

**IWA Webinar “The future of disinfection in drinking water & wastewater”**  
**Q&A Report – 11/11/2022**

Webinar recordings available at: [www.iwa-network.org/learn/the-future-of-disinfection-in-drinking-water-wastewater/](http://www.iwa-network.org/learn/the-future-of-disinfection-in-drinking-water-wastewater/)

**Questions received from participants during registration:**

#	Questions	Speaker	Answer
1	Are we moving towards a less intensive sodium hypochlorite use resulting from the chlorate level set in the european directive?		In NL the motivation isn't legal standards but health and approaching natural water quality.  In countries where there is a legal requirement, more effort will be needed in storage of sodium hypochlorite to minimize decomposition
2	Can photocatalysis be used for water disinfection? If so how to scale up?		This has been applied in UV, however benefits were limited for practice
3	Do you see citizen science playing a role in the global north? Or is this more a global south approach?		Citizen science is a very broad concept. We've used it in Amsterdam
4	How a SME can create market's awareness for a solution that is already in the market and is a good initiative for sustainability?		Many 'sustainable initiatives' e.g. are not actually sustainable looking at the bigger picture. So it should be part of a larger plan that REALLY looks at sustainability
5	How can Black water be treated at low cost?		Oxidation ponds, wetlands if you have space. Recovery of energy and materials might make it more feasible

6	How could we manage the FRC (free residual chlorine) in long pipe line network?		
7	How do I become a water quality expert with advanced knowledge?		Study hard
8	How do these disinfection technologies can be ramped up in a economical way		Not sure what is meant by ramped up, and which technologies? Most are commonly applied
9	How the principles of water supply hygiene can help to improve to decrease the amount of chlorine in water?		See the Netherlands example: no chlorine but strict hygiene codes including training, checks, improvement, audits etc.
10	How to calculate the DBP residual with the chlorine dosing?		DBP formation does not only depend on the dose. Concentration of precursors is also important to have an idea of potential DBP formation
11	How to Save Water for future generations?		Look at water as a flux and make sure the cycle is sustainable. (challenging with climate change)
12	How would you rate performic acid (PFA) vs. other disinfection technologies such as UV or chlorine?		This adds AOC to the water and will therefore promote microbial growth in water. Therefore not applied in Netherlands. PFA is commonly used as disinfectant of WW with similar results than disinfection with chlorine (but no DBPs)
13	I wish seeing applications and suggestions for crisis contexts and camps conditions		That is outside the scope of this webinar. Certainly wouldn't go chlorine free in those situations

14	Is the future of disinfection UV LED? Does point of use re-disinfection provide a viable alternative to residual chlorine?		UV LED is being used in probably drinking water in the UK and on ground water in Las Vegas NV. Point of use disinfection not very economic and hard to bring to a safe level. People tend not to perform correctly or maintain equipment, but may be practical in certain conditions. UVC-LED is being used for some drinking water bottle filling stations.
15	Kindle let me know how can we use other disinfectant chemical rather than chlorine		There are other disinfectants, such as chloramines or ozone that are used commonly.
16	Monitoring status of DBP across the globe?		
17	How could we manage the FRC (free residual chlorine) in long pipe line network?		
18	How do I become a water quality expert with advanced knowledge?		Study hard and keep looking for opportunities.
19	How do these disinfection technologies can be ramped up in a economical way		
20	How the principles of water supply hygiene can help to improve to decrease the amount of chlorine in water?		
21	What technologies exist to treat toxic waste before pouring it into rivers?		Wastewater treatment plants are used to treat wastewater generated in communities. There are a number of these processes that can be used.

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#	Questions	Speaker	Answer
1	regarding the life time, where are these hours coming from (evidence or expectations?)		On going testing is document the operating hours of the UVC-LED. The challenge of UVC-LED is that the technology is changing quite rapidly...so this is an ongoing effort to better document the operating hours of systems.
2	can this work in Under developed countries		UVC LED can be deployed in under developed countries. The international ultraviolet Association is looking into deployment of UV technology ..please contact me directly and I can provide the contact person.
3	Are there any disadvantages to using UV? Is it high energy using or not?		my experience has been on Wastewater side so there are a number of challenges that have to be mitigated as part design and operations. Energy use at wastewater plants is always compared to the biological treatment (which uses 80 percent of the power at the treatment facility). So power is generally realtively low. The power right now for UVC-LED is a bit on the high side compared to Mercury vapor lamps. The development of UVC-LED unitts are getting close to match the output of medium pressure lamps and moving close to the output of low pressure mercury UV lamps
4	do you have units that can be put inside tanks to prevent growth within them.. i presume with the more pinpointed wavelength there will be less damage to plastics and it could be used for example for rainwater storage vessels		I suggest that you contact manufactures of UVC-LED systems as they might be able to answer your question. Can you please send your contact information.

5	<p>I fully understand the effectiveness and eco-friendliness of your company's products UVC-LEDs, but UV is also harmful to the human body. So, are the protection measures for the human body sufficient when operating UVC-LEDs?</p>		<p>With UVC-LED the systems are installed in enclosed reactors so the reactor protects the operators/human from the exposure. UVC-LED has not at least at this time been deployed in open channels so can not answer relative to that application.</p>
6	<p>Prof. Hunter, Thank you for all this information. I am also working in water purification using UVC in the presence of nanoparticles. So, what is the power of this LEDs and how many LEDs will be required to clean water (ex. hospital waste) . Thank you in advanced for your answer.</p>		<p>can you please send me some information on water quality and flow. UVC-LED are being used in hospitals for disinfection of water in operating rooms and to disinfect devices</p>
7	<p>How does the operations cost compared to Cl2 or ClO2 or any other chemical disinfection methods.</p>		<p>Work conducted by EPRI indicates that UV and UVC-LED are comparable to chlorine disinfection in the wastewater industry. In the US chlorine has increased in cost significantly and availability has decreased make utilities examine alternative methods of disinfection.</p>
8	<p>The collimated bench scale has a tube which doesn't work as a collimator and rather concentrates the light intensity, in this case, how did you determine the UV fluence of the system?</p>		<p>Intensity is actually measured and used to validate the fluence being deployed to organism</p>
9	<p>for the collimated beam results (BASE 22) graphs, there is 255, 265 and 280 nm wavelengths, what does the x-axis represent? and then which was the best wavelength in that case and why?</p>		<p>I can only answer based on my experience. In testing we typically on the wastewater side we are looking 255 as that match up close to the 253.7/254 nm for inactivation of fecal coliforms. We have also been looking at 280 nm as 280 nm is the least cost for production UVC-LED. So the selection of the wavelength is</p>

			really based on the target organism one chooses.
10	how do you assure your networks are disinfected without residual ??		My experience is on the wastewater side but based on my understanding with using UV one would also have to add chlorine or another chemical to maintain a residual in the network/water distribution system.
11	How can be guaranteed a good quality water at the end of the line, i mean, for the last house/industry/comercial "on the road"?		
12	Can you easily control chlorite, using ClO2 in final disinfection?		
13	How to protect the distribution?		
14	are there any manage disadvantages to uv technology? any health implications or high energy consumption?		
15	IS Clostridium Perfringens a "Target" Organism in the Netherlands?		It is considered an 'operational parameter' that requires further investigation when detected. Therefore we strive to have it absent in drinking water. It is also considered a process performance indicator for persistent organisms such as Cryptosporidium (for certain treatment processes)
16	is there a possibility of replacing UV- LED with white light since it consumes considerable less energy and can be entirely green source of energy		Can not answer your question. Please send your contact information and I will put you in contact with UVC-LED manufacturers
17	the 25000 hours of the UV-LED is that continuously running? And up to how much flow rate have you treated using UV-LED?		UVC-LED are continuously testing the systems to verify the operational hours. One of the keys to getting longer operational hours is cooling so there a large number of factors that

			can impact the number of operational hours. The Typhoon unit installed in the UK has a capacity of 28 MLD
18	Do you think nano bubble aeration could help water be kept safe in distribution systems?	Gary L. Hunter	I'm not familiar with this method. From the name I can't see how it would help to disinfect any contaminants.
19	Dear Dr. Hunter: Thank you for sharing this promising technology. I have two questions: (i) What is the typical fluent rate of UVC-LED? (ii) Can LED also be applicable for vacuum UV light (185 nm)?	Gary L. Hunter	Fluence rate is really dependent on target organism. Typical UV dose for basic level disinfection (30 day - geo mean of 200 fecal coliform/100 mL in wastewater the dose would be in the 30 - 40 mJ/cm <sup>2</sup> . In reuse the dose base on California water reuse requirements would need to be 100 to 140 mJ/cm <sup>2</sup> . Drinking water maybe 20 to 40 mJ/cm <sup>2</sup> . I can not answer if UVC-LED can be manufactured down to 185 nm..I know the manufactures can manufacture down to 222 nm. Please send me your contact information and I can put you in contact with UVC-LED manufactures.
20	Is this working efficiently in a wastewater plant with the daily capacity above 500 MLD.		As far as I know UVC-LED has not been applied at a WWTP full scale. There are a number of trials on going to examine deployment of UVC-LED at larger WW facilities.
21	Does this work for heavy metals such as Arsenic, Lead, Mercury, and others?		UVC-LED is more for the removal of micro-organisms. Other process would need to be implemented to remove metals.
22	Dear Mr. Smeets: Thank you for your interesting talk. I agree that ozonation can decrease precursors of trihalomethanes, but are you controlling other types of DBPs caused by ozone such as nitrite and bromate?		Yes, bromate is the main concern and challenge. Therefore maximum ozone dosing depends on the bromate level in the feed water. Dosing is generally much lower, to limit bromate formation. The improvements I showed actually improved disinfection dramatically (from 2 to >6 log reduction of bacteria) without any increase of bromate. Therefore ozone dosing could be reduced to the minimum required for the other goals

			of ozonation: breakdown of micropollutants and organics.
23	Is the backflow protection an physical air gap or non return valves		This depends on the type of connection. High risk connections (slaughter houses, hospitals, laboratories) need an air gap. House connections have non return valves.
24	what's the biostable materials?		live answered
25	Thanks for the nice talk! How do you achieve that low AOC concentration? @ Patrik Smeets		In general by breaking down organics through oxidation (ozone or advanced oxidation) followed by biological filtration (activated carbon or slow sand filtration).
26	how to do you manage risk identified in the distribution network		live answered
27	Prof. Hunter, Thank you for all this information. I am also working in water purification using UVC in the presence of nanoparticles. So, what is the power of this LEDs and how many LEDs will be required to clean water (ex. hospital waste) ?. Thank you in advanced for your answer.		The power of UV is a function of the equipment and vendor selected so it can vary considerably. The number of units would be determined based on the water quality of the system being considered. You would have to check with specific vendors to determine the number of units that would be required.
28	What kind of disinfectant do you use to get a chlorine free drinking water and guarantee a residual through your distribution network?		'Disinfection' in treatment can consist of filtration (sand or membranes), UV disinfection and/or oxidation (ozone, AOP, ClO <sub>2</sub> ). However after treatment no residual is added or present in the water when it enters the distribution system. Focus is on preventing contamination, or timely response when contamination occurs rather than keeping a disinfectant residual.
29	is the recorded lecture will be sent		live answered
30	Maria, can you say how to measures these DOM in drinking water prodction directly? Your results are in ng/L of DBPs, but these must	Maria Jose Farre	live answered



	be from Lab analyses. Can we use typical UV254 or wider optical spectrum sensor direct inline to detect these DOM as indicators of potential DBPs? In the UK there is still a lot of Chlorination.		
31	Thanks for the answer! Another question, with global warming, it can be more challenging to keep the temperature lower than 25 degree in the future (I guess). To tackle that issue, would you go for including more other microbials in your QMRA system or more focusing on developing other disinfection methods?		We're doing several studies on opportunistic pathogen growth under increasing temperature conditions. This includes legionella and others. We're also developing QMRA for these opportunistic pathogens for decision support. This is not a legal requirement.
32	How do you ensure that water in the distribution is safe after it's been comprised due to a burst or other causes without a chlorine residual?		In case of a burst the chlorine is generally insufficient to provide much protection against chlorine resistant pathogens, it just masks the E. coli. So it can last much longer since it goes undetected. In case of a detected contamination, a boil water notice (don't drink from the tap) is issued until the system is under control again.
33	What is the most preferred and accurate way for Legionella testing?		This is not really my expertise. We do promote to test for legionella pneumophila (not spp which is the current legal requirement) since that is the real issue. Removing existing non-pneumophila species may actually promote pneumophila growth.
34	MOLEAER provides technology - air is the oxidatice medium supplying very efficient O2 transfert into liquide phase. Nanobubbles are so small that they are not boyant but		

	travel through Brawnina moovement in water and stay in water for a longer period of time: days... due to size of bubbles, also HO-formation take splace on their surface. This is why I think the technology may be useful in thsi area....		
35	With climate change and rising temperatures, how is it that the Netherlands can guarantee a distribution at T<25°C. And if the risk is minimal how is it that the rest of Europe/world continue to use disinfection to ensure water safety. Shouldn't the community directives be reviewed?		
36	Thanks. Really impressive - but has a water company ever been prosecuted due to a lack of residual disinfection?		
37	If you respond only when Focus is on preventing contamination, or timely response when contamination occurs rather than keeping a disinfectant residual.		
38	In Portugal, sodium hypochlorite is the only disinfectant allowed to be use in water treatment plant for human consumption. Chlorate production is a common and hard to eliminate.		
39	Dear Dr. Farre: Thank you for sharing topics in detail. I agree that prediction of DBPs is important to reduce		Yes, we have found correlations with the measurements of MS and THMs and HANs. This work is published. We

	potential health risk. But because there more than 600 types of DBPs and most of them are unregulated, it will be realistically difficult to control all types of DBPs. So, have you found any correlation between formation potentials between regulated DBPs (THMs and HAAs) and unregulated ones (nitrogenous DBPs, Br-DBPs etc)?		are currently doing more research on this topic.
40	Dear Dr Maria Jose Farre, In order to preventing THM production, do you agree with replacement ClO2 with other compound of Chlorine? What will be the impact of dbp of ClO2?		To reduce THMs ClO2 as pre-oxidant is a common method already employed.
41	Do you know of any UVC-LED used as a post treatment in sea water desalination systems ?		I have not seen that application but that does not mean that there are not system being used in this application
42	Sorry to be clear I think +UK water utilliites are very reulcatnt to go without chlorine residual		