



One-day symposium on UV disinfection in developing countries

November 6, 2014 - Delft, The Netherlands



2.1 billion people have gained access to improved drinking water sources since 1990. Despite the increase in coverage the challenge of drinking water disinfection in developing countries still persists, as not all improved sources are necessarily safe. The risks associated with disinfection by-products of chlorinated drinking water are often underestimated, particularly in developing countries. In recent years an increasing number of demonstration projects have highlighted the great potential of UV disinfection as point of use, point of entry, or community-based treatment system.

This one-day symposium on UV disinfection in Developing Countries organized by IUVA and UNESCO-IHE in November 2014 in Delft (The Netherlands) will encompass basic principles of UV disinfection, applications, commercial solutions, research and future up-scaling potential of this safe and reliable technology.

A pool of international experts in the field of disinfection and UV technology will present the following topics:

- The challenge of disinfection in developing countries
- Global trends in waterborne diseases
- Basic principles of UV disinfection
- Review of existing point of use systems
- Solar-UV based processes and fundamentals
- New UV sources and their possible applications (LEDs)
- UV applications in developing countries – Field experiences
- Case studies of UV installations: lessons learned

Finally, the academic, practitioner and manufacturer experts will be involved in a panel discussion on the future potential of UV for clean water in developing countries, including a critical look at the future role of UV technology in meeting the needs for safe drinking water in developing countries.

Sponsors

One-day symposium on UV disinfection in developing countries



Prof. Maggy Momba was born in Democratic Republic of Congo. She holds a BA degree in Education, BSc Honours and MSc degrees in Biology, MSc and PhD degrees in Microbiology. Currently, she is a Full Research Professor in the Department of Environmental, Water & Earth Sciences at Tshwane University of Technology (TUT) and a South African Research Chair in Water Quality and Wastewater Management. Prof Momba conducts research activities on various aspects of water with emphasis on drinking water purification and wastewater management, health-related water microbiology, bioremediation and pollution preventive measures. After 25 years of specializing in the field of water research, she is a National Research Foundation (NRF) C2 Rated Scientist. Prof Momba has over 180 publications. Her research achievements have led to an international award for 'Outstanding Community Support' in 2004, a South African Women in Water Award and a Vice-Chancellor's Senior Research Medal in 2005, a Woman Researcher of the year in 2008 and 2011, Vice Chancellor Female Senior Research of the year in 2012 and Institutional Innovator of

the year in 2012. These awards elevated her status as a force to reckon with, in terms of water research in South Africa and beyond. Prof Momba is a member of not fewer than 13 national and international scientific committees, among others, Water Research Commission (WRC) steering committees, the Water Institute of South Africa, the Editorial Board of Water SA, the International Water Association, the DNA Bar-coding of Life Committee, and reviewer of about 10 refereed journals. Prof. Momba is a mother and a devoted Christian.

The challenge of drinking water disinfection in developing countries

The availability of safe drinking water is a substantive health concern. Tremendous progress has been made up to date: over 2 billion people have gained access to improved drinking water since 1990, and the Millennium Development Goal of halving the number of people without access to improved drinking water was achieved in March 2012, ahead of schedule. However, 783 million people still do not have access to safe drinking water. Lack of access to safe drinking water is certainly true in most parts of Africa and Asia, particularly in rural areas where water supplies or treatment systems are non-existent or inadequate. One reason safe

drinking water is of paramount concern is that 75% of all diseases in developing countries arise from polluted drinking water. A number of studies have suggested that the key to reducing or even eradicating the burden of waterborne diseases is through appropriate sanitation facilities and piped water systems. Centralised systems could take decades to be established, especially in impoverished rural communities of developing countries, where populations are dispersed and the proportion served is less than half that in urban areas. Rapidly growing, unplanned, peri-urban areas are also not effectively served by centralized systems. Moreover centralized approaches are often plagued by high capital costs, lack of proper operation, and an overreliance on treatment technologies that cannot be afforded or maintained in developing countries due to lack of skilled human resources. If only one barrier is possible, it has to be disinfection unless evidence exists that chemical contaminants are more harmful than the risk from ingestion of microbial pathogens. During the symposium, challenges of drinking water disinfection in developing countries, especially in Africa will be discussed.



Mr. Tonnie Telgenhof Oude Koehorst is manager of business development & Sales UV at Nedap Light Controls where he has been for more than 30 years. With a degree in electrical engineering he worked on several Power Supply projects for customers like Xerox and Eastman Kodak in the past. He is now responsible for the UV business at Nedap Light Controls, world's leading company for Electronic Lamp Drivers for UV applications, like the drinking water plant in New York, that is powered by Nedap technology.

Case studies of UV installations: lessons learned

"Access to safe water is a fundamental human need and therefore a basic human right" (Kofi Annan).

This was bottom line the target we had at Nedap during our search for a "pure and simple" solution for drinking water systems for rural areas. The following challenges were set for this system: usage of present water sources, multi barrier process, (limited) storage of water and most important low costs. In addition also requirements for transportation and maintenance of the system were highlighted. An innovative water purification device that combines well-established solar energy systems and UV water treatment technology has the potential to bring low-cost, safe water to millions in the developing world. The design of the Naiade purification system will be presented together with the industrialization and the type testing at several institutes. Furthermore the field tests will be discussed and results shown, together with the experiences over the last years.

The Naiade purification unit can be set up and operational within 30 minutes. No special infrastructure is required and a single unit can meet the water requirements of between 250 and 400 people at costs as low as € 1,50 per person per year.

In September 2013 the Naiade received the IUVA Green UV Award.



Prof.dr. Ana Maria de Roda Husman has over 20 years of experience as a principal investigator in molecular virology and water microbiology. She advises policy makers at the Dutch government, the European committee, and a.o. WHO, ECDC, and EFSA on the possible public health risks on environmentally transmitted infectious diseases from exposure to human pathogens in water, soil and air, and possible intervention measures. She has published over 100 peer-reviewed papers in scientific journals, and several book chapters, reviews and reports. She directs infectious disease research and policy advise at the dept. of Environment at the Center of Infectious Disease Control. She holds the chair of Global changes and environmentally transmitted

infectious diseases at the Institute for Risk Assessment Sciences of Utrecht University. She has served as an expert for WHO since 2004 for the revision of the Guidelines for Drinking Water Quality, and is a partner in the WHO Collaborating Center for Risk Assessment of Pathogens in Food and Water. She was appointed in the Dutch Soil Protection Technical Committee since 2013.

Global trends in waterborne infectious disease

Waterborne diseases are caused by pathogenic microorganisms, including bacteria and protozoa, and other pathogenic parasites and viruses, that are transmitted through ingestion of contaminated water. Infection commonly results during bathing, washing, drinking, or the consumption of food. Diarrheal diseases account for the highest disease burden. Other common waterborne infectious diseases include schistosomiasis, and hepatitis. Children in low-

income countries are mostly affected. According to the World Health Organization, such waterborne infectious diseases account for an estimated 4.1% of the total DALY global burden of disease, and cause about 1.8 million human deaths annually. The World Health Organization estimates that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene. Prevention of waterborne disease includes protection of source waters, treatment of source waters and safe distribution of drinking water. And, household water treatment and safe storage. Different waterborne pathogens behave differently, and therefore their sources, humans, animals and/ or the environment itself, their behavior in water and their inactivation and removal mechanisms in general are discussed.



Dr. Pilar Fernández is one of the most relevant researchers in the field of solar photocatalytic disinfection of water. Her expertise covers Solar Energy Engineering; Advanced Oxidation Technologies; Water Treatment and Purification; Solar Photocatalytic Destruction of Microorganisms in Water; Colloids and interfaces in water. Her main focus of research is towards solar reactors for water treatment and disinfection. Her previous collaborations have included research in Uganda, South Africa, Peru, among other countries. She is head of the Solar Water Treatment Group at Plataforma Solar de Almería (CIEMAT, Spain), and is a visiting Professor at the University of Ulster and University of Medellín (Colombia).

SODIS Enhancement Technologies: Pilot testing in developing countries

Her talk will introduce the scientific basics of solar reactors for water disinfection. The talk will review of experiences of her group on solar reactors engineering for disinfection of drinking water and wastewater for irrigation reuse. Different ways to enhance the effectiveness of solar disinfection like the use of solar mirrors, low cost solar reactors, and solar assisted advanced oxidation processes will be presented. The experience of on solar reactors testing with different water pathogens at Plataforma Solar de Almería (Spain) and in other locations in Africa and Latin America will be reviewed.



Dr. Michael R. Templeton is a chartered civil engineer and Senior Lecturer in Public Health Engineering in the Department of Civil and Environmental Engineering at Imperial College London. He holds a bachelor's degree in engineering science and a PhD in civil-environmental engineering, both from the University of Toronto. He is also the Vice-President of the Europe, Middle East and Africa region of IUVA. Dr Templeton's research focuses on disinfection processes in both developed and developing world contexts, and his previous collaborations have included research in Nepal, Ethiopia, and Senegal, among other countries.

Basic principles of UV disinfection

His talk will introduce the scientific fundamentals of UV disinfection, to ensure everyone is on the same footing for the subsequent technical talks relating to UV technology options. The talk will include an overview of the biological inactivation mechanism of UV, how UV is generated, and what water quality parameters are most important in determining UV disinfection effectiveness.



Dr. Karl G. Linden is the Helen and Huber Croft Professor of Environmental Engineering at the University of Colorado Boulder, USA. He teaches classes Sustainable Water Reuse, Water, Sanitation and Hygiene, and UV Processes in Environmental Systems. Dr. Linden's research investigates appropriate water treatment technology for the inactivation of pathogens and the degradation of organic contaminants in water with a focus on UV. He has worked in India, Rwanda, Peru and Central America. Dr. Linden was the 2013 recipient of the Pioneer Award in Disinfection and Public Health. He is a Trustee of the AWWA Water Science and Research Division, and current President of the International Ultraviolet Association (IUVA).

Point of use UV systems: The good, the bad and the ugly

UV systems for disinfection of water have been developed over many scales from personal use UV disinfection wands to huge systems treating millions of cubic meters per day. This presentation will provide a critical review of the current state of point of use and point of entry UV disinfection systems available around the world, and their appropriateness for applications in developing countries.



Dr. Tamar Kohn is an Assistant Professor at the Swiss Federal Institute of Technology, Lausanne (EPFL), where she heads the Laboratory of Environmental Chemistry. She obtained an MSc in Environmental Sciences from ETH Zurich, a PhD in Environmental Engineering from Johns Hopkins University, and she spent two years as a post-doctoral fellow at UC Berkeley. Dr. Kohn's research aims to understand the fundamental processes controlling the fate of waterborne pathogens in natural and engineered systems. She is particularly interested in the sunlight-mediated inactivation of enteric viruses.

Solar-UV based inactivation - fundamentals and applications

Dr. Kohn will discuss our current understanding of solar-UV mediated pathogen disinfection, with an emphasis on viruses. Her talk will include an overview over the relevant solution-phase photochemical processes, as well as the resulting molecular biological changes in pathogens that cause inactivation. She will furthermore discuss the advances in modeling and predicting of solar-UV disinfection, and she will highlight some applications that utilize solar-UV for water and wastewater treatment.



Mr. Oliver Lawal has worked in the water treatment industry for over 15 years. He currently serves as President of Aquionics Inc., a leading supplier of UV treatment equipment and working on the front line of UV-C LED commercialization. He previously held a number of research and executive positions based in England, France, Germany, Holland and New Zealand, before moving full time to the US in 2005. Oliver holds two engineering degrees from Manchester University in the United Kingdom and is a Chartered Engineer (PE). He has been published in a variety of national and international forums. He actively serves on the board of directors of the International Ultraviolet Association and has been involved in the Cincinnati area Water Confluence from inception.

New UV sources and their possible applications

Water disinfection employing UVC LEDs in lieu of conventional mercury based technology has been a hotly anticipated breakthrough development for almost a decade. Since the launch of the first commercially available system in 2012, the true possibilities with this technology are only now becoming fully evident. UVC LEDs present a fundamental shift in disinfection possibilities. Compact systems can be used in applications such as medical devices, pharmaceutical batch processing, personal use and rural community decentralized treatment. The inherent benefits of UV-C LEDs, which are; mercury free, instant on/off, low voltage sources, create key drivers for market adoption. This paper will provide an understanding of UV LED based technology compared to other UV source based disinfection solutions and how the technology can be applied in the real world.



Mr. Fermin Reygadas is an Ashoka Fellow and the Executive Director of Fundacion Cantaro Azul, a non-profit organization based in Mexico that designs, implements, and evaluates ultraviolet water disinfection solutions for households, schools, and kiosks in rural communities. Fermin has an interdisciplinary MS from the Energy and Resources Group at UC Berkeley and is a PhD candidate in the same program. Since 2004, Fermin has led and participated in several water projects in Mexico, Bolivia, and Sri Lanka. His work has been recognized by the US Environmental Protection Agency's Student Design for Sustainability award, the Sustainable Products and Solutions Program award, the Big Ideas at Berkeley competition, and as a finalist of the Prize for Water Adaptation Actions at the 6th World Water Forum.

UV water disinfection in rural households – results from a rigorous evaluation

Fermin will present the results of a rigorous and comprehensive evaluation of an ultraviolet water disinfection system designed for rural households. This stepped wedge randomized control study was co-led by Fermin and other researchers at UC Berkeley and involved the installation and one-year follow up of over 350 ultraviolet systems in north Mexico. Fermin's talk will focus on the field efficacy and user compliance components of the study, but will also briefly describe the system design and laboratory validation processes, as well as the water quality and health impact assessments.



8:00 - 9:00 *Registration*

8:45 - 9:15 *Opening and welcome*

9:15 - 10:00

Key note: The challenge of drinking water disinfection in developing countries

Maggie Momba, Tshwane University of Technology, South Africa

10:00 - 10:30

Global trends in waterborne infectious disease

Ana Maria de Roda Husman, RIVM, The Netherlands

10:30 - 11:00 *Coffee break*

11:00 - 11:30

Basic principles of UV disinfection

Mike Templeton, Imperial College, London, UK

11:30 - 12:00

Point of use UV systems: The good, the bad and the ugly

Karl Linden, University of Colorado, Boulder, US

12:00 - 12:30

Solar-UV based inactivation – fundamentals and applications

Tamar Kohn, École Polytechnique Fédérale de Lausanne, Switzerland

12:30 - 13:30 *Lunch*

13:30 - 14:00

UV water disinfection in rural households – results from a rigorous evaluation

Fermin Reygadas, Ashoka Fellow and Executive Director of Fundacion Cantaro Azul, Mexico

14:00 - 14:30

SODIS Enhancement Technologies: Pilot testing in developing countries

Pilar Fernandez, Plataforma Solar de Almeria, Spain

14:30 - 15:00

New UV sources and their possible applications (LEDs)

Oliver Lawal, Aquionics, US

15:00 - 15:30 *Coffee break*

15:30 - 16:00

Case studies of UV installations: lessons learned

Tonnie Telgenhof Oude Koehorst, NEDAP, The Netherlands

16:00 - 16:45

Panel discussion

What role can UV play in developing communities? – Taking an honest look

17:00 – 18:00 *Happy Hour Mixer*

Costs and registration

The costs for attending the symposium are
€ 250 (Early bird registration, until September 6)
€ 300 (Regular registration, after September 6)
€ 75 (Student registration)

Please register here:
<http://www.eventzilla.net/web/event?eventid=2139040945>

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