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technical memorandum

The Goodwater Range of Tucana UV Disinfection Units

Advantages of using axial inflow configuration in conjunction with a computer designed flow modification system.

Technical Memorandum 102

Published: 16th June 2011

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Advantages of Using an Axial Inflow Configuration in Conjunction With a Computer Designed Flow Modification System.

To the layperson, the use of UV Irradiation to disinfect water supplies can be seen as a very straightforward process. At the most basic level you install a UV Unit and your water is treated !

The reality however is much more complicated than that and the Goodwater Tucana range of UV disinfection units have been designed to incorporate a number of features which ensures that the Tucana Range delivers **verifiable** high performance treatment without breaking the budget.

The Goodwater Tucana Range of UV disinfection units offer the following features as standard:

- ✓ High performance low pressure UV lamps.
- ✓ A sophisticated electronic lamp ignition system.
- ✓ An axial inflow configured reaction chamber.
- ✓ The incorporation of a reaction chamber flow modification plate.

So how do these last two features enhance the Goodwater Tucana Range enabling them to deliver such a superior performance when compared to other comparable UV disinfection units available ?

Advanced Reaction Chamber Design.

The reaction chamber is the stainless steel housing which accommodates the UV lamp(s) and is where the UV disinfection process takes place. The water flow through the UV reaction chamber is crucial to the performance of any UV disinfection system and our manufacturers have undertaken detailed studies in order to improve and optimize the UV reaction chamber design. Computational Fluid Dynamics (CFD) was used to simulate the movement of a large number of theoretical fluid particles through the reaction chamber.

Radial v Axial Inflow

In a conventional or “radial” UV reaction chamber, the water inlet is placed at 90 degrees to the main chamber body (See Figure 1). With this design, the water flow is pushed along one side of the UV reaction chamber wall where the UV intensity is at its lowest. Because of this, the disinfection of the water in the reaction chamber is not as efficient or effective as it could be.

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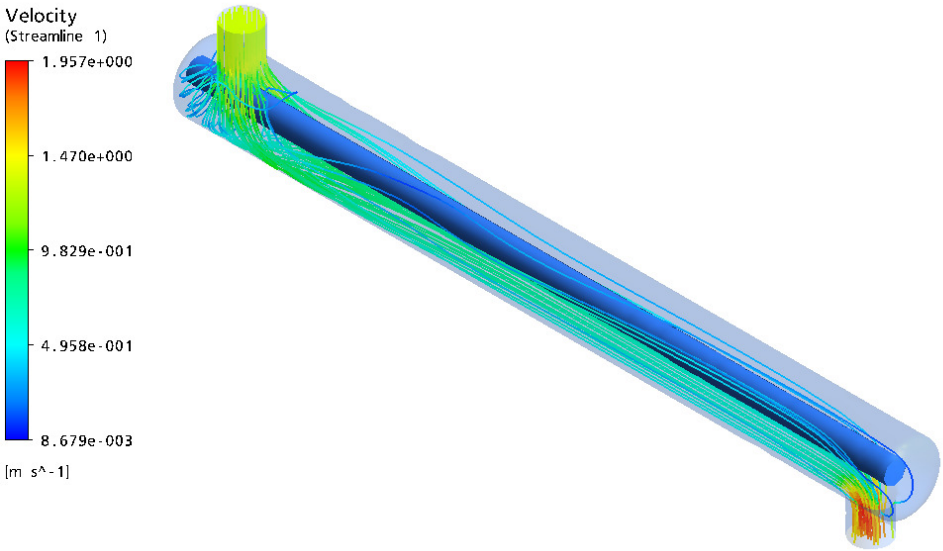

Figure 1 shows the CFD Representation of the flow through a conventional "radial" UV reaction chamber.

In contrast, Goodwater's Tucana range of UV disinfection units utilise an axial inflow configuration.

Figure 2: Goodwater Tucana UV unit with axial inflow and flow modification plate.

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With an axial inflow, the water flows more evenly through the reaction chamber making the disinfection process much more efficient in comparison to the conventional radial UV design.

However further research demonstrated that even the axial inflow configuration might be improved upon. Flow modelling using Computational Fluid Dynamics (CFD) revealed that as water flows through the UV chamber (from the right), the water stream moves away from the axis of the lamp allowing a slight reduction in the effectiveness of the disinfection process. (See Figures 3 & 3a)

Figure 3 & 3a: CFD representation of the flow through an axial inflow reaction chamber.

How to Improve the Flow Characteristics of the Reaction Chamber ?

Continuing research using CFD indicated that it might be possible to improve the water flow through the reaction chamber. The conclusion of this development work is that the reaction chamber used by the Tucana range of UV Disinfection Units now incorporates a carefully designed flow modification plate which modifies the water flow through the reaction chamber so that the flow does not deviate away from the axis of the lamp thereby further enhancing the effectiveness of the axially configured Tucana UV disinfection System. Figure 4 demonstrates this effect.

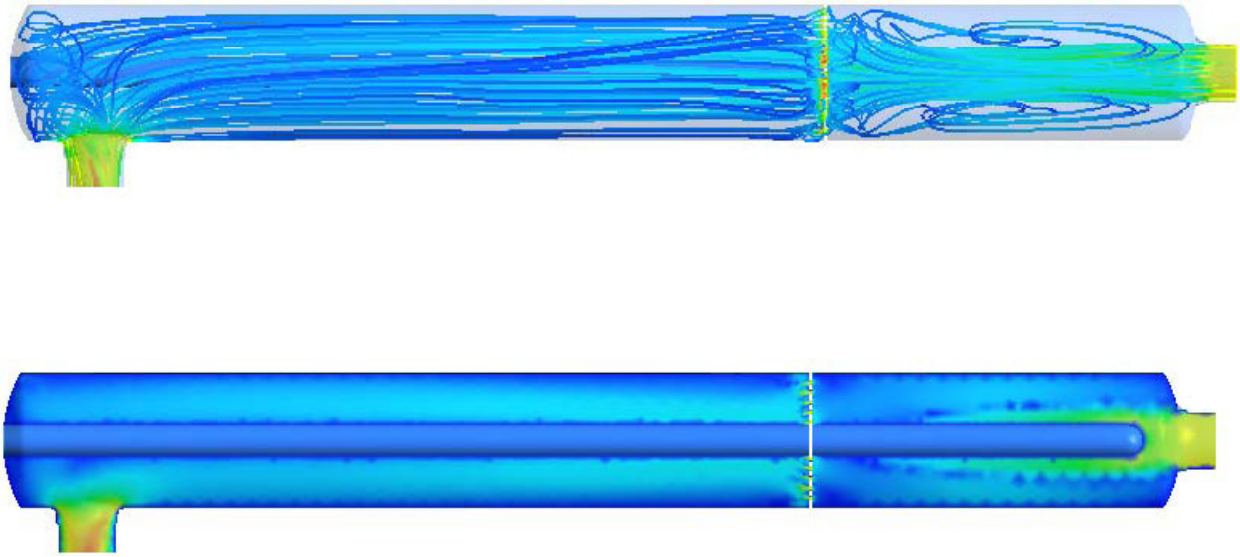

Figure 4: CFD representation of the flow through an axial inflow reaction chamber with the flow modification plate installed.

The Design of the Flow Modification Plate.

Inside a UV reaction chamber, the UV intensity is at its highest closest to the lamp and consequently, the further away from the lamp, the lower the UV intensity experienced becomes. This means that:

- ✓ A water droplet close to the lamp receives a higher UV dosage than a water droplet at the UV chamber wall.
- ✓ The longer a water droplet remains exposed to the UV, the higher the UV dosage it receives.

To create a situation in which all the water in the UV chamber receives an equal UV dosage during its passage through the reaction chamber, the water flow at the wall of the chamber needs to be slower than the water flow at the surface of the lamp.

The design of the flow modification plate manages the water flow through the reaction chamber, not only eliminating the flow deviation described above but also by modifying the velocity of the water flowing through the reaction chamber so that the water flow nearest the wall of the reaction chamber, flows more slowly when compared to the water closest to the lamp. This has the desired effect of evening out the UV dose received by the water during its passage through the reaction chamber.

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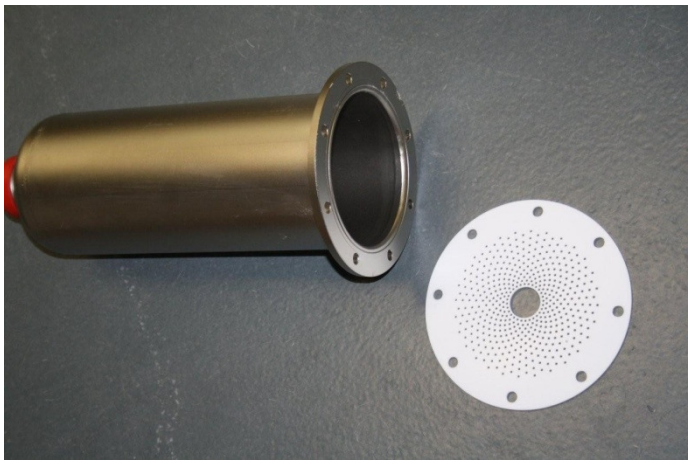

Figure 5a The Flow Modification Plate

Figure 6a Cut-away Reaction Chamber showing the installed Flow Modification Plate

The use of CFD has allowed the development of a sophisticated flow modification plate which ensures that all the water flowing through the Tucana reaction chamber is exposed to the same UV intensity, regardless of the relative position of the water within the reaction chamber.

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Process Verification: The Influence of Reactor Chamber Design on the Disinfection Process.

The way water flows through the reaction chamber influences the efficiency of the disinfection process and the effect of different reaction chamber designs can be demonstrated using the technique of UV irradiance mapping. Using these techniques it can be shown that the Tucana UV disinfection systems with their axial inflow configuration are far more effective than conventionally designed radial inflow systems.

The addition of the flow modification plate to the axial inflow UV reaction chamber further ensures that the distributed dosages are even higher and that the dosage spread is smaller.

The results of the UV irradiance testing is summarised in Table 1 where it can be seen that the average and minimum doses that the water received varied with the different reactor designs.

	Conventional Flow	Axial inflow	Axial inflow + Flow plate
Average dose mJ/cm^2	38.6	35.4	37.4
Minimum dose mJ/cm^2	5.2	24.7	31.4

Table 1: Average and minimal UV dosages applied to the water using different UV reactor designs.

The table shows that because of its axial configuration and incorporation of the flow modification plate the reaction chamber used in the Tucana system distributes higher UV dosages than a conventional radially designed system. Although the average distributed dosage is highest for a conventional system, the minimum dosage applied is unlikely to be sufficient to effectively eliminate bacteria.

The large UV spread and the low minimum dosage makes the conventional system inconsistent for disinfection purposes. A minimum dosage of at least 30 mJ/cm^2 is easily achieved when a reaction chamber with axial inflow and a flow modification plate are used.

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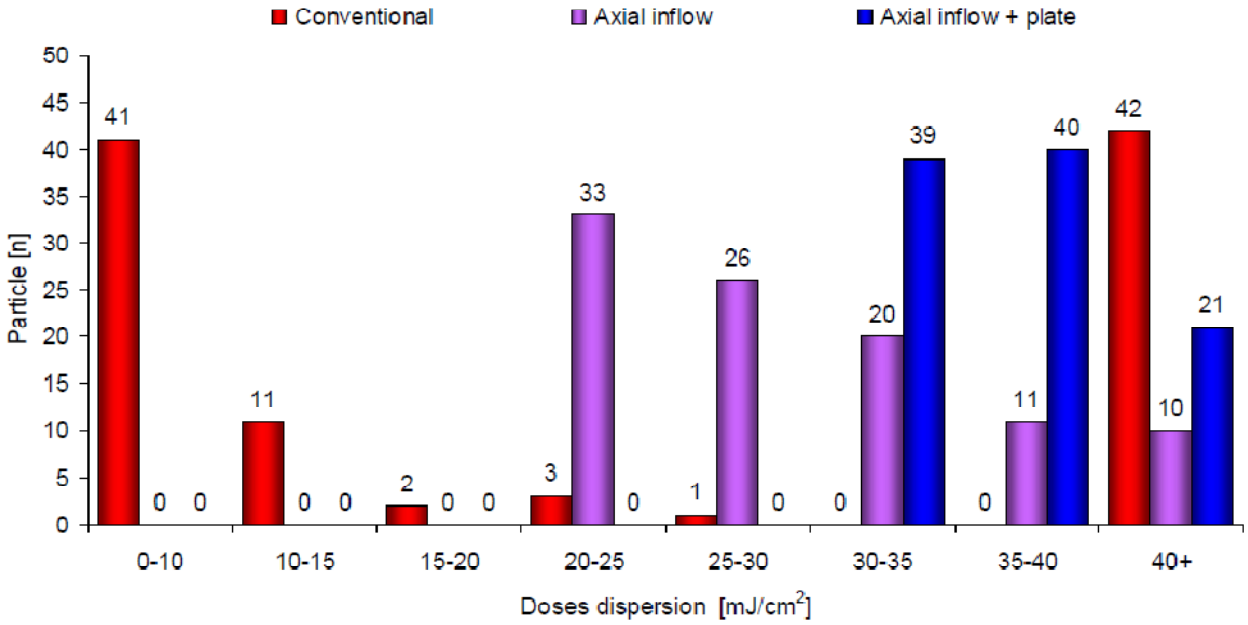

Figure 6 illustrates that the received dosage spread is also smaller for a Goodwater Tucana design than for a conventional radial unit.

It can therefore be concluded that the most effective design of a UV reaction chamber for disinfection purposes utilises an axial inflow reaction chamber incorporating an effective flow modification plate. The overall treatment capacity is high with an average UV dosage of 37.4 mJ/cm^2 and a minimum of 31.4 mJ/cm^2. As a result, accurate and reliable disinfection is achieved.