Atlantium
Illuminating Water Technologies

The Essential Guide to Purchasing UV Systems

How to Achieve Biosecurity in Aquaculture Operations

1. Introduction

There is a wide variety of UV systems in the market, offering a wide range of prices and qualities. However, little or no information is available on how to select the most suitable system, and potential users are often misinformed by misleading facts and prejudices.

This quick guide will lead you through the essential questions for purchasing the right UV system for your Aquaculture facility.

Throughout the guide you will find two types of textbox:

Did you know?

The "**Did you know?**" textbox provides additional useful information regarding a certain topic that is related to the question asked in the section.

Warning

The "**Warning**" textbox highlights points of potential failures or common misconceptions that are related to the question asked in the section.

We hope you enjoy this guide and find it useful.

For additional questions and information, please contact us at: info@atlantium.com

2. Getting Started

The first step in defining the UV system for your facility is the following four basic questions.

2.1. What is the purpose of the UV system?

This question will help you define the required UV dose for the UV system.

- Do you need a UV system to protect your facility from a specific pathogen?
- Do you need a UV system for complying with regulations?
- Is it for the inlet or outlet of the facility?

The size and type of the UV system will be determined according to its purpose. Set the required UV dose so that it suits your requirement.

2.2. What is the flow rate of the water that is to be treated?

This is an important factor which will determine the type and size of the UV system.

2.3. What is the UV transmittance (UVT) of the water?

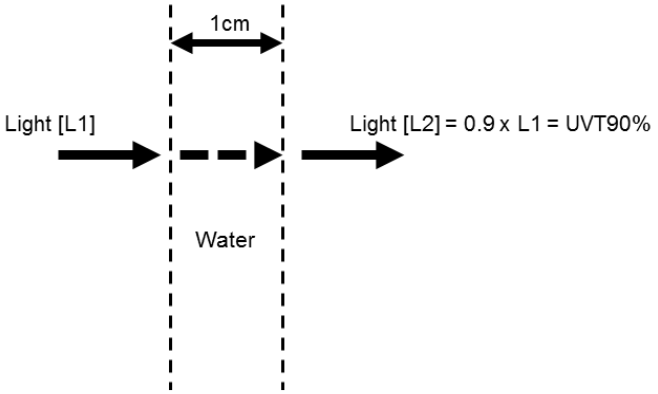
The UVT will be different depending on the water source and also the production stage. UVT greatly affects the UV dose, and consequently the type and size of the UV system.

Did you know?

What is UVT?

UVT is the level of water quality, indicating the percentage of light which passes through the water.

In the example shown below, 90% of L1 was received after crossing 1cm of water, which is an indication of a 90% UVT.



2.4. What UV dose type should be used?

Average Dose:

The UV system delivers UV dose levels that are higher and lower than the required UV dose.

Pathogens that receive a UV dose, which is lower than the required dose, will survive and contaminate the fish tanks.

Reduction Equivalent Dose (RED):

Ensures that the lowest UV dose, which is delivered in the disinfection chamber, is the required UV dose for eliminating the target pathogens.

Only systems that are designed according to RED can provide water biosecurity to aquaculture facilities.

Warning

The UV dose type should always be RED. Otherwise, the UV system will not provide you with biosecurity.

Did you know?

The UV dose function:

UVT is the level of water quality, indicating the percentage of light which passes through the water.

UV Dose = f(Flow, UVT, Lamp Power)

The UV dose is a function of water flow, UVT and the power of the UV lamp. An increase in UVT or lamp power directly increases the UV dose, while an increase in flow rate inversely affects the UV dose.

Since all three parameters are directly related to the UV dose, they must always be monitored during the operation to ensure that the UV system delivers the required UV dose!

3. UV System Design

Evaluating the basic parameters (UV dose, flow and UVT) is a good start. But the parameters alone are still not sufficient for ensuring that the required minimum UV dose is indeed delivered during operation.

In this section we will explore additional features and questions which will guide you through the variety of UV system designs and specifications.

Average dose does not provide average protection. It provides no protection at all!

3.1. How can I be certain that the technical specifications of the UV systems are valid?

The only way to ensure that a UV system can actually deliver a certain UV dose, in a range of water flows and UVT, is by having it validated according to an internationally recognized validation protocol.

The most widely accepted validation protocols are EPA (USA), DVGW (Germany), and ÖNORM (Austria). Third party validation is difficult to obtain, as the UV system needs to qualify for a variety of technical and operational requirements, which, in addition, certifies the UV system's monitoring sensors and overall disinfection performance.

Warning

Be aware of claims, made by UV providers, about in-house performance assurance or bio-dosimetric tests, as these can often be misleading and incorrect, and the UV system will simply fail to provide the required UV dose!

Did you know?

RED is certified via third party validation:

RED is an absolute value and must be ratified by third party institutions, specialized in evaluating performance of UV systems, and determining their RED according to an internationally recognized validation protocol such as EPA (USA), DVGW (Germany), and ÖNORM (Austria).

If a UV system is not validated according to one of these protocols, the designated UV dose is an average dose and there is no way of knowing what RED the UV system delivers.

3.2. How do I know if the system is validated?

Since validation is an arduous and complex process, only certain specialized independent institutions can actually perform it.

Once the validation is given to a UV system, official documents will be produced to certify the scope and range of the validated systems.

Always ask to receive and carefully examine the validation documents of the UV system!

The EPA (USA) DVGW (Germany) ÖNORM (Austria)

Warning

ISO, ISF-51, ISF-55, EPA registration and FDA are NOT third party validations.

Always ask for the official validation documents, stating the validation protocol, scope of validation, and the UV system which was validated.

3.3. How to verify if the UV system is actually delivering the required UV dose during operation?

Validation aside, monitoring the performance of a UV system and ensuring that it truly delivers the required UV dose is extremely difficult, as the field conditions change rapidly and are never optimal. Therefore, validation documents are not sufficient for ensuring that the UV system operates properly.

A reliable UV system should always employ the following:

- UV sensor per lamp

  Why? The real performance of the lamp must always be monitored for each and every lamp individually. If one lamp fails or is too weak, the system will not deliver the required UV dose and will not provide water biosecurity. The provider's performance guarantee is not sufficient in this case and real performance must constantly be monitored in real time.

- An integrated UVT sensor

  Why? Water UVT can change dramatically during production, due to water source variations, feed or increase in organic material in the water. As UVT is one of the most important factors influencing the UV dose, an integrated UVT sensor must always be used to feed the real UVT values back to the UV system's controller for an accurate measurement of the UV dose.

Three factors ensure sustainable operation of a UV systems:

1. Third party validation
2. Dedicated UV sensor per lamp
3. Integrated UVT sensor

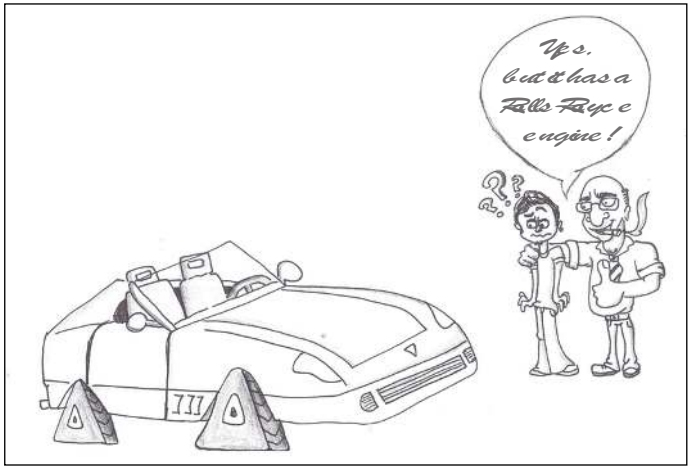
3.4. Which lamp type should be used? Low Pressure (LP) or Medium Pressure (MP)?

Each lamp type has its advantages and disadvantages.

The important point is not necessarily which specific lamp type is used, but the complete configuration and design of the UV system, which enables efficient power consumption, accurate monitoring, low maintenance, and validated UV dose.

Lamp type is only one factor which determines the UV system performance and should be looked at within the general configuration of the UV system.

A car with the most powerful engine in the world will not drive if, say, its wheels are badly designed.



How will it drive?

3.5. How frequently should the lamps be changed?

Lamps should be changed according to their performance. If a lamp's efficiency (the amount of power it generates) is not sufficient for delivering the required UV dose, it must be replaced immediately. For this reason, each and every lamp should be monitored independently, by a dedicated UV sensor, for reliable and accurate lamps status indication at all times.

Warning

The only way to be certain that the UV lamps are working properly and can deliver the required UV dose is by ensuring that the UV system has a dedicated UV sensor foe each individual lamp. The manufacturer's stated hours of operation should be used only as a reference.

Did you know?

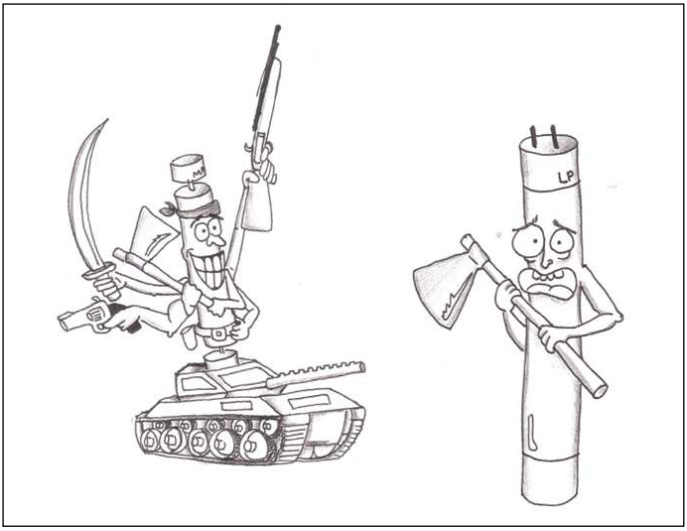
Three main factors influence a UV lamp's life-span:

1. Type of lamp –
   Life-span of LP lamps is usually double that of MP lamps.
2. Operation mode –
   lamps' official life-span is determined in lab conditions. In the field, the UV system might be turned on and off frequently. This can dramatically influence the performance of the lamp and consequently accelerate its decay, resulting in a much shorter life-span than officially stated.
3. Operating temperature –
   LP lamps are very sensitive to their operating temperature. Changes above or below the optimal operating temperature (about 38°C) affect their output and consequently the effective life-span.
   MP lamps are generally not sensitive to temperature, and changes in operating temperature do not affect their output.

3.6. What is the most effective wavelength for disinfection?

Contrary to what is conventionally believed, the wide germicidal wavelength of MP lamps (200-415nm) is much more effective against pathogens and viruses than the single monochromatic wavelength of LP lamps (254nm).

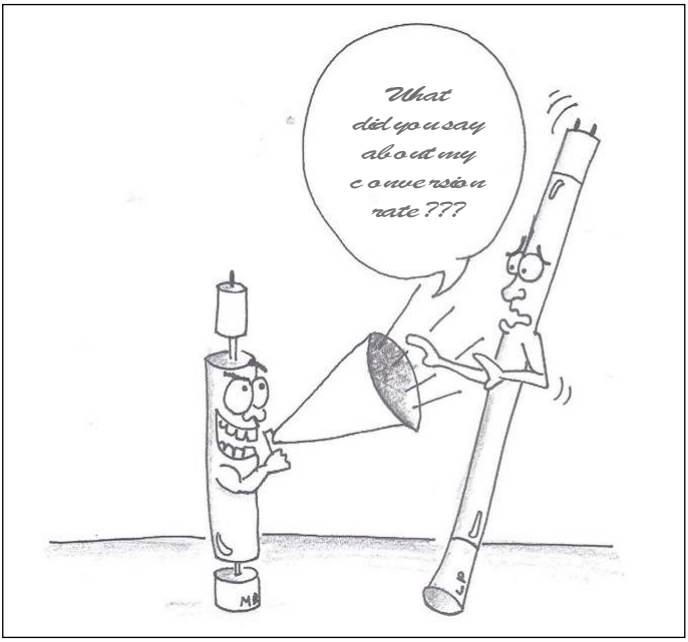
A wide germicidal wavelength attacks microorganisms at several fronts, achieves better disinfection results, and severely hinders microorganisms' repair mechanism.



The advantages of wide germicidal wavelength

3.7. Are LP UV systems more power-efficient than MP systems?

Not necessarily. Although the conversion rate (rate of converting electricity to UV light) of LP lamps is three times that of MP lamps, some validated MP UV systems have been especially designed with an optical amplification mechanism, making them as power efficient as validated LP systems.

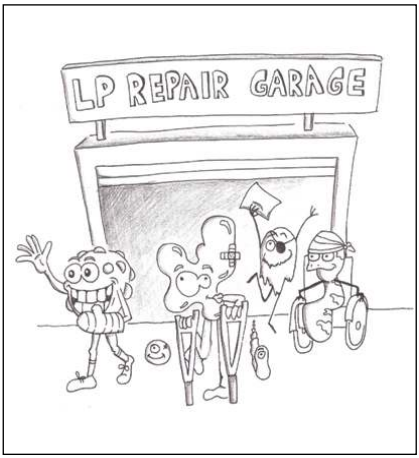


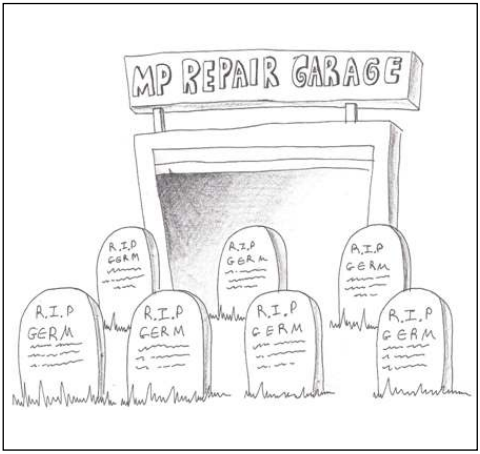
Amplification mechanism

3.8. Is the disinfection quality of LP lamps and MP lamps similar?

Not quite. MP disinfection is considered better than LP for two main reasons:

- Recent studies show that due to MP lamps' wide germicidal wavelength, considerably less UV dose is required to achieve the same disinfection level as LP lamps *(see also question **3.6** on page **11**)*.
- With LP lamps, bacteria regeneration is very common, and is a source for contamination in the fish tanks.
  Conversely, bacteria treated with MP lamps are less likely to repair themselves.





Partial wounds or total kill?

3.9. Can the UV lamp affect water temperature?

No matter which lamp type (LP or MP) is used, the water temperature is not affected by the UV system, given the correct sizing of the system under normal flow conditions.

Warning

Deposit formation, caused by heat that is generated from UV lamps, is an issue shared by all UV lamp types and is related to water chemistry.

In cases where water chemistry demands it, automatic cleaning systems, such as wipers, should be integrated into the UV system regardless of the UV lamps used (MP or LP).

3.10. Can water temperature affect UV lamp performance?

One of the main factors that affect the performance of LP lamps is the operating temperature *(see question 3.5 on page **10**)*.

As discussed above, MP lamps are much less sensitive to operating temperature than LP lamps. Therefore, with LP lamps, cold or hot waters adversely affect the lamp performance, as it is not possible to ensure optimum operating temperature of the lamp.

In cold water fish farming, LP lamps are considerably less effective than MP lamps.

3.11. Does having more lamps mean better protection?

Absolutely not!

Always aim to get the required UV dose with the least number of lamps.

Why?

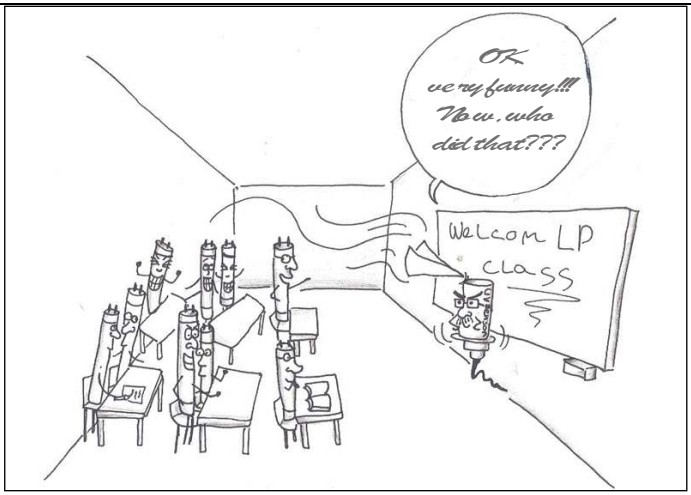
- The more lamps in a given UV system, the less ability to monitor each individual UV lamp and ensure proper function of the UV system.
- If one lamp is off or too weak, the entire UV system will fail to deliver the required UV dose, and "escape routes" are easily formed. As each lamp treats only a fraction of the passing water, the rest of the lamps in the UV system will not be able to compensate for the "escape route", caused by the deficient lamp.
- More lamps mean more maintenance, more quartz-sleeves to clean, and inevitably more shut-down time.

Warning

Claims that a multi-lamp UV system can provide the UV dose, even with one or two lamps down, contradict the system's validation scope and are erroneous and misleading.

Only some MP UV systems, in which each lamp treats 100% of the water volume, can in some cases guaranty this feature.

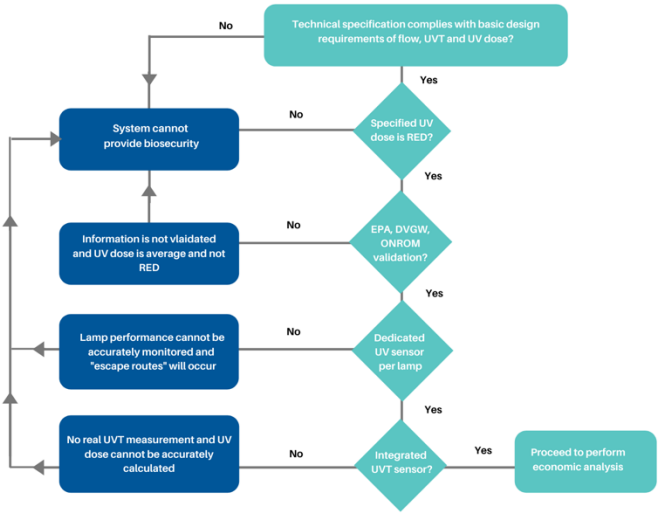
With LP systems, where each lamp treats only a fraction of the flow, "escape-routes" are formed and the disinfection performance is compromised.



Lamp monitoring issues

3.12. How to compare performances and costs of several UV systems?

The following chart provides a simple method to sort through a variety of proposals and choose only the UV systems that can provide the required biosecurity. Then you can proceed and easily compare the costs of only the relevant UV systems.



For the purpose of an economic analysis, you may want to consider the following questions:

- What is the cost of the equipment?
- Are there any additional costs associated with the installation of the equipment, such as piping or civil work?
- What is the annual cost of lamps and quartz-sleeve replacements?
- What is the annual electricity expenditure?
- What are the expected annual maintenance costs in terms of labor and spare parts?
- Does the UV provider have local technical support?

Using the following table, you can compare the cost worthiness of the relevant UV systems and choose the most suitable one for your facility.

	UV #1	UV #2	UV #3
Equipment cost			
Annual lamps replacement cost			
Annual quartz replacement cost			
Annual maintenance cost			
Annual electrical consumption cost			
Local technical support?	Yes/No	Yes/No	Yes/No