1 INTRODUCTION TO UV THEORY

1.1 Overview of UV Swift™SC

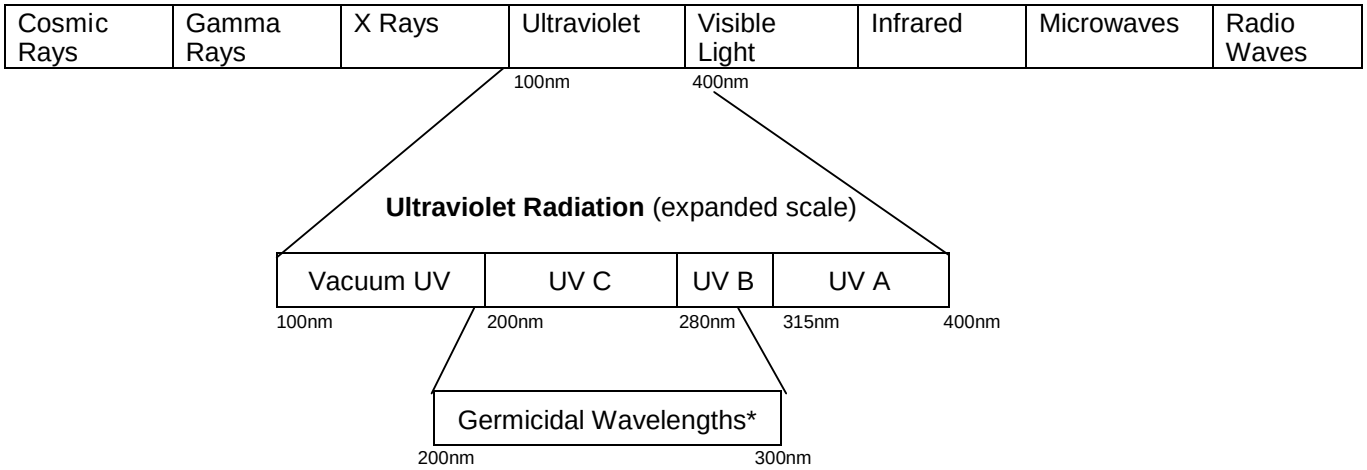
The TrojanUVSwift™SC uses ultraviolet light to disinfect drinking water and process water. The simple effective design makes it suitable for many large scale applications in water treatment. Unlike chemical disinfection, UV does not require the handling of dangerous substances and adds no toxic compounds to the water. The UVSwift™SC sealed and pressurized reactor chamber allows a high volume of water flow to be disinfected. It is a closed system that prevents outside particles from contaminating the treated water. The modular design of the UVSwift™SC makes it versatile and permits easy access to the equipment.

1.2 What Is Ultraviolet Light?

UV light is defined as electromagnetic radiation having a wavelength less than that of visible light (400 nm) and greater than that of X-Rays (100 nm). The unit of wavelength used is a nanometer (nm) equal to 10^{-9} meters. The optimum UV wavelength for germicidal effect is 265 nm, which is found only in small amounts in solar radiation because energy at these wavelengths is absorbed by the atmosphere.

The primary source of UV energy in current technology is a special short wave arc lamp (like the ones supplied with your system). The primary reason for its use is that a significant amount of its UV energy output is near the wavelength of 265 nm. This radiation is generated by striking an electric arc through a metallic compound vapor. Discharge of the energy generated by excitation of the metallic molecules results in the emission of the UV light.

Electromagnetic Spectrum



*Peak effectiveness approximately 260-265nm

1.3 Disinfection vs. Sterilization

Sterilization implies the total elimination of pathogens or disease carrying microorganisms.

In contrast, disinfection is a reduction in the concentration of pathogens to non-infectious levels.

1.4 Applications of UV Light

Ozone Destruction: Ozone is typically used in high purity water systems to oxidize trace chemicals and to disinfect stored water. Often ozone cannot be tolerated in the final product water and therefore any residual must be removed. 254 nm UV energy is absorbed by ozone, causing it to break down into dissolved oxygen.

TOC Reduction: In high purity water systems, UV is often used in conjunction with ion exchange equipment for the reduction of trace organics, referred to as TOC (Total Oxydizable Carbon). High-energy UV lamps, emitting UV energy below 200 nm, are used to trigger the photolysis of water, producing very powerful hydroxyl free radicals (OH). These hydroxyl free radicals attack organic compounds, breaking them down into carbon dioxide and water when fully oxidized. Some organic materials are broken down into weakly ionised acid-based groups which are then easily removed by polishing mixed bed ion exchange equipment.

Disinfection: The most common application of UV light is disinfection. 254 nm UV energy penetrates the cell membrane of micro organisms and alters the genetic material of the cell (DNA) destroying its ability to reproduce. In this application, UV is commonly used as an alternate disinfectant to chlorine and other chemical oxidants and also as a protection for other technologies in a complete water treatment system.

1.5 Factors Affecting UV Disinfection

Ultraviolet light kills bacteria, protozoa and viruses, by destroying their genetic material.

The performance of a UVSwift™SC to disinfect water is expressed in terms of reduction of bacteria, or "kill". Each system is designed to reduce microorganism counts to a certain allowable level, which depends on the requirements of the specific application or regulatory requirements. The dose of UV light available to kill bacteria is measured in Watts / meter^2, which is equivalent to the product of the light intensity and the duration of exposure, or retention time. Any factor that affects light intensity or retention time will affect performance.

$$\text{Dose} = \text{Intensity } (W/m^2) \times \text{Retention Time (sec)}$$

The UVSwift™SC is designed to deliver a dose that takes into account lamp aging.

Factors Affecting Performance			
DOSE =	**INTENSITY**(W/m^2)	**X**	**RETENTION TIME**(sec)
	Water Quality • UV Transmittance • Suspended Solids • Level of Dissolved Organics • Total Hardness Lamp Condition • Sleeve Cleanliness • Aging Treatment Process		Flow Rate

UV Transmittance:

UV transmittance is defined as the percentage of UV light at 254 nm not absorbed after passing through 1 cm of water sample. Transmittance depends on dissolved and suspended matter in the water. Reduced transmittance lowers the intensity of the light in the water, thus requiring longer exposure time in order to deliver the proper UV dose. The visual clarity of a water sample is not always a good indicator of its UV transmittance since water that is clear to visible light may absorb invisible ultraviolet wavelengths.

Note:	*There is NO correlation between turbidity and UV Transmittance.*

Suspended Solids:

Suspended solids consist of any filterable particle in the water and are measured in parts per million (ppm) or (mg/l). They lower UV transmittance by scattering and absorbing the light. They can also reduce kill by protecting bacteria from exposure to the UV light.

Level of Total Dissolved Solids:

Specific organic compounds in the process water will absorb some energy, which is emitted in the germicidal wavelength region of the spectrum.

Total Hardness:

The presence of high levels of inorganic magnesium or calcium carbonates in a water stream may contribute to coating of the quartz sleeve.

Sleeve Cleanliness:

To ensure maximum performance from the unit, it is essential that the quartz sleeves be kept clean. If a coating is allowed to build up on the sleeves, the amount of the UV light transmitted to the water will be reduced.

Treatment Process:

Water processing equipment located upstream of the UVSwift™SC such as filters, can affect performance. Different treatment processes produce water with different UV transmittance characteristics and different observed cleaning frequency patterns.

Flow Rate:

The flow rate through the UVSwift™SC will determine the retention time, which in turn determines the delivered UV dose at a given UV intensity.