,9	6,160
Eberthella typhosa 1,4,9	4,100	*Shigella dysenteriae* - Dysentery 1,5,7,9	4,200
Escherichia coli 1,2,3,4,9	6,600	*Shigella flexneri* - Dysentery 5,7	3,400
Legionella bozemanii 5	3,500	*Shigella paradysenteriae* 4,9	3,400
Legionella dumoffill 5	5,500	*Shigella sonnei* 5	7,000
Legionella gormanil 5	4,900	*Spirillum rubrum* 1,4,6,9	6,160
Legionella micdadei 5	3,100	*Staphylococcus albus* 1,6,9	5,720
Legionella longbeachae 5	2,900	*Staphylococcus aureus* 3,4,6,9	6,600
Legionella pneumophila (Legionnaire's Disease)	12,300	*Staphylococcus epidermidis* 5,7	5,800
Leptospira canicola-Infectious Jaundice 1,9	6,000	*Streptococcus faecaila* 5,7,8	10,000
Leptospira interrogans 1,5,9	6,000	*Streptococcus hemolyticus* 1,3,4,5,6,9	5,500
Micrococcus candidus 4,9	12,300	*Streptococcus lactis* 1,3,4,5,6	8,800
Micrococcus sphaeroides 1,4,6,9	15,400	*Streptococcus pyrogenes*	4,200
Mycobacterium tuberculosis 1,3,4,5,7,8,9	10,000	*Streptococcus salivarius*	4,200
Neisseria catarrhalis 1,4,5,9	8,500	*Streptococcus viridans* 3,4,5,9	3,800
Phytomonas tumefaciens 1,4,9	8,500	*Vibrio comma* (Cholera) 3,7	6,500
Proteus vulgaris 1,4,5,9	6,600	*Vibrio cholerae* 1,5,8,9	6,500
Molds	**UV Dose**	**Molds**	**UV Dose**
Aspergillus amstelodami	77,000	*Oospora lactis* 1,3,4,6,9	11,000
Aspergillus flavus 1,4,5,6,9	99,000	*Penicillium chrysogenum*	56,000
Aspergillus glaucus 4,5,6,9	88,000	*Penicillium digitatum* 4,5,6,9	88,000
Aspergillus niger (breed mold) 2,3,4,5,6,9	330,000	*Penicillium expansum* 1,4,5,6,9	22,000
Mucor mucedo	77,000	*Penicillium roqueforti* 1,2,3,4,5,6	26,400
Mucor racemosus (A & B) 1,3,4,6,9	35,200	*Rhizopus nigricans* (cheese mold) 3,4,5,6,9	220,000

Protozoa	UV Dose	Protozoa	UV Dose
Chlorella vulgaris (algae) 1,2,3,4,5,9	22,000	*Giardia lamblia* (cysts) 3	100,000
Blue-green Algae	420,000	Nematode Eggs 6	40,000
E. hystolytica	84,000	Paramecium 1,2,3,4,5,6,9	200,000
Virus	**UV Dose**	**Virus**	**UV Dose**
Adeno Virus Type III 3	4,500	Influenza 1,2,3,4,5,7,9	6,600
Bacteriophage 1,3,4,5,6,9	6,600	Rotavirus 5	24,000
Coxsackie	6,300	Tobacco Mosaic 2,4,5,6,9	440,000
Infectious Hepatitis 1,5,7,9	8,000		
Yeasts	**UV Dose**	**Yeasts**	**UV Dose**
Baker's Yeast 1,3,4,5,6,7,9	8,800	*Saccharomyces cerevisiae* 4,6,9	13,200
Brewer's Yeast 1,2,3,4,5,6,9	6,600	*Saccharomyces ellipsoideus* 4,5,6,9	13,200
Common Yeast Cake 1,4,5,6,9	13,200	*Saccharomyces sp.* 2,3,4,5,6,9	17,600

1. "The Use of Ultraviolet Light for Microbial Control", Ultrapure Water, April 1989.
2. William V. Collentro, "Treatment of Water with Ultraviolet Light - Part I", Ultrapure Water, July/August 1986.
3. James E. Cruver, Ph.D., "Spotlight on Ultraviolet Disinfection", Water Technology, June 1984.
4. Dr. Robert W. Legan, "Alternative Disinfection Methods-A Comparison of UV and Ozone", Industrial Water Engineering, Mar/Apr 1982.
5. Unknown
6. Rudolph Nagy, Research Report BL-R-6-1059-3023-1, Westinghouse Electric Corporation.
7. Myron Lupal, "UV Offers Reliable Disinfection", Water Conditioning & Purification, November 1993.
8. John Treij, “Ultraviolet Technology”, Water Conditioning & Purification, December 1995.9. Bak Srikanth, “The Basic Benefits of Ultraviolet Technology”, Water Conditioning & Purification, December 1995
* Approximate - Various sources may report different inactivation dosages.

http://www.todayshealthyhome.com/germicidal.htm

Hospitals use UV light as an adjunct to their normal sterilization procedures. It just makes sense to do all you can to kill germs in a hospital.

When it comes to water purification and water treatment, UV light kills many more microbes than chlorination. The hepatitis virus can survive swimming around in chlorinated water for a considerable time, but is quickly wiped out by UV Light.
http://www.mnwelldir.org/docs/uv_light/uv_light2.htm