WHITE PAPER:

A PROPERLY TREATED SWIMMING POOL IS A SAFE PLACE

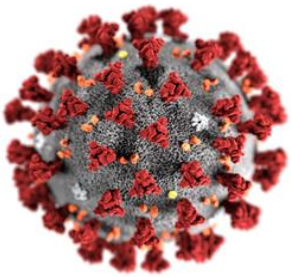
Fluidra's mission is to assure a perfect pool experience for all the users, in residential swimming pools, in semi-public commercial pools (communities) and publicly used commercial pools.

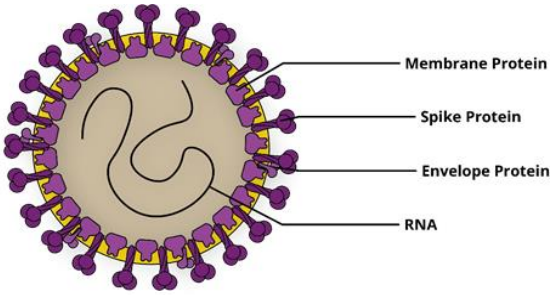
In these times of uncertainty with the fear of the coronavirus being in many peoples' minds, let's have a look to swimming pools, their potential risks and the necessary pool water treatment to make sure the swimming pool is a safe place for us to be.

The main question everybody asks is:

1. **If swimming pools are being chlorinated in accordance with current recommendations & best practices is this sufficient to inactivate COVID-19 virus?** And, the additional one**: 2. Should users be doing something they didn't do before?**

Having a look to the virus, SARS-CoV-2





Covid-19 is the respiratory illness caused by the virus SARS-CoV-2, that we all call Coronavirus. It is just one of the seven coronavirus that can infect human beings, like SARS (Severe Acute Respiratory Syndrome Coronavirus) and MERS (Middle East Respiratory Syndrome Coronavirus) [4].

This family of viruses have similar physical and biochemical properties and comparable transmission routes.

Virus genetic material is packaged inside protein structures called capsids. Viruses are divided into three groups depending if they are surrounded by an outer lipid membrane (enveloped) or not (non-enveloped) [5]. Depending on their group, the difficulty to kill them varies.

Ease of kill	Difficult ↑ Easy	Small non-enveloped
		Large non-enveloped
		Enveloped

Enveloped viruses are easier to kill: SARS-CoV-2, the virus responsible for the COVID-19 outbreak, is an enveloped virus and therefore the easiest to kill.

The World Health Organisation (WHO) states that a **residual concentration of free chlorine of ≥0.5 mg/l** in the pool water after at least 30 minutes of contact time at a pH <8.0 is sufficient to kill enveloped viruses like coronaviruses [2] .

In the Table there are some conditions in which more resistant viruses are inactivated.

Pathogen (non-enveloped viruses)	Free Chlorine (mg/l)	Time of Chlorine exposure (min)	Inactivation %	pH
Coxsackie	*0.48 – 0.50*	*4,5*	*99*	*7,8*
Poliovirus	*0,50*	*12,72*	*99,99*	*6,0*
Rotavirus	*0,20*	*0,25*	*99,99*	*7,0*

Table: Inactivation of Viruses. CDC Organization[7]

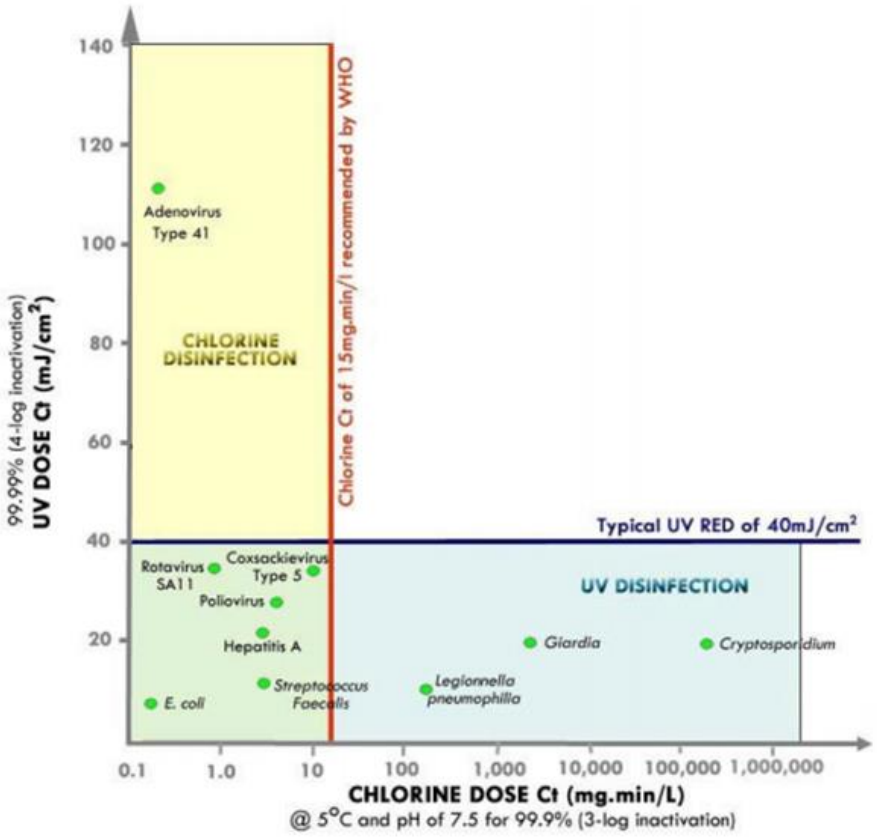


Diagram: Efficacy levels of chlorination and UV in the inactivation of various viruses[6]

The Diagram shows different efficacy levels to inactivate different viruses and pathogens. Coxsackievirus, Poliovirus and Rotavirus are examples of non-enveloped viruses. It can be seen that these are inactivated at chlorine Ct of less than 15mg-min/litre. (A Ct value

is the product of the concentration of a disinfectant (e.g. free chlorine) and the contact time with the water being disinfected.)

Therefore an enveloped virus such as the COVID-19 virus would be situated in the green area of the Diagram and will be inactivated at even lower Ct values.

As shown on the Diagram, **UV disinfection** amplifies the efficacy spectrum considerably against other viruses.

Ultraviolet light has the ability to destroy the genome (DNA / RNA) of viruses, bacteria, and fungi, including coronaviruses. Standard disinfectants are effective against SARS-CoV-2 but as an extra level of protection, and/or to shield against possible errors in the manual disinfection process, ultraviolet light can be used to disinfect pool water after the chemical disinfection process is completed.[8]

Conclusions

Answer to Question 1: If swimming pools are being chlorinated in accordance with current recommendations & best practices is this sufficient to inactivate COVID-19 virus?

Yes, for a conventional swimming pool with good hydraulics and filtration, operating within its design bathing load, adequate water quality is achieved with **a free chlorine level of ≥0.5-1 mg/l** throughout the pool.

This means: with a free chlorine level of ≥0.5-1 mg/l the water is not only disinfected, it also has a disinfecting potential to tackle with any virus or germ which may be taken into the water. [9]

Automation is very recommendable for ease of mind. (Otherwise the person in charge of the pool bears all the responsibility for the users' health.)

Routine measurement of the main values is essential (pH value and free chlorine level (DPD-1); it may be carried out manually or automatically.

Residential Pools and semi-public pools:

The correct level of free chlorine in the pool water can be reached by dosing solid chlorine tablets or liquid chlorine chemical products. An automation of this dosing & regulation process is possible and highly recommended. Another good alternative is to use Salt Water Chlorination devices that generate automatically active free chlorine from dissolved salt in the pool water.

To amplify the spectrum of disinfection, as an extra level of protection, and to shield against possible errors in the manual disinfection process, ultraviolet light (UV) can be installed to disinfect pool water (in combination with either chlorine dosing or salt chlorination).

Automation is very much recommended mainly in semi-public pools, which use to have a higher bather load than residential pools, as well as automatic online measurement of the main values by a smart pool analyzer.

Publicly-used commercial pools:

To maximise safety, the recommendation is an automation of all three steps: the pH-value regulation (1), the disinfection (2) and the continuous measurement (3).

(1) A correct pH value regulation between 7.2 and 7.6 with acids or by means of CO_2 will be essential to guarantee the effectiveness of disinfection.

(2) To amplify the spectrum of disinfection, the use of UV is highly recommended in combination with either chlorine dosing or salt chlorination.

(3) Continuous measurement of pH and chlorine levels and an automatic regulation of these parameters is a must in public pools. Recommendation: Display the values to the users, so they are fully informed about the water's quality.

Answer to Question number 2: **Should the users be doing something else?**

As in our daily life we recommend maintaining **adequate personal hygiene**. For example, if there may be a risk of having touched surfaces such as changing room benches, doors or knobs, it is advisable to **wash your hands** and / or sanitize them with disinfectant before entering the pool. We recommend bathers to **always shower before and after swimming in the pool**. It is also recommended to wash suits and bath towels, to eliminate all bacteria or viruses.

In addition to the pool water, it is recommended to **keep the surrounding areas of the pool disinfected**, as well as its equipment, such as showers, ladders, etc. applying products specially indicated for this use.

REFERENCES

1. Guidelines for drinking-water quality, fourth edition, incorporating the first addendum. Geneva: World Health Organization; 2017 (http://apps.who.int/iris/bitstream/10665/254637/1/9789241549950-eng.pdf, accessed 3 March 2020)

2. Water, sanitation, hygiene and waste management for COVID-19. Technical brief. 19 March 2020. (https://www.who.int/publications-detail/water-sanitation-hygiene-and-waste-management-for-covid-19)

3. PWTAG Code of Practice for Swimming Pool Water – 2016 Updated to reflect the requirements of Managing Health and Safety in Swimming Pools (HSG179) jimbutterworth.co.uk/2pwtag.pdf

4. https:// https://www.wef.org/news-hub/wef-news/the-water-professionals-guide-to-the-2019-novel-coronavirus/ accessed 2nd March 2020

5. Select Effective Disinfectants for Use Against the Coronavirus That Causes COVID-19. (https://www.infectioncontroltoday.com/environmental-services/select-effective- disinfectants-use-against-novel-virus-covid-19) accessed 2nd March 2020)

6. Environmental Protection Agency Water Treatment Manual Disinfection 2011. (https://www.epa.ie/pubs/advice/drinkingwater/Disinfection2_web.pdf)

7. Effect of Chlorination on Inactivating Selected Pathogen. Centers for Disease Control & Prevention. (https://www.cdc.gov/safewater/effectiveness-on-pathogens.html)

8. About UV disinfection. (https://www.researchgate.net/publication/339887436)

9. **About Hydrogen peroxide, known as liquid active oxygen in the swimming pool market** (https://www.ncbi.nlm.nih.gov/pubmed/203115) : "H2O2 in a 3 percent concentration inactivated all the viruses under study within 1--30 min. Coronavirus and influenza viruses were found to be most sensitive. Reoviruses, adenoviruses and adenoassociated virus were relatively stable. **H2O2 is a convenient means for virus inactivation**." Recommended concentration in pool water: 10 – 30 ppm H2O2.

Potassium peroxymonosulfate, known as solid active oxygen in pools, respecting the recommended concentration of 5 - 10 ppm KMPS in water is also convenient to act against virus. (https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2)

Bromine in its different forms (Br2, BrCl, HOBr-) are used in swimming pools and spas (jacuzzi). The use of Bromine to inactivate bacteria, viruses and protozoa has been reported in a number of laboratory-scale disinfection studies (Kim, 2014). (https://www.who.int/water_sanitation_health/publications/bromine-02032018.pdf?ua=1) Recommended residual levels: 1-3 ppm in residential pools; 3-5 ppm in residential spas.

Others:

Guidelines for safe recreational water environments. Volume 2 Swimming pools and similar environments. Publication WHO, 2006. (https://www.who.int/water_sanitation_health/publications/safe-recreational-water-guidelines-2/en/)

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