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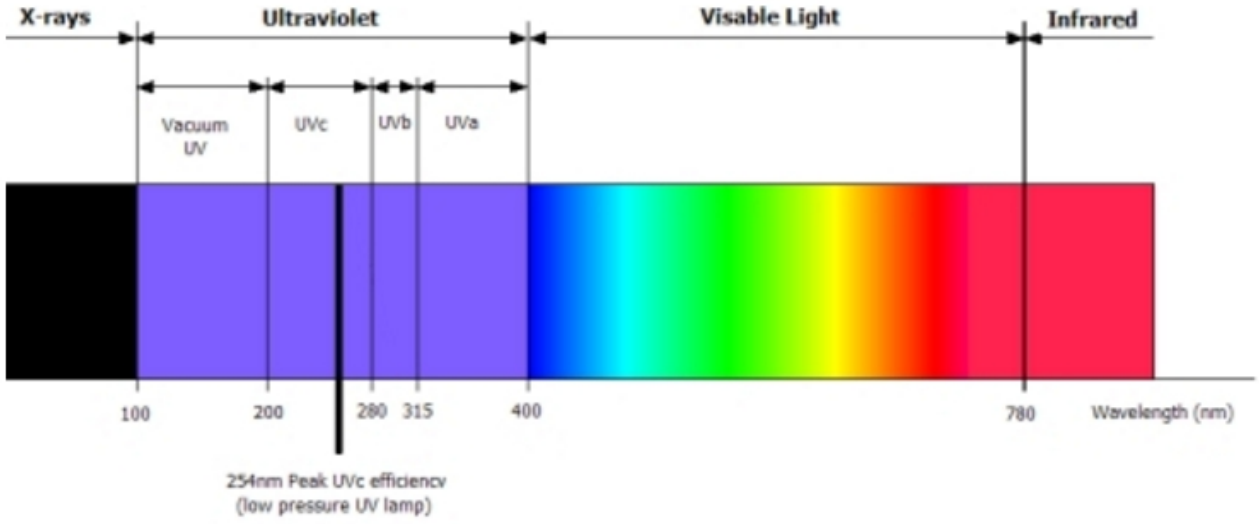
Ultraviolet Sterilisation

Information Sheet 3

Ultraviolet disinfection is used extensively in water purification to control bacteria and other pathogens .

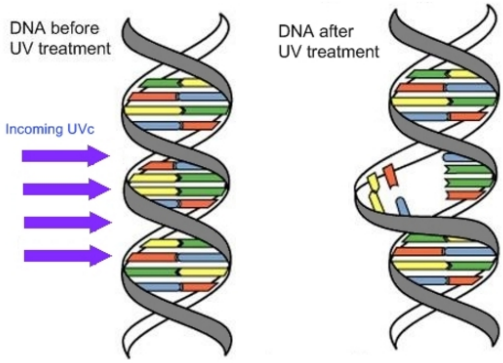
How does UV work?

Ultraviolet or UV energy is found in the electromagnetic spectrum between visible light and X-rays and is not visible to the naked eye. It is part of the sun's light that is responsible to some extent for the natural sterilisation of surface water on the earth.



In order to eliminate pathogens, the UV rays must actually strike the individual cells with a minimum intensity depending on the particular microorganisms . UV energy penetrates the outer cell membrane, passes through the cell body and disrupts its DNA preventing reproduction.

UV treatment does not alter water chemically; nothing is being added except energy which is ultimately dispersed as heat.



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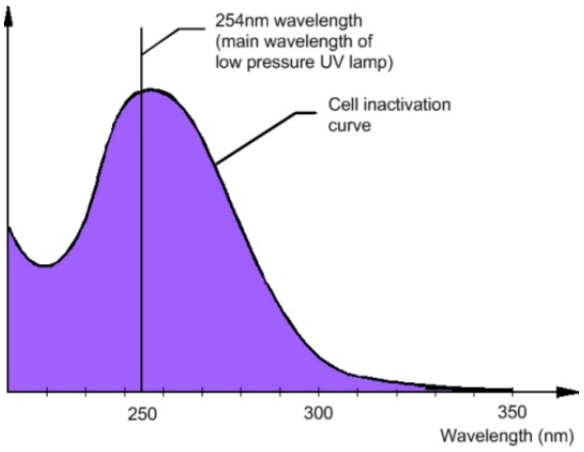

UV units for water treatment

Special low-pressure mercury vapour lamps produce ultraviolet radiation at 254 nm, the optimal wavelength for disinfection and ozone destruction.

The UV lamp never contacts the water; it is either housed in a quartz glass sleeve inside the water chamber or mounted external to the water which flows through UV transparent Teflon tubes. Some ultrapure water systems use 185 nm UV units for reducing TOC (total organic carbon).

UV Dose

The degree of disinfection by ultraviolet radiation is directly related to the UV dose applied to the water. The dosage, a product of UV light intensity and exposure time, is measured in microwatt second per square centimetre (µws/cm²), millijoule per square centimetre (mJ/cm²) or Joules per square metre (J/m²).

UV Dose = Retention Time x Intensity

Where: Retention time is determined by flowrate and reactor volume

and Intensity is determined by the lamp output, lamp age, quartz sleeve transmissivity (coating) and water quality (UV transmittance).

The attached Ultraviolet Dosage Table table lists dosage requirements to destroy common microorganisms.

Most UV units are designed to provide a dosage greater than 30mJ/cm² after one year of continuous operation.

Lamp Replacement

UV lamps should be replaced regularly and not left to burn out. The UVc wavelength reduces with use and after 1 year is likely to fall below the necessary dose. All of our systems are sized to achieve the desired intensity or dose at the end of 12 months when the lamp should be replaced.

The UVc light wavelength is invisible to the naked eye. The blue/violet light that comes from the UV lamp does not necessarily mean that the UV lamp is still destroying bacteria.

PLEASE NOTE: UVc light is dangerous, do not, under any circumstances look directly at the UV lamp.

Monitoring Performance

Our systems can be fitted with a UV intensity monitors, which can be configured to activate an alarm or a remote signal if the UV level drops below a pre determined value (i.e. if the lamps are nearing their the end of their lifetime, or if the water clarity has dropped in the chamber).

Water should also, ideally be sampled and tested for bacteria counts regularly.

Cleaning

As water passes through the UV unit, minerals, debris and other material in the water can deposit on the quartz glass sleeve. This will limit the penetration of UV rays through the sleeve and into the water.

To maintain high clarity, the glass around the lamp must be cleaned regularly. Cleaning frequency depends on the water quality.

Penstar DaRo UV SYSTEMS LTD WRAS

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Ultraviolet Dosage Table

Doses of UV (at 254nm) in mWsec/cm² (mJ/cm²) required for the inactivation of 90%

Organisms	Dose	Yeasts	Dose
Bacterium coli in water	5.4	Bakers yeast	3.9
Bacillus anthracis	4.52	Brewers yeast	3.3
S. enteritidis	4	Common yeast cake	6
B.megatherium (veg)	1.13	Saccharomyces ellipsoideus	6
B.megatherium (spores)	2.73	Saccharomyces sp.	8
B. parathyphosous	3.2	Saccharomyces cerevisiae	6
B. subtilis	7.1	Torula sphaerica (found in milk & cheese)	2.3
B. subtilis (spores)	12		
Corynebact, diphteriae	3.37	**Various algae**	
Eberthella typhosa	2.14	Diatoms, Blue algae, Green algae	360 - 600
Escherichian coli	3		
Micrococcus candidus	6.05	**Protozoa**	
Legionella pneumophila (Legionnaires disease)	3.8	Paramecium	64 - 100
Micrococcus piltonencis	8.1	**Mould spores**	
Micrococcus sphaeroides	10	Aspergillus amstelodami (meat)	66.7
Neisseria catarrhalis	4.4	Aspergillus flavus	60
Phytomonas tumefaciens	4.4	Aspergillus glaucus	44
Proteus vulgaris	2.64	Aspergillus niger (bakeries)	132
Pseudomanas aeruginosa	5.5	Cladosporium herbarum(cold stores)	60
Pseudomanas fluorescens	3.5	Mucor mucedo(meat, fat, bread, cheese)	65
S. typhimurium	8	Mucor racemodus A	17
Sarcina luta	19.7	Mucor racemodus B	17
Serratia marcescens	2.4	Oospara lactis	5
Dysentry bacilli	2.2	Penicillium digitatum	44
Shigella paradyscenteriae	1.68	Penicillium expansum	13
Spirillum rubrum	4.4	Penicillium chrysogenum (fruit)	50
Staphylococcus albus	1.84	Penicillium roqueforti	13
Staphylococcus aureus	2.6	Rhizopus nigricans	111
Streptococcus hemolytics	2.16	Scopulariopsis brevicaulis(cheese, etc.)	80
Streptococcus lactis	6.15		
Streptococcus viridans	2	**Viruses**	
Tubercle bacillus	10	Most viruses are inactivated by doses of UVC at 254nm of between 1.0-10.0 mWsec/cm²	