**Safe Drinking Water in Water Kiosks: Effect Of NOM on Virus Removal by Multiwalled Carbon Nanotubes (MWCNT).**

Celine Jacquin1,2, Kamila Domagala3, Jacqueline Traber1, Timothy R. Julian2, Eberhard Morgenroth1, Thomas Graule3

*1 Department of Process Engineering, Eawag, Swiss Federal Institute of Aquatic Science and Technology, Überlandstrasse 133, 8600 Dubendorf, Switzerland*

*2 Department of Environmental Microbiology, Eawag, Swiss Federal Institute of Aquatic Science and Technology, Überlandstrasse 133, 8600 Dubendorf, Switzerland*

*3 Laboratory for High Performance Ceramics, Empa, Swiss Federal Laboratories for Materials Science and Technology, Überlandstrasse 129, 8600 Dübendorf, Switzerland*

**Highlights**

* MS2 virus removal by adsorption is proportional to MWCNT mass.
* SRNOM adsorption onto MWCNT follows Freundlich isotherms.
* MS2 removal depends on SRNOM concentration.

**1. Introduction**

Safe drinking water access in low and middle-income countries is limited, especially in urban slums and rural area [1]. To increase safe water access and reduce waterborne diseases, water kiosks at community-scale were developed. For these decentralized water facilities, the water treatment technologies are selected according to their low costs, low maintenance, sustainability and ease of use [2]. In well operated and equipped water kiosks, bacterial removal is performed, while virus removal is seldom feasible [3]. It is therefore of major interest to develop solutions to increase virus removal and consequently decrease the waterborne diseases associated with these pathogens. The purpose of this study was to evaluate the interest of using MWCNT to produce filters that could be applied as a post-treatment in water kiosks, acting as a safe barrier against virus. In recent decades, the development of Carbon NanoTubes filters showed a high potential for water treatment and most specifically for virus removal in the case of electrochemical CNT filters [4]. However, NOM is expected to be a major limitation for virus removal, since it is also known to adsorb onto MWCNT. To better target the application of MWCNT for virus treatment, it is therefore important to better understand the competition mechanisms between virus and NOM.

**2. Methods**

MS2 (DSMZ 13767) were used as human virus pathogen surrogates due to their similitude with enteric viruses of human health concern. MS2 infectivity was evaluated using the MS2 plaque assays.

The MWCNT used in this study were purchased from CheapTubes. Their specific surface is equal to 116.63 m2/g, their diameter varies between 10-25nm, while their length is equal to 100µm.

SRNOM (IHSS) was used as a NOM surrogate to be able to compare our results with the existing literature. NOM characterization was performed using Liquid Chromatography with Organic Carbon Detector (LC-OCD) and TOCmeter.

Batch experiments were performed in glass vials of 25mL, using the bottle technique (one bottle corresponds to one point). After adding a fixed mass of MWCNT into MS2 stock solution, with or without SRNOM, the vials were mixed for 3h at 40rpm. After adsorption, samples were filtered with 0.45µm PES filters prior analysis.

**3. Results and discussion**

Batch experiments showed that MS2 removal is due to adsorption and is proportional to the mass of MWCNT. For pH between 5 and 8, the removal is equal to 0.3log/mgMWCNT. Batch experiments with SRNOM at different pH showed that SRNOM adsorbs onto MWCNT too, with a higher affinity at pH5. Competition between SRNOM and MS2 was tested with co-adsorption experiments and with preloading experiments. Figure 1 shows the results of the co-adsorption experiments, where the competitive effect of SRNOM even at low concentration. Virus removal drops by 38% at a concentration equal to 0.4mgC/L. This concentration corresponds to concentrations found in clean ground waters. Virus removal in low and middle-income countries using pristine MWCNT filters is highly compromised since a wide diversity of waters could be used for drinking water treatment.

Figure 1: Virus removal by MWCNT as a function of Suwannee River Natural Organic Matter (SRNOM) concentration

**4. Conclusions**

The use of pristine MWCNT filters for virus removal is highly compromised by the presence of NOM that irreversibly adsorbs onto MWCNT. Saturation is quick since at a concentration of 5mgC/L of SRNOM, virus removal drops from 3.7log to 0.02log. MWCNT functionalization could be on option to limit NOM adsorption.

**References**

[1] Juma, M., Nuhu, S., Juma, F.B., 2018. Challenges of Water Accessibility in Peri-Urban Areas in Tanzania: A Case of Kigamboni Dar es Salaam. J. Soc. Sci. Res. 4, 47–54.

[2] Peter-Varbanets, M., Zurbrügg, C., Swartz, C., Pronk, W., 2009. Decentralized systems for potable water and the potential of membrane technology. Water Res. 43, 245–265. https://doi.org/10.1016/j.watres.2008.10.030.

[3] Gibson, K.E., 2014. Viral pathogens in water: occurrence, public health impact, and available control strategies. Curr. Opin. Virol., Virus entry / Environmental virology 4, 50–57. https://doi.org/10.1016/j.coviro.2013.12.005

[4] Vecitis, C.D., Schnoor, M.H., Rahaman, M.S., Schiffman, J.D., Elimelech, M., 2011. Electrochemical Multiwalled Carbon Nanotube Filter for Viral and Bacterial Removal and Inactivation [WWW Document]. https://doi.org/10.1021/es2000062