

OZONE

N E W S

The Newsletter of the International Ozone Association



Milan, Italy, site of next IOA World Congress, July 2-7, 2023



Kansas City, MO, site of IOA-PAG Conference, August 28-31, 2023

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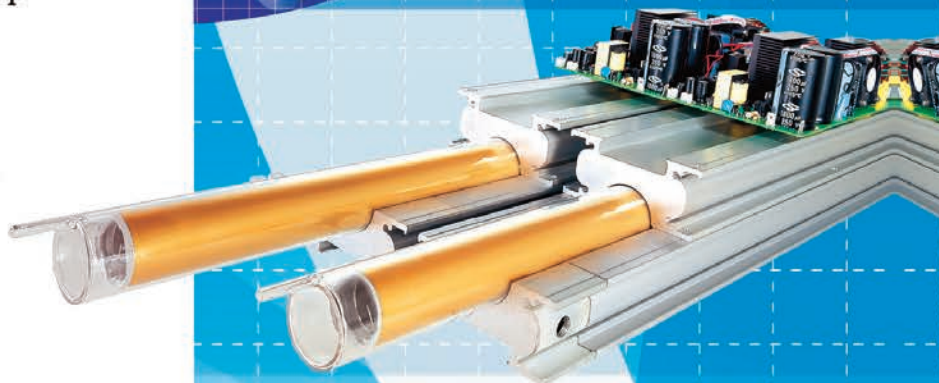
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OZONE NEWS**Volume 51 No. 1****February, 2023****Editor: Barry L. Loeb**

Ozone News (ISSN 1065-5905) is a bimonthly publication of the International Ozone Association (IOA). Annual Subscription Rate \$150.00. For editorial and advertising information, please contact:

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Membership and Publication Information:

The International Ozone Association is a nonprofit educational and scientific organization dedicated to the collection and dissemination of information on, and to promote research in, any and all aspects of ozone and related oxygen species technologies. Membership is open to any individual, corporation, or organization having interest in the latest developments and advancements in ozone technology.

As a member of the IOA, you will receive bimonthly issues of the Ozone News newsletter, bimonthly issues of the technical journal Ozone: Science & Engineering (OS&E), and IOA's Publication Catalog which includes worldwide conference proceedings, monographs, and special reprints. In addition, members receive discounts on IOA worldwide publications and meetings.

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The upcoming World Congress in Milan and the regional conference in Kansas City, MO have been announced. See information in this issue for call for papers which are due shortly.

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Industry News

XYLEM TO ACQUIRE EVOQUA

Xylem, a leading global water technology company and Evoqua, a leader in mission-critical water treatment solutions and services announced that Xylem will acquire Evoqua in an all-stock transaction that reflects an implied enterprise value of approximately \$7.5 billion.

The combined company will build on Xylem's global leadership in water solutions and Evoqua's leadership in advanced treatment solutions and services. Evoqua is a leader in North America water treatment, headquartered in Pittsburgh, PA and operates in more than 150 locations across nine countries. Evoqua previously acquired IOA member company, Pacific Ozone Technologies.

The combined company will be led by Patrick Decker, Xylem's President and CEO.

De Nora and Aclarity Sign Agreement to Destroy PFAS in Groundwater

De Nora signed a Memorandum of Understanding with venture capital backed water technology company Aclarity, Inc. that will target treating harmful contaminants, such as per- and poly-fluoroalkyl substances (PFAS) in water at industrial scale. The MOU combines Aclarity's PFAS destruction technology with the De Nora SORBTM FX product line to quickly and safely eliminate PFAS in ground water.

De Nora, an IOA Gold Sponsor, was founded in 1923 and is listed on the Milan Stock Exchange and specializes in electrochemistry. They are among the world's leading suppliers of water filtration and disinfection technologies for the industrial, municipal and marine sectors and the world's leading swimming pool disinfection components supplier.

Aclarity is a venture capital based woman owned and founded water technology company based in Massachusetts. Aclarity's low energy electrochemical system quickly and safely destroys harmful contaminants in water at the industrial scale in landfill leachate and other concentrated PFAS streams.

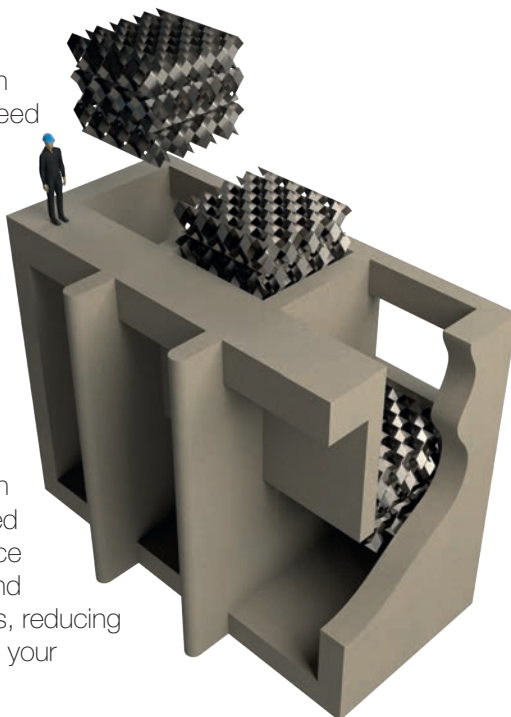
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Industry News (cont'd)

SAAD JASIM RECEIVES OPEA ENTREPRENEURSHIP AWARD



Since 1947, the Ontario Society of Professional Engineers (OSPE) have issued awards to recognize professional engineers in Ontario who have made outstanding contributions to their profession and their community. This year the Engineering Medal – Entrepreneurship Category was awarded to the IOA's Dr. Saad Jasim, with a ceremony in late November. Following is the OSPE writeup on Dr. Jasim which accompanied the announcement of the award.

Over the past 25 years, Dr. Jasim has focused his professional engineering work on health and safety. Currently, he is working on a project to introduce a technology applying ozone as a safe & effective sanitizer in the fight against COVID-19.

He developed, sponsored and led the project; "Removal of Cyanotoxins in Surface Waters Using Ozone & Advanced Oxidation Processes", with the University of Windsor, Canada and Mitacs, 2018-2020. The project investigated the "Removal of Cyanotoxins from Harmful Algal Blooms (HABs)-a Climate Change challenge" in the Great Lakes Region, Canada and USA.

His experience has helped many industries, municipalities, and educational institutions in dealing with complex water quality issues. He successfully used ozone as a primary disinfectant for

A technical diagram of a Mazzei Sidestream Injection & Pipeline Flash Reactor (PFR). The diagram shows a main pipeline with a side stream injection point. The injected fluid is shown as a green spray that mixes with the main flow (blue). The mixing occurs in a flash reactor section, which is a curved pipe with internal baffles. The final output is shown as a well-mixed blue and green fluid. The Mazzei logo is prominently displayed at the top right.

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Industry News (cont'd)

a large municipality (Windsor) and helped in controlling taste & odour, other water quality challenges such as removal of Chemicals of Emerging Concern (Pharmaceuticals, Endocrine Disrupting Compounds, Personal Care Products), and the removal of Cyanotoxins from Harmful Algal Blooms. Many municipalities followed the successful application of Ozone in Windsor.

His contribution as the Founding CEO of the Walkerton Clean Water Centre has been significant as he has developed the Centre into a premier training centre for many water professionals. He successfully managed the project for the construction of the new LEED GOLD building for the Walkerton Clean Water Centre.

Dr. Jasim has also successfully developed and implemented a project for the "Reuse of Treated Sewage Effluent" to deal with water scarcity in arid environments, a growing concern with respect to Climate Change. Dr. Jasim also completed on time and below budget, the design and construction of the water treatment plant for the removal of Arsenic and Manganese in

White Rock, BC, which resulted in 2 Patents applications.

Dr. Jasim has received awards from the International Ozone Association, the OWWA (Ontario Section of the American Water Works Association), the Ontario Ministry of the Environment, the Windsor Essex Region Chamber of Commerce and other organizations in recognition of the high quality of his professional engineering work.

He is the Immediate Past President of the International Ozone Association (2020-2022). The first Canadian to lead this organization.

He is an Adjunct Professor at the Civil and Environmental Engineering, University of Windsor since 1996. He co-supervised 7 Masters student at the University of Windsor, ON, one Master's student at Western University, London, ON, and 2 PhD students at the University of British Columbia, Vancouver, BC. He published many peer-reviewed articles, and presented over a hundred papers at national and international conferences.

Congratulations, Saad on this significant award.

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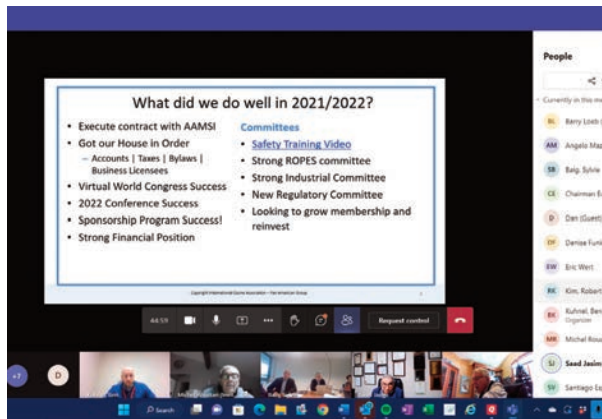
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IOA News

IOA INTERNATIONAL BOARD MEETING



On December 1, 2022, a meeting of the Board of Directors of the International Ozone Association was held in Toulouse, France. This was a combined online and in-person meeting.

IOA President Frédéric Violleau opened the meeting, welcomed attendees, reviewed the agenda and reviewed the IOA Antitrust Statement. A quorum was confirmed.

The minutes of the August 21, 2021 Board meeting were approved as written.

Regional Group Reports

EA3G – Sylvie Baig

The EA3G Group currently has 189 members concentrated in Germany, France, Switzerland, UK and India.

A booklet “*The Low-Dose Concept as Bioregulator of Cellular Antioxidants and Immune Modulator*” authored by Renate Viebahn-Hänsler and Olga Sonia León Fernández was completed and will be available for sale the end of 2022.

The new membership directory has been completed and will be placed online shortly.

Ongoing is a book on Wastewater/Pollutants coordinated by Sylvie Baig and Michel Roustan, based on a selection of 31 papers from past IOA-EA3G conferences. This book is about 95% completed.

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The next EA3G webinar is scheduled for early 2023 and will focus on Implementation and Engineering.

Ozone Days was held March 23-24 at UniLaSalle, Beauvais France. The IOA offered a keynote address at the beginning of the conference.

An IOA-EA3G regional conference was held in Toulouse, France with 80 attendees from 20 countries. There were 40 technical presentations.

Activities are now focused on the upcoming IOA World Congress, July 2-7, 2023 in Milan, Italy.

NIG Group (Submitted by Dr. Fumitake Nishimura)

Membership remains relatively stable at 101. Financial results were positive due to safety manager training sessions and approval certificates.

The JOA annual conference was held November 24-25, 2021 with 102 participants.

A project investigating two-phase stainless steel corrosion is nearing completion. Two-phase (duplex) stainless steel is made up of austenitic stainless steel and ferritic stainless. Its strength is almost twice that of conventional stainless steel. Initial results showed no difference in the test pieces of the two types of steel.

PAG Group (Ben Kuhnel for Nick Burns)

Membership is at 262, a slight drop from 2021.

A contract was executed with AAMSI, Sacramento, CA for providing administrative services to IOA-PAG and this function was transferred from Las Vegas.

A successful virtual World Congress was held in 2021. The sponsorship program, providing free conference admission to students has been successful. A strong ROPES committee continues to engage the younger IOA members.

A PAG annual conference was held in Las Vegas, August 15-18, 2022. There were 168 attendees from 9 countries.

The Membership Committee has secured 11 annual Sponsors. They are looking to apply sponsorship funds to scholarships to attend conferences.

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Further information

www.ioa-ea3g.org

Contact IOA office

ioa@esip.univ-poitiers.fr

- 3-day scientific and technical sessions
- 3-day exhibition
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**Milan, Italy
2 - 7 July 2023**

Water Treatment
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Research Development Events Members
Knowledge Advances
Standards Awards
Fundamentals Industry News
Field application Engineering
Food Processing
Ozone Therapy Worldwide
Agriculture Publications

The Industrial Committee held a webinar “Ozone in Horticulture” with 149 attendees. They are now focusing on cooling tower applications.

A new Regulatory Committee has been formed. Its goal is to educate US and Canadian Regulators. A future webinar is planned. The committee will also track regulations.

Future conferences are Kansas City, August 28-31, 2023; Las Vegas, NV, August 26-29, 2024 and a World Congress in Atlanta, GA, August 25-28, 2025.

Committee Reports

Publications Committee (Barry Loeb)

All issues of Ozone News and OS&E have been completed. We used our full allotment of 600 pages for OS&E in 2022. Starting in 2023 we will no longer have a page limit, but a minimum of 50 papers per year. The “too-large” backlog of papers has dropped to a more manageable level. OS&E remains a nicely profitable journal for Taylor & Francis.

The Impact Factor of OS&E increased somewhat to 2.604, reflecting on the hard work of our Associate Editors and

Editorial Board in increasing paper quality.

Taylor & Francis has proposed a revised contract with a one-year, renewable term. This contract was reviewed and approved by the board. It since has been signed and executed.

The two feature sections of Ozone News, “Tony’s Column” and “Saad’s Perspectives” continue to have a positive impact on Ozone News. Ozone News advertising in 2022 was similar to 2021. We need to get more member companies to consider advertising. Ozone News continues to cover its publishing costs by advertising.

A new Publications Catalog will may be issued after the Milan and Kansas City conferences.

Finance Committee (Sylvie Baig)

The surplus from the 2021 World Congress was \$24,354. This is being distributed to the regional groups.

The 2021 financial summary showing a surplus of \$10,701 was reviewed and approved.

The updated 2022 financial summary showing income and



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expense of \$114,314 was reviewed and approved.

The 2023 IOA budget, showing income and expense of \$116,575 was reviewed and approved.

Strategic Planning (Sylvie Baig/ Frédéric Violleau)

The group will be convening early in 2023 to review the status of IOA Editors as Barry Loeb is retiring the end of 2023.

Next Board Meeting

The next IOA Board meeting is scheduled in Milan, Italy Sunday June, 25, just prior to the opening of the World Congress. Committee meetings will be held on June 24.

A BIG YEAR FOR IOA CONFERENCES.



Milan Duomo

The 26th IOA World Congress is being held in Milan, Italy July 2-7, 2023. Milan, with its robust Northern Italian cuisine is a world-class fashion city and the banking capital of Italy. It is also rich in history, from its Roman ruins and soaring Duomo to a host of ancient churches, medieval castles and Renaissance palaces. It is served by two airports, Malpensa (overseas flights) and Linate (domestic and European flights). It has an excellent Metro system. One of Milan's most famous attractions is at the Santa Maria delle Grazie where Leonardo da Vinci's "The Last Supper" is located.

The conference will include an opening reception, technical presentations, award presentations, technical tours and a closing banquet. There will be a medical ozone conference held in parallel with the conference. A call for papers has been issued and information is located throughout this issue. Also, visit [s](#) and tap on the section "World Congress". Material will be added to this site over the coming weeks.

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Kansas City Intercontinental Hotel

The IOA Pan American Group will be holding their annual regional conference at the Intercontinental Hotel in Kansas City, MO August 28-31. The Intercontinental Hotel is located in the premier shopping and dining area of Kansas City, Country Club Plaza. Attendees will be within easy walking distance of the shopping and dining. The conference will feature technical sessions, a large equipment exhibition, workshops, round table sessions and networking sessions. Reservations for the conference and the hotel are now open, with information available within this issue.

We were pleased to be able to return to in-house conferences in 2021 after a nearly two-year hiatus due to the pandemic. Conferences are critically important to the IOA and IOA members as this is where exchange of information is accomplished and we get to meet our peers in the industry. Please follow the respective websites www.ioa-ea3g.org, www.ioa-pag.org and www.j-ozone.org for updates on conference information.



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Tony's Column



Tony Sacco, Spartan Environmental Technologies

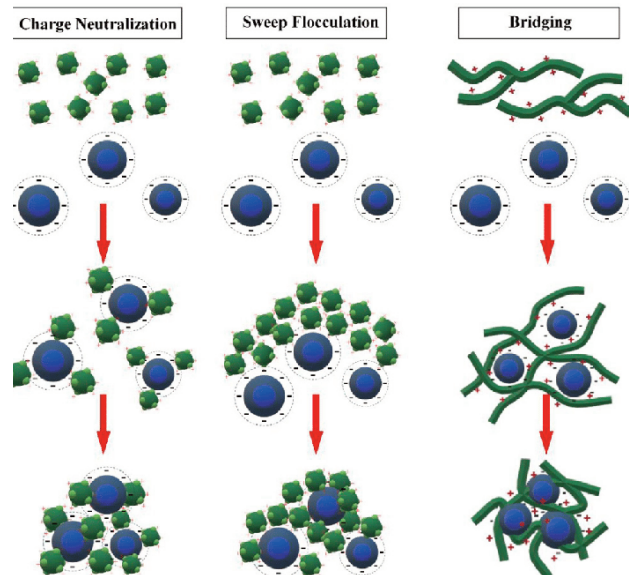
Ozone Enhanced Coagulation and Flocculation

Often ozone is promoted as having multiple simultaneous benefits in water treatment. For example, ozone can be used as a primary disinfectant and for taste and odor control. It can be used as a pre-oxidant and as an aid in coagulation. Being able to provide these benefits improves ozone's economic benefit to the end user.

In this brief note, ozone's impact as an aid in coagulation or flocculation will be covered. This property of ozone has been reported in the literature over the last half century. In a number of drinking water treatment plants using pre-ozonation, improvements in coagulation and flocculation have been observed such as a reduction in coagulants or flocculants while still maintaining turbidity levels after filtration. The effect was unexpected and has been observed and reported on since the 1970's.

Before discussing this property of ozone, it may be worthwhile to define coagulation and flocculation since they tend to be used interchangeably, but colloid scientists define coagulation as processes that compress the electrical double layer to agglomerate particles and flocculation as processes where polymer bridging causes the particles to come together (Kim 1995). The illustration above from Sun et al., (2019) shows several common coagulation and flocculation processes.

In the EPA Enhanced Coagulation and Enhanced Precipitative Softening Guidance Manual, (1999), enhanced coagulation is "defined as the process of obtaining improved removal of DBP precursors by conventional treatment." This is normally accomplished by increasing the dosage of coagulant and pH control, although other parameters can also be employed to



improve the process. The result is typically measured as reduced TOC and turbidity levels.

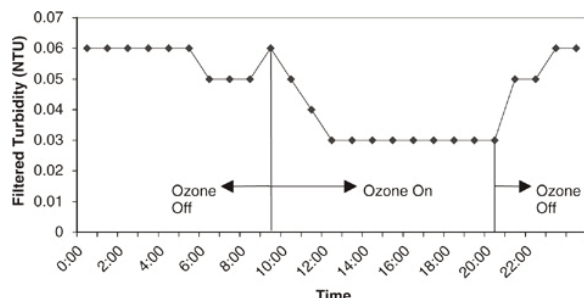
Ozone enhanced coagulation is a relatively new water treatment technology, but it has shown promise in a number of applications. It is particularly useful for treating surface water sources, such as lakes and rivers, which often have high levels of organic matter. It can also be used in combination with other treatment processes, such as filtration, to further improve the quality of the water. From the literature, ozone can act as an aid to both coagulation and flocculation. Although, this effect does not always occur or occur with the same intensity depending on the application and water quality.

Jekel (1994) referring to earlier literature reviews and articles noted ozone's impact of coagulation and flocculation based on measurements of particle size distribution changes, reduction in DOC, reduced turbidity, better settling rates, and improved filter runs. Dose ranges were mainly 0.2 to 2.0 mg ozone/l (0.1 to 0.5 mg ozone/mg DOC). Jekel (1994) indicated that the improvements were related to algae flocculation, destabilization of particles and polymerization of dissolved organics.

Georgeson (1988) observed reductions as high as a 50 percent in cationic polymer usage with pre-ozonation as compared to pre-chlorination. Chang et al. (1991) noted that optimal ozone-induced particle destabilization was found to occur in waters with hardness-to-TOC ratios >25 mg CaCO₃/mg C and ozone doses of about 0.4–0.8 mg O₃/mg C. Jasim et al. (2008), showed in a dual train pilot scale study, that pre-coagulation ozonation improved turbidity and particle count especially for size ranges of 2-3, 3-5 µm and 5-10 µm, compared to the non-

ozonated side at low water temperatures.

Mazloun et al., (2004), illustrated the rapid improvement in turbidity with the use of Pre-coagulation ozonation (below)



In terms of explaining the reasons why ozone improved coagulation and flocculation Jekel (1994) indicated that the improvements were related to algae flocculation, destabilization of particles and polymerization of dissolved organics.

Cui et al. (2020) in another review suggested ozone oxidation changes the surface characteristics of particles directly or by affecting the organic molecules on the surface of these particles. This in turn allows metal ions in solution to bind to particle surfaces and cause agglomerates to form (coagulation). Cui et al. (2020) also noted that ozone can polymerize metastable organics, which results in particle aggregation through bridging (flocculation). Ozone oxidation breaks up organometallic complexes, forming in situ production of coagulants (coagulation).

Cui et al. (2020) further noted that pre-ozonation has a more significant effect on the coagulation of particles in water of medium hardness than on the coagulation of particles in soft water. The most important factors affecting the efficiency of ozonation for coagulation include: the characteristics of the raw water, ozone dose and coagulation conditions (dose and type of coagulant).

Not all research has shown the improvement in coagulation with ozonation. Schneider et al. (2000) studied pre-ozonation effects on coagulation in jar tests and concluded that ozone had limited benefits. Becker et al (2001) concluded that with high DOC, ozone will produce smaller oxygenated compounds that require greater metal containing coagulants to achieve the same level of coagulation.

It appears then that given the proper conditions (hardness, pH, alkalinity, and type and concentration of NOM ozone dose, coagulant type and dose, and pH) ozone can act as an aid in coagulation and flocculation resulting in a reduction in chemical additions normally required, reduced turbidity and

lower DBP. This effect is not limited to just ozone, other oxidants can also enhance coagulation and flocculation. Ozone seems to be more effective than other oxidants for this purpose with fewer negative side effects. Versus pre-chlorination, for example, ozone can reduce the formation of THM's.

It would seem prudent, if ozone is being contemplated for use with a coagulation/flocculation process, to study the affect of ozone on the coagulation/flocculation process. This might indicate additional benefits of ozone and inform decisions on ozone dosage, points of addition, or potential changes in water quality parameters.

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Acknowledgement

The author would like to acknowledge the assistance of Dr. Saad Jasim in reviewing this article and providing important corrections and recommendations.

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Ozone and Ozone based Advanced Oxidation Processes (AOPs) for the Reuse of Treated Sewage Effluent (TSE) -Part I

Climate change could profoundly alter future patterns of both water availability and use, thereby increasing global levels of water stress. The potential extreme changes in water quantity and increase demand due to urban sprawl, may aggravate global 'water stress'.

Water reuse reclaims water from a variety of sources, apply additional advanced treatment processes for reuse in beneficial purposes such as agriculture-irrigation, potable water supplies, groundwater replenishment, industrial processes, and environmental restoration. Wastewater reuse can provide alternatives to existing fresh water supplies and be used to enhance water security, sustainability, and resilience.

Health risk due to presence of pathogens, contaminants of emerging concerns (CECs), heavy metals and other compounds in treated wastewater is one of the primary limiting factors that hamper its reuse potential. Apart from public health, treated wastewater was also found to have some detrimental effects on soil. Excessive nutrients in treated wastewater that is used for agriculture irrigation could lower the hydraulic conductivity of the soil and promote biofilm which would eventually clogs the pore spaces between soil particles.

Antibiotics resistant bacteria is a serious problem associated with wastewater treatment and reuse. Wastewater treatment plant and its effluent have been identified as the breeding ground of antibiotic resistance bacteria. Combined presence of antibiotics and huge spectrum of bacteria in wastewater treatment plant has enabled the bacterial community to swap genes that resist antibiotics and eventually turning into superbugs. Of concern is the uncertainty of potential adverse effects on wildlife and humans due to chronic exposure to low concentrations of these compounds.

Risks associated with reusing treated wastewater

Wastewater discharged by domestic, commercial, agricultural and industrial sectors contains a myriad of pollutants [1–7]

such as: -

- (i) Toxic compounds (e.g. pesticides, polychlorinated biphenyls, solvents)
- (ii) Pathogens (e.g. bacteria, protozoa and virus)
- (iii) Heavy metals (e.g. lead, mercury, arsenic, cadmium)
- (iv) Nutrients (e.g. phosphorus and nitrogen) and
- (v) Contaminants of emerging concern (CECs) (Pharmaceuticals, personal care products, plasticizers, nanoparticles, endocrine disrupting chemicals, etc.).

These pollutants pose significant threats to living organisms and environment. Nearly one in every five children who are younger than 5 years old succumb to death every year due to water related diseases [2]. Discharge of excessive nitrogen from inefficient use of fertilizers and from human/animal waste has caused many environmental issues. Loss of aquatic biodiversity due to eutrophication and ground water pollution by nitrates are some of the concerned environmental problems caused by nitrogen imbalance [2].

Treated Sewage Effluent

Various treatment steps are usually employed in wastewater treatment plants to remove these contaminants prior to discharge or reuse. However, despite these treatment steps, many studies have highlighted the presence of the pollutants [8–13] at various concentrations in treated wastewater, thus raising several concerns related to the usage of this alternative water resource. In addition, concerns have been raised about the spread of antibiotic resistant bacteria or antimicrobial resistant gene proliferation in the environment due to discharge of treated wastewater. Among all, public health is the most crucial issue that needs to be seriously and carefully addressed in all the reuse applications of treated wastewater [12, 14].

Pathogens and contaminants of emerging concern in treated wastewater are the two pollutants that pose the most significant threat to public health [15–17]. The public could be exposed to these pollutants due to direct contact with the polluted treated water (people working or handling treated wastewater, e.g., farmers and workers) or residents who are staying nearby and using polluted water sources. Possible routes for direct contact are via oral ingestion, inhalation and skin contact. Another potential exposure pathway is via indirect consumption of food products of agriculture crops and animals that are being bred using contaminated treated wastewater [14]. Many scientific studies have reported the presence of bacteria, protozoa, helminth and viruses in treated wastewater effluent. Health risk due to pathogen exposure is much greater and almost immediate in comparison to chemicals, which are found in trace amounts in treated wastewater sources. Several studies [18–20] on treated effluent quality of wastewater treatment plants reported on the constant detection of *Cryptosporidium parvum*, a pathogenic protozoan that is responsible for severe diarrheal illness in humans. Another diarrheal causing protozoa

is *Giardia* [7,21], which is also commonly found in treated wastewater. Even single exposure to *Cryptosporidium* can lead to severe health issues [22]. Although many advanced wastewater treatment plants utilize chlorine to disinfect their effluents, there were many cases where chlorine were reported to be largely ineffective in disinfecting pathogens in water sources. Presence of chlorine resistant bacteria is one of the reasons for poor disinfection rate using chlorine [5,23]. Li et al. [24] observed significant regrowth of total coliforms and *Salmonella* after chlorinating reclaimed water. It was postulated that opportunistic pathogens such as *P. aeruginosa* and *Staphylococcus aureus* could be more resistant to chlorine than enteric bacteria [25].

Reuse of Treated Sewage Effluent (TSE)

Treated sewage effluent (TSE) could potentially play a significant role in supplementing the water demand and water scarcity due to climate change.

Pharmaceutical compounds are used extensively to treat diseases in humans and animals. However, a large fraction of these compounds is released to the environment through the excrement of the receptors. Their presence in the environment is of growing concern worldwide. The continuous load of pharmaceutical compounds through human excrement as well as effluents from hospitals and manufacturing plants is responsible for their widespread detection in municipal wastewaters. Conventional municipal wastewater treatment plants (MWWTPs) have limited success in removing many pharmaceuticals (26), resulting in the discharge of these

pollutants into receiving surface and ground waters that are often the sources of drinking water.

A vast number of pharmaceutical compounds have been reported in both the influents and effluents of wastewater treatment plants as well as natural waters and drinking water sources in the Great Lakes Basin (7, 27). Incomplete removal by conventional treatment technologies and potential adverse health effects of pharmaceutical compounds has led to a search for appropriate treatment methods for their efficient removal. Many studies have been reported comparing the removal efficiencies of pharmaceuticals, personal care products and endocrine disrupting compounds by the conventional primary and secondary treatment technologies and by alternative tertiary treatment technologies (e.g., membrane filtration, activated carbon adsorption, and ozonation) for secondary effluents (27; 28, 29, 30). According to these studies, advanced treatment technologies seem to be much more efficient in the degradation of most pharmaceutical compounds compared to conventional treatment methods for wastewater and drinking water treatment.

Benefits of reusing treated wastewater

Grey water generated from daily usage of urban residents and industrial water discards are the primary sources for treated wastewater. These wastewater resources can be effectively used form any useful urban, agriculture and industrial applications as long as they are treated adequately. In many regions, treated wastewater is primarily used for irrigation and landscaping. Table 1 summarizes the utilization of treated

Table 1. Reuse of treated wastewater for various applicaitons

No	Sector	Applications
1	Urban	• Irrigation and landscaping of public parks, recreational field, school yards, golf course, highway medians and residential. • Fire protection. • Toilet flushing in commercial and industrial buildings. • Vehicle washing
2	Agricultural reuse	• Irrigation of non-food crops (seed crops, industrial crops, processed food crops, fodder crops, orchard crops, etc.) and commercial nurseries. • Irrigation of food crops. • Watering of Livestock
3	Recreational impoundments	• Artificial lakes and ponds
4	Environmental reuse	• Creating artificial wetlands and enhancing natural wetlands • Sustaining and augmenting river or stream flows.
5	Non Potable Reuse	• Groundwater recharge/Recovery of treated water for subsequent reuse or discharge • Recharge of adjacent surface streams
6	Potable Reuse	• Indirect Potable Reuse • Direct Potable Reuse
7	Industrial Reuse	• Process cooling, cooling tower and boiler water make-up

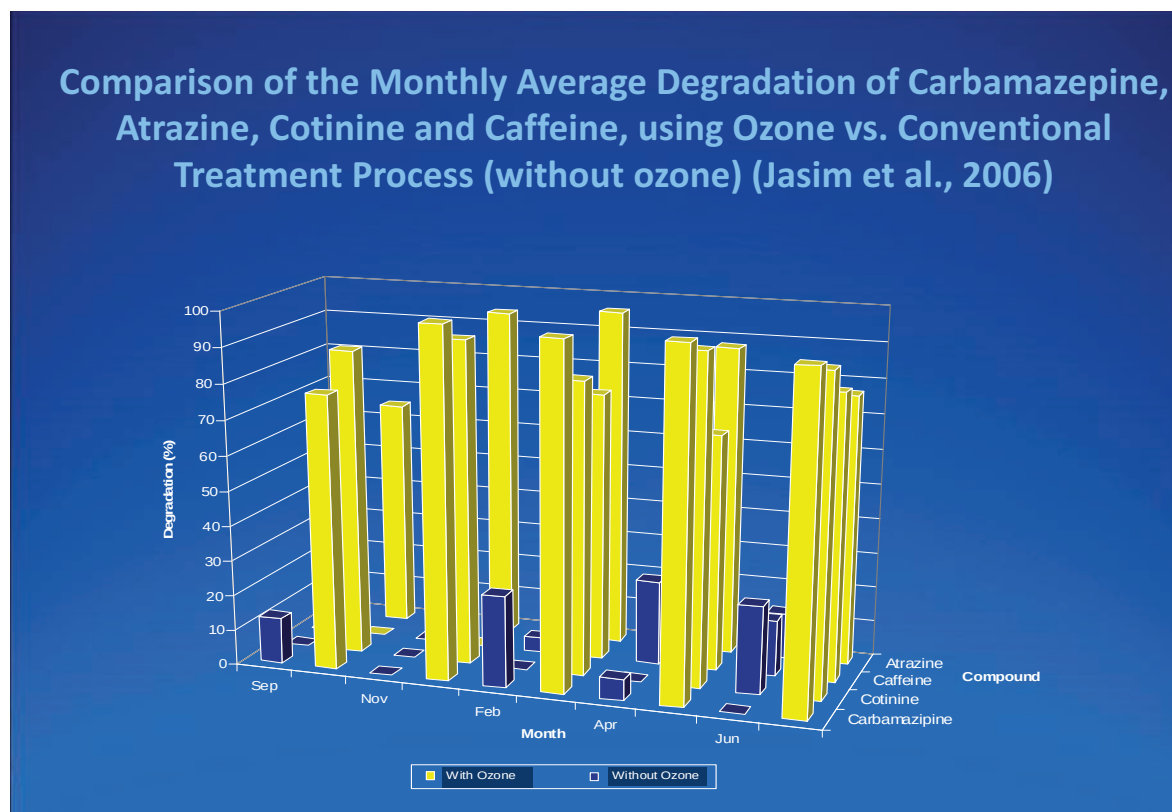


Figure-1 a, Ozone application for the degradation of Pharmaceuticals, Personal Care Products and Endocrine Disrupting Compounds in Detroit River (7).

wastewater in various sectors (30). The water quality requirement of each end-user determines the type of wastewater and its degree of treatment. For instance, TSE water quality required for food crop irrigation and process cooling is distinctly different.

Ozone and Ozone based Advanced Oxidation Process (AOP)

Ozone and ozone based Advance Oxidation Process (AOP) high efficacy for oxidation of pharmaceuticals and other CECs compounds in water and wastewater have been noticed in studies conducted through lab and pilot scale experiments to evaluate its effectiveness in degradation of these compounds under different operational conditions, Figure-1, (7).

Ozone is a powerful oxidant and reacts with target compounds in a water system either directly or indirectly through its decomposition into reactive and non-selective hydroxyl radicals, while advanced oxidation process (AOP) is particularly more efficient for removing ozone recalcitrant compounds due to the less preferential nature of the hydroxyl

radicals, Figure-2 (31). The reactivity of ozone with target compounds in water is strongly related to their molecular structure and the quality parameters of water such as pH, dissolved organic carbon content (DOC) and alkalinity. Ozone itself is known to react instantly especially with unsaturated double bonds and aromatic rings substituted by an activating group such as $-OH$ (phenol) and $-NH_2$ (aniline), while the degradation of other compounds depends on the hydroxyl radical generation capacity during ozonation. Alkalinity of wastewater is known to increase ozone stability in water because it acts as an inhibitor in ozone decomposition by scavenging OH radicals. However, higher ozone demand by organic carbon content of water (for oxidation purposes) reduces stability of ozone in water.

To be continued...

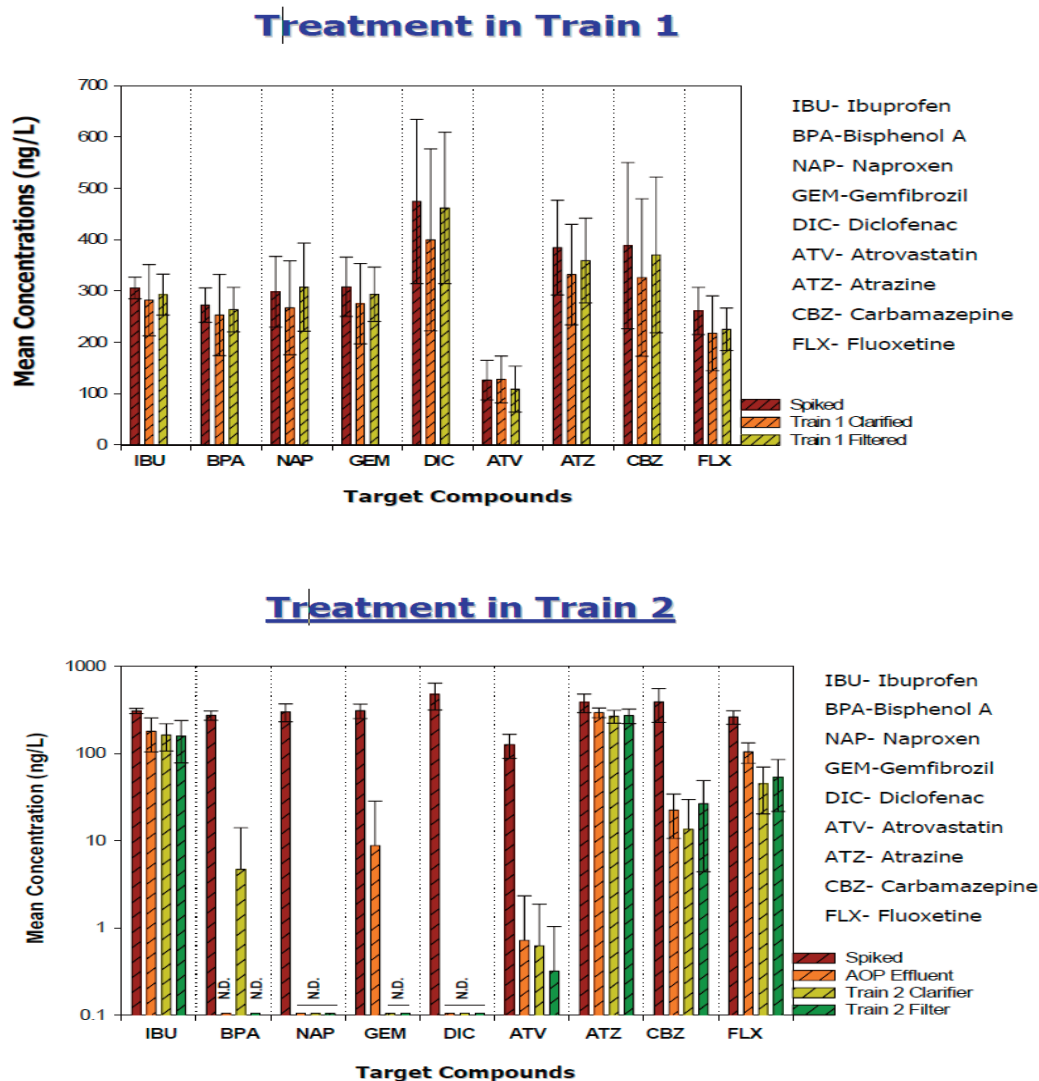


Figure-2, Removal/degradation of Chemicals of Emerging Concern (CECs) in a dual train pilot plant study, Lake Huron, Train-1, conventional treatment processes, and Train-2 with ozone based Advanced Oxidation Process, (31).

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Speakers whose abstracts are selected will receive a discount of \$100 off of the Early Bird Conference registration fee!

Attention Students:

When submitting your abstract, inform support@ioa-pag.org if you'd like to be considered for a Memorial Scholarship Award to receive a complimentary Conference registration!

Roundtable Discussions:

Roundtable discussions will be featured in the Technical Program. If you would like to lead/moderate a discussion using this format, please submit your idea through the Call for Abstracts link.

Questions?

For questions regarding the IOA-PAG Conference or Abstract submissions, please contact the IOA-PAG at support@ioa-pag.com or (916) 441-0629.





The International Ozone Association
is pleased to invite you to take part in the

26th World Congress & Exhibition

2 - 7 July 2023, Milan, Italy

Ozone and Advanced Oxidation Leading-edge science and technologies

This event continues a long series of successful congresses organized worldwide to provide an international forum for all concerned with fundamental, engineering and applied aspects oxidation techniques involving ozone and advanced oxidation systems.

SCOPE

The upcoming congress will host experts from all over the world to present and discuss the latest advances in knowledge and technology for development and application of processes based on ozone or any advanced oxidation system for:

- Environment preservation and human health protection: water, gas, soil and waste purification, water reuse and recycling, recovery of valuables
- Industrial manufacture and conditioning: pulp and paper, agri-food, electronics, chemicals, oil&gas, ...
- Medical therapy.

OBJECTIVES

The IOA wishes to continue to offer the world the unique opportunity:

- To interface with scientists, researchers, students, engineers, users, technical experts, representatives of leading organizations from various disciplines,
- To share the latest information on research topics, current issues, technologies under development, new applications, full-scale experiences, equipments and products,
- To consider and discuss directions able to deliver innovative, competitive and sustainable solutions which address current and next challenges.

PROGRAMME

The congress will feature:

- Three concurrent scientific and technical sessions including keynote lectures, oral communications, short oral presentations with connected poster exhibition and workshops (3-5 July),
- Exhibition of Industry's technologies, products and services (3-5 July),
- Technical visits of full-scale application plants (6-7 July),
- Social and cultural events for delegates and their guests: tours, congress dinner (2-5 July)

ANNOUNCEMENT

▣ CALL FOR PAPERS AND EXHIBITORS ▣

Water Treatment
Science and Technology
Research Development Events Members
Knowledge Advances
Fundamentals Standards Awards
Field application Industry News
Food Processing Engineering
Ozone Therapy Worldwide
Agriculture Publications



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TOPICS OF INTEREST

Relevant to the Congress theme include but are not limited to the combinations of:

- Chemical and biochemical reactions
- Reaction mechanisms
- Reaction kinetics and modelling
- Advanced oxidation processes
- Synergies with ozonation
- Hydrodynamics and mass transfer
- Reactor design / Modelling / Validation
- By-product's formation and control
- Process optimization and control tools
- Ozone generation
- Multiphase reactors
- Gas diffusion devices
- Regulatory requirements
- Gas treatment and odour control
- Soil remediation
- Biosolids treatment
- Water disinfection
- Emerging contaminants, occurrence and treatment
- Pollutant removal
- Wastewater treatment for reuse or discharge
- Application in agricultural and industrial processes
- Action on materials and surfaces
- Measurement and on-line monitoring
- Operation studies
- Competitiveness of technologies
- Medical applications
- ...

SUBMISSION OF ABSTRACTS

Researchers, scientists, practitioners are invited to propose oral or poster presentations related to the theme topics.

Authors should submit an extended abstract in English of two to four pages (with tables and figures) by 13 March 2023:

- Preferably online at www.ioa-ea3g.org/congress/
- By e-mail with the submission form to the IOA-EA3G Secretariat.

Each proposal should be accompanied by the Submission form enclosed duly filled.

The Programme Committee will notify authors about the acceptance of their papers for oral or poster presentation before 31 March 2023. Any speaker will be allowed to make a maximum of two presentations.

SUBMISSION OF WORKSHOPS

Workshops aim to transfer knowledge through intensive interaction with the audience. Prospective organisers should submit their proposals according to the abstract submission system.

SCHEDULE

1 st March	Early programme and registration
13 March	Submit abstracts by this deadline
13 March	Book your booth, sponsoring option
31 March	Notification of acceptance of papers
1 st May	Discover the general programme
29 June	Deadline for full papers or presentations
2 July	Attend the Congress with your guests

AWARDS AND PUBLICATIONS

During the congress, the Programme Committee will select and award a prize to the best paper presented by a PhD student. All accepted papers will be printed in the congress proceedings handed out to participants at registration. After the congress, the editors of the IOA journal "Ozone: Science & Engineering" will make a final selection for a potential publication as peer-reviewed article.

EXHIBITION AND SPONSORSHIP

The exclusiveness of the Congress allows exhibitors and sponsors an ideal opportunity to meet a unique and targeted audience. Organizations and companies are invited to support the Congress organization and to display their technologies, products and services related to the Congress theme.

For detailed information on exhibition and sponsoring options, please contact the Congress Office to make the most of this event.

IOA office ioa@esip.univ-poitiers.fr

REGISTRATION

Registration will be available beginning of March. Speakers will have to register by 30 April to fix the Programme.

The registration fees will cover scientific and technical sessions, book of abstracts, electronic proceedings, lunches, coffee breaks, exhibition, cultural and technical tours and congress dinner.

CONGRESS VENUE

The Congress venue will be Politecnico di Milano, Piazza Leonardo da Vinci, 32, 20133 Milano MI, Italy.

LANGUAGE

The official language will be English.

CONTACT AND UPDATES

For any request: IOA-EA3G Secretariat

Fax +33(0)549 454 060

E-mail: ioa@esip.univ-poitiers.fr

CONGRESS WEBSITE

www.ioa-ea3g.org/congress



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SUBMISSION FORM ▢ REQUEST FOR INFORMATION

SUBMISSION

Authors are kindly invited to propose an extended abstract related to original contribution on any of the topics of the congress by 13 March 2023. Abstracts can preferably be submitted online at www.ioa-ea3g.org/congress or by e-mail to the IOA-EA₃G secretariat. Each proposal submitted by e-mail should be accompanied by this submission form dully filled. An acknowledgement of receipt of your submission with ID number will be sent to your e-mail address after submission. If you do not receive any confirmation, your submission needs to be re-submitted.

For submission of abstract or request of further information, to be returned before 13 March 2023 by e-mail to:
IOA-EA₃G Secretariat, E-mail: ioa@esip.univ-poitiers.fr

YOUR SUBMISSION OR REQUEST

☐ I wish to submit an abstract or a workshop, see the document enclosed sent by E-mail entitled:		
.....		
Speaker's name:		
Co-author's names:		
PREFERENCE: ☐ ORAL presentation ☐ POSTER presentation (with oral summary) ☐ WORKSHOP		
☐ I wish to receive the final program of the congress and information for registration		
☐ I wish to receive information on sponsoring options ☐ I wish to receive information on exhibition		
☐ Other:		

Please mark the field - theme and topic - to which the subject of your abstract belongs.

THEMES (choose only one please)

- | | | |
|---|---|--|
| ☐ Chemistry | ☐ Medicine | ☐ Drinking water |
| ☐ Chemical Engineering | ☐ Agri-Food application | ☐ Medical application |
| ☐ Biology | ☐ Process industry application | ☐ Other |
| ☐ Physics | ☐ Wastewater treatment | |

TOPICS (several allowed)

- | | | |
|---|--|--|
| ☐ Reaction mechanisms, kinetics, by-products | ☐ Modelling, validation, system design | ☐ Industrial applications |
| ☐ Ozonation | ☐ Analytical methods | ☐ In-field full scale applications |
| ☐ Advanced oxidation | ☐ Agri-Food safety and quality | ☐ Product / Process R&D |
| ☐ Disinfection | ☐ Waste, Air and Soil treatment | ☐ Hybrid ozone processes |
| ☐ Ozonolysis | ☐ Wash water, process water | ☐ Innovative applications of ozone and related oxidants |
| ☐ Hydraulics, hydrodynamics, mass transfer, contactors | ☐ Wastewater treatment, recycling and reuse | |
| | ☐ Ecosystem preservation | |

YOUR CONTACT DETAILS

☐ Mrs. ☐ Mr. LAST NAME:	First Name:	☐ IOA Member
Organisation:		
Address:		
Country:		
Phone: + E-mail:		

EDITORIAL GUIDELINES for abstract and workshop submission

All proposals must meet the editorial guidelines detailed at www.ioa-ea3g.org/congress.

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The Newsletter of the International Ozone Association

ISSN 1065-5905

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