

Ultraviolet Technology

How Does Ultraviolet Work?

Strong sunlight purifies by permanently inactivating bacteria, viruses, moulds and spores. Almost a century ago, scientists identified the part of the spectrum, which is responsible for this well-known effect: wavelengths of 240 - 280 nm, primarily in the UV-C spectrum.

Such energy can now be produced commercially by electrical discharge devices and UV technology has been harnessed for a range of applications from disinfection to oxidising organics.

Hanovia UV systems generate the same ultraviolet germicidal rays as sunshine, but hundreds of times stronger. No bacteria, viruses, moulds or their spores can withstand this treatment.

How is UV light generated?

The UV Arc Tube, a quartz tube similar to a fluorescent strip light, is filled with an inert gas, which provides the initial discharge and the means of exciting the minute amount of mercury present. A Low Pressure glow discharge produces a line spectrum at 185.0 and 253.7 nm.

As the current is increased, the Arc Tube heats up rapidly; the pressure increases and produces the typical Medium Pressure spectrum shown in fig 1. It is a complex combination of spectral lines, continuum and absorption lines. Fig 1 shows:

- ▶ the position of UV-C in the electromagnetic spectrum
- ▶ the UV absorption curve of DNA
- ▶ the outputs of Low and Medium Pressure electrical discharge lamps and arc tubes

Fig 1. also compares the spectrum from the Medium Pressure Arc Tube with the germicidal effectiveness curve, and shows that the Arc Tube produces a powerful bactericidal dose of UV across the desired waveband. Hanovia offers both Low and Medium Pressure technology and will advise which is appropriate according to the application.

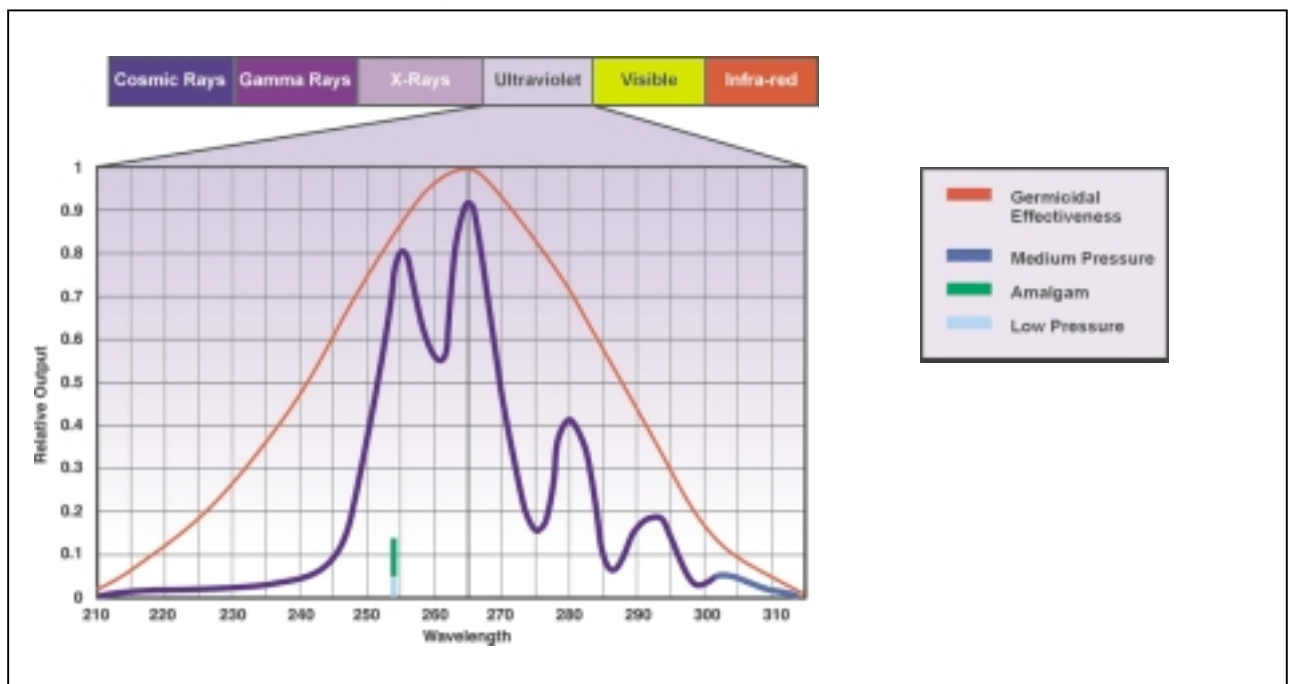
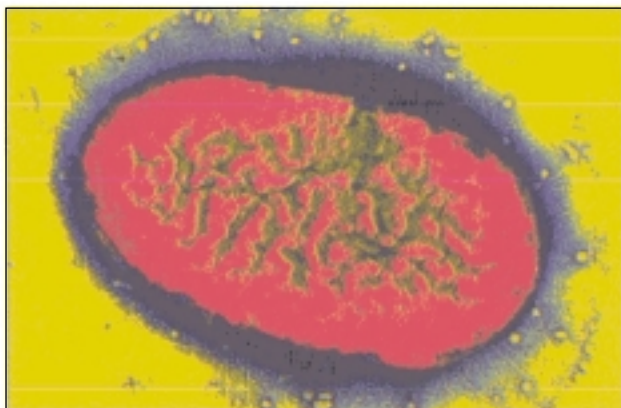


Fig 1

UV Disinfection and its Applications

When a cell is subject to germicidal UV, these processes occur:

- ▶ UV penetrates the cell wall
- ▶ High energy photons of UV are absorbed by cell proteins and DNA
- ▶ UV damages protein structure causing metabolic disruption
- ▶ DNA is chemically altered so organisms can no longer reproduce
- ▶ Organisms unable to metabolise and reproduce cannot cause disease or spoilage



The D10 Concept

The D_{10} value of any micro-organism is defined as the UV dose necessary to effect a 90% reduction. The relationship between dose and kill rate is logarithmic as shown in table 1.

Examples of other D_{10} values are shown in table 2.

Table 1: D_{10} for E coli, major water borne pathogen

Dose in mJ/cm^2	Reduction in number of viable organisms
5.4	90%
10.8	99%
16.2	99.9%
21.6	99.99%

Species D_{10} in mJ/cm^2	
Streptococcus viridians	2.0
Legionella pneumophila	2.0
Staphylococcus aureus	2.6
Listeria monocytogenes	3.4
Pseudomonas aeruginosa	5.5
Salmonella enteritidis	7.6
Bacillus subtilis (spores)	12.0
Polio virus	6.5
Saccharomyces carlsbergensis	10.0
Pichia anomola	35.0
Mucor mucedo	17.0
Penicillium digitatum	44.0
Aspergillus niger	130.0

Different industries have a different dose requirement depending on the contaminating microorganism present. For example pharmaceutical industries require a dose of $32 \text{ mJ}/\text{cm}^2$ for their process water while the brewing industry require $50\text{-}60 \text{ mJ}/\text{cm}^2$ to control wild yeast.

UV Dose & Sizing

UV Dose = Intensity x Time (mJ/cm^2)

The Intensity is determined by the UV Arc Tube power and Time by the period of exposure to UV. Hanovia will recommend the appropriate UV dose for each application, taking into account Arc Tube ageing, fluid transmission characteristics, and the temperature correction applicable to the UV output where Low Pressure Arc Tubes are used.

Disinfection Applications of UV

Liquids

- ▶ Drinking Water - mains or private supply
- ▶ Effluent, re-use and irrigation water
- ▶ Product and process water
- ▶ Syrups, brines, whey and starch
- ▶ Aquaculture and hydroponics
- ▶ Swimming pools and spas
- ▶ Ballast water disinfection

Air

- ▶ Tank Space
- ▶ Aseptic rooms
- ▶ Offices and hospitals
- ▶ Air conditioning systems
- ▶ Positive pressure environments
- ▶ Indoor air quality enhancements

Surfaces

- ▶ Food products
- ▶ Conveyors
- ▶ Extended Shelf life packaging
- ▶ High risk/low risk transfer

Recent Developments in UV

Disinfection is just one example of a broad range of photo-chemical effects of UV, and Hanovia has led developments for other uses of UV in industrial applications.

Just as UV damages DNA in living organisms, it also effects many other chemical bonds. Different bonds are effected at different UV wavelengths.

The chemical effects of UV include:

- ▶ Emission of high energy photons which break molecular bonds
- ▶ Conversion of non-ionic organic molecules to charged species making them susceptible to ion exchange removal
- ▶ Production of Hydroxyl (-OH) radicals which oxidise certain molecular bonds causing photochemical breakdown

The process of breaking chemical bonds with UV is called Photolysis.



Photolysis Applications of UV

- ▶ Chloramine destruction in swimming pools
- ▶ Destruction of residual ozone after disinfection and sanitation (deozonation)
- ▶ Reduction in residual chlorine from earlier treatment (dechlorination)
- ▶ Destruction of pesticides in the water supply
- ▶ Removal of NDMA and MTBE
- ▶ Odour control
- ▶ Production of Ultra-pure water for the electronics and semiconductor industry
- ▶ Total Organic Carbon (TOC) reduction

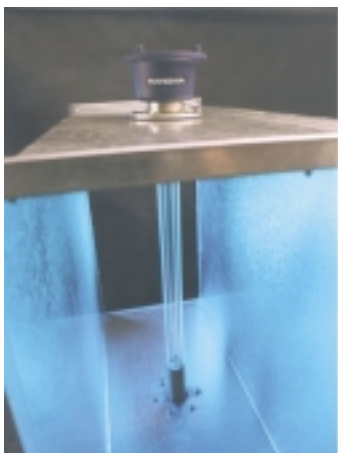
Why Choose Hanovia?

World Leader

- ▶ Hanovia is the World Leader in UV technology with over 80 years experience
- ▶ Complete service and total design capability
- ▶ All UV technologies available from a single supplier

Arc Tubes

- ▶ Hanovia is the only UV systems company which manufactures its own Medium Pressure arc tubes and UV monitors enabling it to offer the full range of appropriate technology:
- ▶ Medium pressure Arc Tube (high UV intensity, temperature independent)
- ▶ Low pressure Arc Tube (cold running with low power consumption)
- ▶ All Hanovia systems and Arc Tubes built to highest possible standards
- ▶ Every Arc Tube individually checked and each completed system tested and run before despatch
- ▶ Test certificates always supplied



Service

- ▶ Hanovia UV systems are readily available through selected distributors in all parts of the world
- ▶ Highly trained sales and service staff select and commission the best plant

Further information

A full range of fact files is available from Hanovia for all applications of UV. Please contact your Hanovia representative.

The Hanovia System



THE PHOTON CONTROL

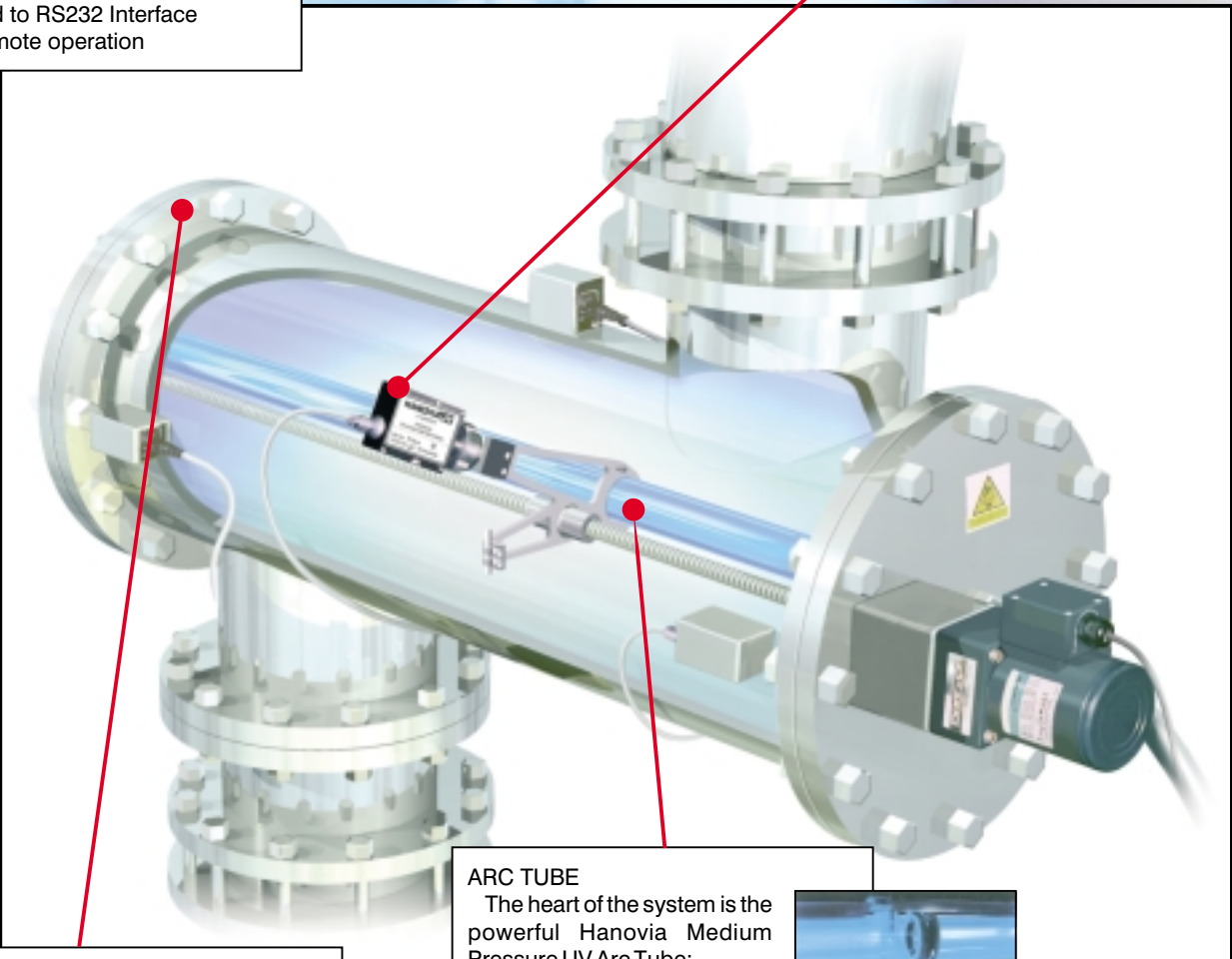
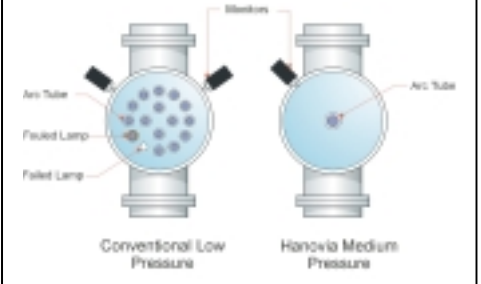
The Photon control system from Hanovia is a revolutionary new microprocessor-driven control module offering:

- ▶ Full traceability
- ▶ Data logging - up to 12 months
- ▶ A menu-driven interface
- ▶ Real time display of performance parameters
- ▶ Download to RS232 Interface
- ▶ Local/Remote operation

THE MONITOR

Provides continuous output measurement of each UV lamp in treatment chamber and keeps system running at maximum efficiency. With any change in process conditions, the system can be designed to:

- ▶ Initiate a local or remote alarm
- ▶ Switch to stand-by unit
- ▶ Close a valve
- ▶ Shut down



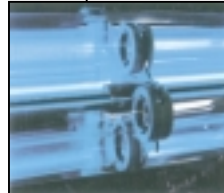
THE TREATMENT CHAMBER

- ▶ Capacity up to 1,500m³ per hour for Photon chamber (above) or 3150m³ per hour for Crossflow municipal range
- ▶ Interior mirror finish to highest standards (optional)
- ▶ 316L stainless steel construction
- ▶ Quartz sleeve, mounted axially, houses Arc Tube and permits replacement without interrupting flow
- ▶ Automatic wiper maintains disinfection efficiency, even for poor quality fluids
- ▶ Optimum hydraulic design for uniform treatment
- ▶ Dose models independently validated with bioassay testing worldwide

ARC TUBE

The heart of the system is the powerful Hanovia Medium Pressure UV Arc Tube:

- ▶ Developed and manufactured specifically for disinfection applications
- ▶ Medium Pressure Arc Tubes maintain effectiveness regardless of the water temperature (Low Pressure Arc Tubes have a restricted temperature range)
- ▶ Large volumes (up to 1,500m³/hour) can be treated with a single Photon system
- ▶ Single or multiple Arc Tubes per chamber



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