INDUSTRY INNOVATIONS

Where Product Innovation Meets Best Practice

Volume 4, Number 2, Winter 2022/2023

HVAC & AIR FILTRATION

Official Publication of
ipac
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VOLUME 4, NUMBER 2, WINTER 2022/2023

INDUSTRY INNOVATIONS

IPAC CANADA – THE SMART WAY TO ADVANCE INFECTION PREVENTION AND CONTROL.

PUBLISHED FOR IPAC-CANADA BY:

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VISION

IPAC Canada – No preventable infections. Ever.

MISSION

IPAC Canada – We inspire, nurture and advance a culture committed to infection prevention and control.

https://ipac-canada.org/industry-innovations.php

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Foreword

"COVID-19 has also forced IPAC professionals to re-examine what has always been considered to be true – clear and simple modes of transmission and their corresponding Additional Precautions requirements. A true paradigm shift has occurred as a result of this pandemic. No longer is there a line in the sand between droplet and airborne spread."

Dear IPAC Canada Members,

Welcome to the Winter 2022 issue of *Industry Innovations*, IPAC Canada's publication aimed at highlighting technological innovations offered by our industry partners.

While the Severe Acute Respiratory Syndrome (SARS) outbreak of 2002-2004 paved the way to integration of infection prevention and control (IPAC) practices into all healthcare settings and the promotion of cross-organizational and cross-sector collaboration, the coronavirus pandemic of 2020, 2021, and beyond has had an even more profound impact on the IPAC field. COVID-19 has reminded us that IPAC must be considered in all aspects of what we do; from our administrative spaces and policies and procedures to our staff breakrooms and public cafeterias, to our care areas and the healthcare environment as a whole. Every nook and cranny of our organizations must be re-evaluated with fresh eyes.

COVID-19 has also forced IPAC professionals to re-examine what has always been considered to be true – clear and simple modes of transmission and their corresponding Additional Precautions requirements. A true paradigm shift has occurred as a result of this pandemic. No longer is there a line in the sand between droplet and airborne spread. COVID-19 has caused an IPAC paradigm shift. For some, the fact that we are now actively seeking out experts in filtration and ultraviolet technology and developing relationships with professionals in the field of fluid dynamics, can be intimidating. It may seem easier to return to what we thought we knew to be true. But what about using this opportunity to explore new and innovative ways (or possibly to think more intentionally about technologies that have been available to us for quite some time) to control transmission of organisms?

This issue of *Industry Innovations* highlights technologies from two different companies. Chem-Aqua, Inc.™ shares its perspective on installation of ultraviolet (UV) systems within HVAC air handling coils while Surgically Clean Air, Inc.™ discusses its viewpoint on indoor air purification systems. Both UV and air filtration are not new concepts to the IPAC field, but both technologies have garnered much attention during the last several years, as adjuncts to traditional IPAC measures.

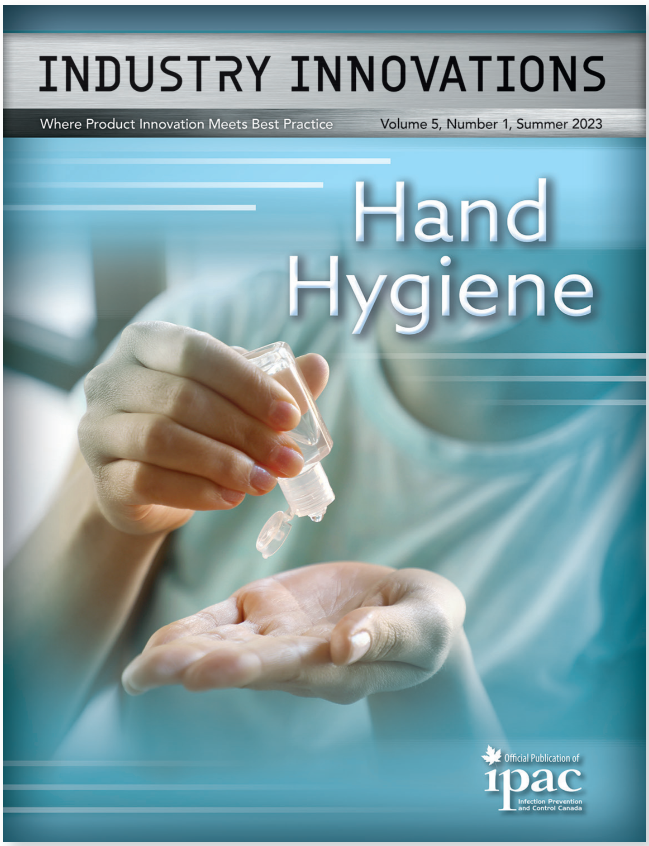
In addition to this publication, consider reviewing what Public Health Agency of Canada and provincial and territorial resources have to say about ultraviolet technologies, air filtration, and environmental strategies in general. A few such examples related to indoor ventilation include the Public Health Agency of Canada's July 2022 document titled *COVID-19: Guidance on indoor ventilation during the pandemic*, Public Health Ontario's September 2022 document titled *Focus On: Heating, Ventilation and Air Conditioning (HVAC) Systems in Buildings and COVID-19*, and Public Health Ontario's recent Q&A post related to *Ultraviolet light disinfection for SARS-COV-2*. Lastly, consider reviewing the CSA's Z317.2:19 HVAC standard – *Special requirements for heating, ventilation, and air-conditioning (HVAC) systems in health care facilities* and additional references shared from our American colleagues at ASHRAE on their *Coronavirus Response Resources* webpage, both of which provide perspectives on the use of ultraviolet technologies and portable air filtration devices.

As you flip through the pages of this *Industry Innovations* issue, remain open-minded to the possibilities that COVID-19 has shown us. While there have been and continue to be many hard lessons learned, COVID-19 has certainly illustrated that the built environment is a key element to consider when evaluating factors that contribute to the transmission of organisms. If we pay our buildings the same attention we do hand hygiene, cleaning, and the provision and use of personal protective equipment, we may just add several additional tools to the IPAC toolbox.

Christine Moussa, BScN, RN, CIC
Guest Editor, *Industry Innovations* ■

INDUSTRY INNOVATIONS

Providing Canada's ICPs with vital, information on the latest technologies for the modern healthcare environment.



Include your white paper and/or advertisement in this standalone publication.

To have your WHITE PAPER or DISPLAY ADVERTISEMENT related to these hot technologies prominently displayed in *Industry Innovations*, contact Al Whalen.

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CHEM-AQUA™
An NCH Company

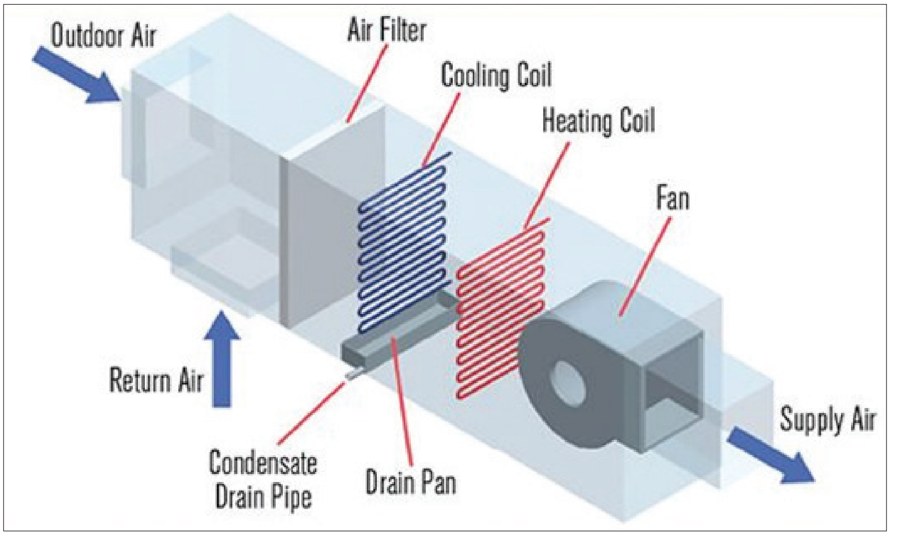
Ultraviolet disinfection for HVAC air-handling coils

Overview

Building heating, ventilation and air conditioning (HVAC) systems use air-handling units (AHU) to deliver, regulate and circulate conditioned air, which enters from outside the building. Fresh outside air enters the AHU where it is usually filtered using minimum efficiency reporting values (MERV) 8-10 filters to remove particulates. The blower then passes this filtered air over coils in the AHU to cool or heat the air depending on the building's requirements. The air is returned from the building and recirculated over the coils a number of times. Fresh air make-up is added as required by building an automation system.

During routine operation, dust, pollutants, bacteria and viruses attach to the HVAC coil surfaces. Moisture from conditioning the air and humidity also combine with these contaminants to create sticky biofilms on and inside the coils. These contaminants interfere with the proper functioning of the air conditioning system and contribute to the growth of microorganisms which can cause odours, corrosion and energy-robbing deposits, creating an environment conducive to growth of harmful bacteria. Tiny particles of pathogens can also be carried in the air that is circulated, heated and cooled in modern buildings.

ASHRAE leadership has approved the following statements regarding transmission of SARS-CoV-2 and the operation of HVAC systems during the COVID-19 pandemic. Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus



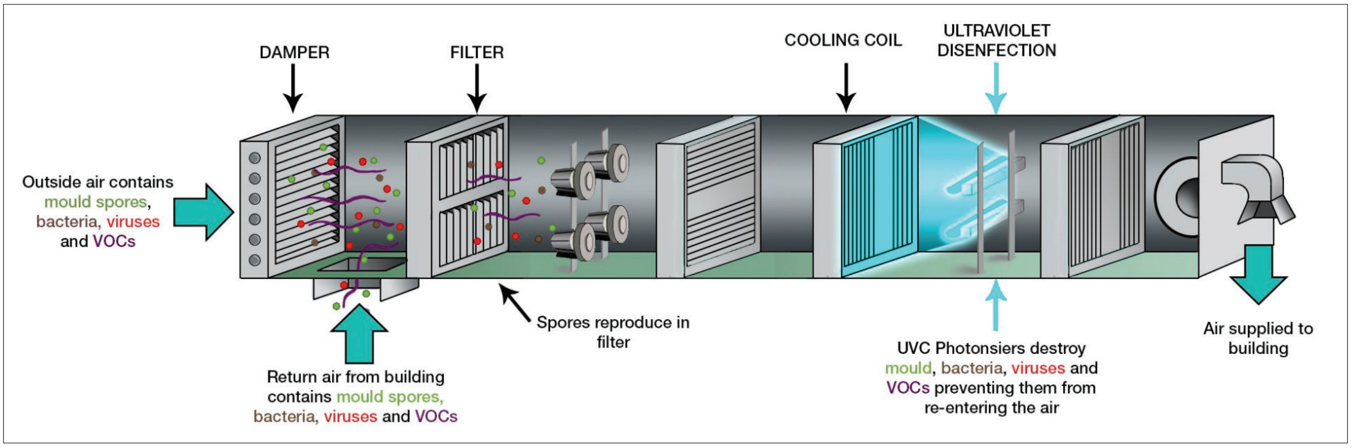
should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning systems, can reduce airborne exposures.

MERV 8-10 filtration removes particulate between 3 and 10 microns. This has been a standard industry practice. Filtration is an excellent initial step in reducing particulate on the coils, however, most bacteria is between 0.3-0.6 microns (*Legionella* measures 0.4 microns) and viruses range between 0.005 and 0.3 microns. Higher-rated filters that can remove particles as small as 0.3 microns would still only remove between 30-40% of airborne pollutants. These higher-rated filters would also increase your pressure drop, meaning that the blowers (which are only rated to certain pressure drop) may not be able to efficiently circulate the building air.

Adding UV-C germicidal disinfection lights mounted on the coils inside the AHU actually disinfects mould, bacteria, viruses, and allergens from the air as it cycles through the system and prevents biofilm on and inside the coils.

Scientists and experts all know that exposure to ultraviolet light in the range of 254 nm (UV-C band) disrupts the DNA of microorganisms thus preventing them from reproducing, thereby effectively killing them. UV light disinfection is widely used in hospitals, buildings and industry to sanitize work surfaces, sterilize food, and to prevent the spread of potentially lethal airborne infectious diseases.

Adding UV-C light systems to the AHU will have a cost, however, there is a return on investment (ROI). The U.S. Department of Energy reports that HVAC systems account for 30-50% of a building's energy use. Installing a UV system will typically reduce energy costs by about 5-10%. This is due mainly to increased air flow through



clean, biofilm-free coils, improving equipment efficiency.

Maintaining clean coils using UV-C also reduces maintenance costs, and extends equipment life.

The UV-C lights also disinfect the air as it recirculates through the AHUs, improving indoor air quality for staff and the general public.

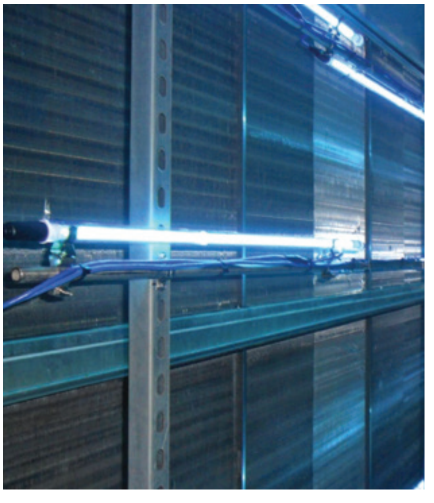
For UV-C equipment in North America, we work with Fresh-Aire UV – A Division of DiversiTech as the equipment manufacturer. Chem-Aqua™ will provide all on-site service.

Fresh-Aire UV was originally formed under the name Triatomic Environmental in 1988 as an engineering company that manufactured oxidation generators and other indoor air-quality products. In 2001, the company expanded its focus to a manufacturer of advanced indoor environmental purification technologies, and developed a series of new product releases with the completion of Fresh-Aire UV, a germicidal UV air handler treatment system. Since 2001, over 4 million installations have occurred worldwide.

Fresh-Aire UV manufactures a wide range of HVAC germicidal ultraviolet light products designed to help reduce energy usage and system maintenance, and increase equipment service life, maintain current ventilation systems, and install ultraviolet germicidal disinfection (UV-C) lights on the coils in the AHUs. UV-C disinfection systems for HVAC are an ideal proactive measure to complement existing filtration. UV-C is proven to disinfect cooling coils continuously, 24/7, safely, and cost-effectively, while simultaneously improving the indoor air quality.

Chem-Aqua™ option

When bacteria, viruses and protozoa are exposed to UV light, the UV energy destroys the genetic material (DNA) within, eliminating their ability to reproduce and cause infection. Unable to multiply, the microorganisms are "inactivated", and no longer pose a health risk. UV-C systems provide three levels of benefits when applied to HVAC systems:



Level 1 – HVAC system efficiency: UV-C energy eliminates and/or prevents the buildup of organic material on the surfaces of cooling coils, drain pans, and interior duct surfaces. This improves airflow, returns and maintains the heat-transfer levels of cooling coils to "as-built" conditions, and reduces maintenance.

Level 2 – IAQ: UV-C improves airflow levels and eliminates organic material on surfaces, which helps to improve indoor air quality (IAQ) by reducing pathogens and odours.

Level 3 – Economic impact: Reductions in energy consumption, energy cost, and carbon footprint; reductions in hot/cold complaints; reductions in staff time needed for chemical or mechanical cleaning; and increases in occupant satisfaction and safety. On average, UV-C slashes 10-25% of HVAC energy use, while using less than 1% energy for the lights. Estimated ROI would be less than two years.

UV-C efficacy verification

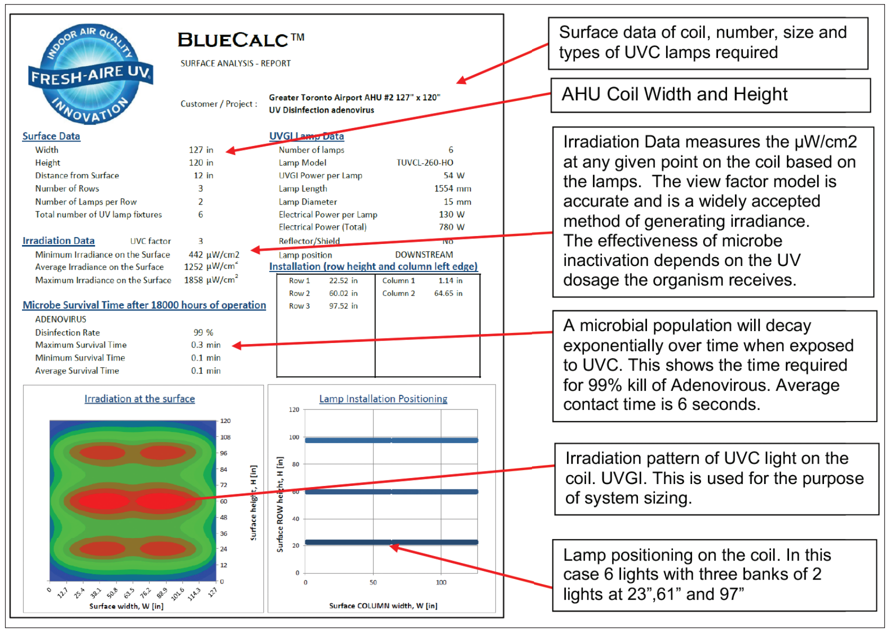
It has been well established that UV-C in combination with air filtration is the most effective and economic technology for air purification. UV-C systems are installed in the HVAC unit mounted on the actual coils and/or ductwork, and are designed to disinfect surfaces and the air as it circulates through the ventilation system.

UV-C systems are tested and validated against bacteria, viruses, mould and fungus. Fresh-Aire UV systems have been tested and achieve up to a *99.999% reduction on microorganisms.

Every microorganism requires a specific UV-C dosage for inactivation, including coronavirus. UV-C disinfection has been employed for decades in water treatment. These microwatt values have been used for reference to gauge UV-C efficiency against a large cross-section of microorganisms.

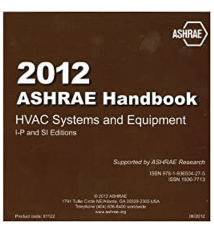
The SARS CoV-2 Neutralization by Germicidal UV-C Light Systems study conducted by the independent laboratory, Innovative Bioanalysis, validated coronavirus inactivation in less than two seconds of exposure to Fresh-Aire UV's germicidal UV-C 254-nanometer light systems.

Dosage of UV-C for complete destruction (uW-sec/cm²)			
BACTERIA			
Agrobacterium Lumefaciens^	8,500	Streptococcus Lactis*	8,80
Bacillus Anthracis*(**Anthrax**)	8,700	Streptococcus Pyrogenes^	4,20
Bacillus Anthracis ***Spores***^(**Anthrax**)	46,200	Streptococcus Salivarius^	4,20
BaciHus Megatherium Sp. (Veg)*	2,500	Streptococcus Viridans*	3,80
Bacillus Megatherium Sp. (Spores)*	5,200	Typhoid Fever^	4,10
Bacillus Paratyphosus*	6,100	Vibrio Comma (Cholera)^	6,50
Bacillus Subtilis*	11,000	Vibrio Cholerae^	6,50
Bacillus Subtilis Spores*	22,000	**MOLDS**	
Clostridium Tetani^	23,100	Aspergillus Amstelodami^	77,00
Clostridium Botulinum^	11,200	Aspergillus Flavus*	99,00
Corynebacterium Diphtheriae*	6,500	Aspergillus Glaucus*	88,00
Dysentery Bacilli*	4,200	Aspergillus Niger (bread mold)*	330,00
Eberthella Typhosa*	4,100	Mucor Mucedo^	77,00
Escerichia Coli*	8,600	Mucor Racemosus (A & B)*	35,20
Legionella Bozemanii^	3,500	Oospora Lactis*	11,00
Legionella Dumoffill^	5,500	Penicillium Chrysogenum^	56,00
Legionella Gormanil^	4,900	Penicillium Digitatum*	88,00
Legionella Micdadei^	3,100	Penicillium Expansum*	22,00
LegioneHa Longbeachae^	2,900	Penicillium Roqueforti*	26,40
Legionella Pneumophfla		Rhizopus Nigricans (cheese mold)*	220,00
(Legionnaire's Disease)	2,760	**VIRUS**	
Leptospiracanicola-		Adeno Virus Type III^	4,50
Infectious Jaundice^	6,000	Bacteriophage (E.Coli)*	6,60
Leptospira Interrogans^	8,000	Coxsackie A2^	6,30
Micrococcus Candidus*	12,300	Infectious Hepatitis^	8,00
Micrococcus Sphaeroides*	15,400	Influenza*	3,40
Mycobacterium Tuberculosis^	10,000	Rotavirus^	24,00
Neisseria Catarrhalis*	8,500	Poliovirus^	21,00
Phytomonas Tumefaciens*	10,500	Variola** (**Smallpox**)	24,00



Studies

- *UV Surface Disinfection ATL Aerosol Study Report NG5999 (07APR2015)
- *American Journal of Infection* Control Studies
  - Effectiveness of an ultraviolet germicidal irradiation system in enhancing cooling coil energy performance
  - Ultraviolet germicidal irradiation of influenza-contaminated N95 filtering face piece respirators
- Third-party Airmid Test Report 5.21.13
- ASHRAE 2019 HVAC Handbook Chapter 62.



"The use of UV-C, restores heat transfer and airflow which results in energy savings, with the possibility of payback in less than two years."

Hyperlink: *https://www.ashrae.org/file%20library/technical%20resources/covid-19/i-p_a19_ch62_uvairandsurfacetreatment.pdf.*

System configuration

The primary variables important to the design configuration of a UV-C system include coil width and height, or air duct dimensions (W x H x L), UV lamp specifications (UV power, arc length, lamp radius), lamp quantity and locations.

The radiant energy, or dosage, delivered to a coil surface is dependent on UV intensity, the duration of exposure, and the lamp to coil distance.

We offer our Blu-Calc UV-C light design and analysis service using state-of-the-art sizing software:

Different-sized coils require different-sized lights to maintain the same kill rate. The air passes through the UV as it recirculates, and the UV effect is cumulative.

UV systems can be placed in ducts and sized so that there is a total kill in one pass, however, that would require many more lights and greater installation requirements. These systems are usually only used in high-risk healthcare systems where there are 100% fresh air make-up requirements.

UV-C System Components

UV-C high-output lamps: UV-C lamp for Commercial Series UVGI systems. This 32" lamp is made from hard quartz with a hot filament, and is warranted for two years of effective 254 NM germicidal UV-C output.

UV power supply (ballast) – Lifetime Warranty: UV heavy-duty power supply, powers two lamps, 120-277 VAC. Water-resistant NEMA-rated enclosure is suitable for installation inside or outside of air system with power switch and fuse.

Included accessories – Lifetime Warranty: Waterproof cable interconnects include an intrinsically sealed IP67-rated lamp over moulds to prevent moisture intrusion between the lamp interface and lamp connectors:

- 12" coil mount bracket
- "L" bracket with for mounting lamps (two per lamp)
- Or – "L" bracket with 32-lb. magnet for mounting (two per lamp)

Door safety interlocks: Mechanical interlock switch to ensure that the UV-C assembly will be de-energized when any door accesses are opened.

UV-C system ongoing maintenance required

UV-C lamps should be replaced at the end of their useful life (two years) regardless of whether the lamp is still lit or not. This is because the UV lamps lose their germicidal effectiveness in time as the gas required to create the UV light is expended over time.

UV-C safety

All UV-C systems provided are UL-2998, which identifies air purification systems that produce or emits zero ozone.

- Human exposure to UV-C light may result in unnoticed eye (cornea) damage and skin (sunburn) damage. While these effects are mostly temporary, they can still be very painful.
- Most materials, including glass and plastic, attenuate UV-C radiation. Maintenance personnel should wear normal protective clothing, eye wear, and gloves when dealing with lamp replacement tasks.
- Dispose of used UV-C lamps the same as any fluorescent light tube. Dispose of used lamps in accordance with regulations regarding mercury content.
- Safety Interlocks (provided with units) should be installed such that opening any door to a UV lamp chamber will turn off the lamps. All access doors and panels should have multi-language warning labels (provided) posted on the outside.
- The UV lamp chamber should have a viewport or window in the AHU large enough for the UV state to be viewed from outside the chamber. ■

2023 NATIONAL EDUCATION CONFERENCE

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SELECTED SESSIONS WILL BE LIVE-STREAMED

RESILIENCE · RECOVERY · REUNITED 2023 · THE PATH FORWARD

IPAC Canada National Conference
Vancouver BC | May 28-31, 2023

PRE-CONFERENCE DAY

SUNDAY, MAY 28

Concurrent Morning Workshops (live stream and in-person)

- Oncology-Transplantation Workshop
- Home Care and Community Workshop

Afternoon Workshop

- Cleaning & Disinfection: Emerging Threats and How to Address (live stream and in person)
  Afternoon Workshop Sponsored by

Diversey™

FEATURED PRESENTERS (live stream and in person)

MONDAY, MAY 29
Keynote Address: The Psychology of Pandemics
Dr. Steven Taylor, University of British Columbia

MONDAY, MAY 29
Scientific Communication to the Public During a Pandemic and Beyond
Dr. Bonnie Henry, Province of British Columbia

TUESDAY, MAY 30
COVID-19's Challenges to Infection Control Dogma
Dr. Michael Klompas, Harvard University

WEDNESDAY, MAY 31
Future of Medical Work – Leveraging AI and IoMT to Improve Patient Care
Peter Jones, Microsoft Canada

WEDNESDAY, MAY 31
CLOSING SESSION:
Losing My Privilege – Becoming a Visible Minority Taught Me About Leadership
Chris Bergeron
@adn | conférencier.e.s

POST-CONFERENCE

WEDNESDAY, MAY 31 (afternoon)
(live stream and in-person)
Become a Better Advocate and Negotiator – Inside and Outside Your Organization
Rob LeForte, The Advocacy Coach

See the updated program and register *https://ipac-canada.org/ipac-canada-annual-conference.php*.
Exhibit and Sponsor prospectus and registration to open in November 2022.

CALL FOR ABSTRACTS

IPAC Canada National Conference
Vancouver BC | May 28-31, 2023

The 2023 National Education Conference will be held at the Vancouver Convention Centre, May 28-31, 2023.

THIS WILL BE A HYBRID CONFERENCE

Abstracts for presentation at the conference will be accepted until 2359 hours (Pacific Time), Monday, January 16, 2023.

The Abstracts Selection Committee reserves the right to select abstracts for presentation on the basis of relevance and interest, and to choose the types of presentation (Oral or Poster).

- Oral session presenters will be provided with a 13-minute session (10-minute presentation; three-minute Q&A). Schedule of presentations to be announced.
- Poster session presenters will be provided with an opportunity to answer questions while at their poster. Schedule of presentations to be announced.

Oral Presentations will not be available on the virtual platform but will be recorded for attendees and members to access post-conference.

Poster Presentations will not be available on the virtual platform. Authors are requested to send a high resolution pdf of their poster to IPAC Canada for inclusion with the published abstract, post-conference.

Presenters will be notified of acceptance by the end of February 2023, and will be advised of the date and time of their presentation. Oral and poster presentations will be presented in the language of the presenter. Registration discounts are not provided for oral or poster presenters.

ABSTRACT PREPARATION AND GUIDELINES FOR ACCEPTANCE

A. CONTENT

1. Abstracts must be submitted online at www.ipac-canada.org. Make sure all sections are completed and check that files have completely posted in the text area and downloaded from a browser where required.
2. Abstracts must adhere to the guidelines of either Format 1 or Format 2. See Section C below. Abstracts must follow all submission guidelines in order to be considered for review.
3. Oral or poster presentations of abstracts that have been previously published or presented must not duplicate the previous publication or presentation. Presentation content must be altered for this specific audience.
4. The potential significance of the observations, as well as the scientific and/or educational quality of the work will influence which abstracts are accepted. Where possible, the author(s) should emphasize the features of the project that are new or different.

DEADLINE FOR SUBMISSION: MONDAY, JANUARY 16, 2023

ABSTRACTS MUST BE SUBMITTED ONLINE: www.ipac-canada.org > Conference/Education

SURGICALLY CLEAN AIR ™

Maximizing air purification with the use of Jade 2.0 HEPA-Rx™

Abstract

Surgically Clean Air, Inc.™ is an industry leader of indoor air purification systems with high-efficiency particulate air (HEPA) filtration, which captures greater than 99.98%* of airborne particulates and pathogens present in indoor air. Our area of expertise lies in indoor air-quality assessment, and in providing consultative, customized air purification solutions to commercial businesses in various industry segments.

Surgically Clean Air, Inc. is a Canadian-based leading provider of premium robust air purification solutions, which purify the air by supplementing existing heating, ventilation, and air conditioning (HVAC) systems. Surgically Clean Air, Inc. was conceptualized in response to the SARS 2003 outbreak, and was founded in 2008 after identifying the critical need for air purification in an underserved dental sector.

Surgically Clean Air, Inc.'s focus is on developing premium, robust systems. It rapidly became a market leader in high-end, commercial-grade, premium indoor air purification designed to outfit any size of space. Workplace safety and wellness are at the forefront of new legislations as staff, employees, students, and communities demand safer environments in which to work, live, and thrive.

Our in-house team of research and development specialists, air scientists, marketing, sales, and customer care representatives place emphasis on continuous improvement to stay on top of technology, market needs, and customer satisfaction to ensure effective and efficient solutions are brought to market.

Specifications

Jade is intended to remove particles and microorganisms from the air within multi-stages of purification. Multi-stages of purification and air cleaning help to reduce the concentration of all types of indoor air pollutants and also prevent introducing further contamination into the air. These multi-stages include:

1) **Pre-filter:** Nylon net pre-filter captures the largest particles as room air is drawn through the intake chamber.
2) **HEPA-Rx™ filter:** The HEPA-Rx filter captures ultra-fine particulates, pollutants, and microorganisms.
3) **Activated carbon filter:** Activated carbon filter adsorbs volatile organic compounds, noxious odours, chemicals, and gases. Trapping trace gases on solid adsorbent materials can be an effective way to reduce their concentrations.
4) **Germicidal UV-C lamp:** The system is operated with germicidal UV-C lamps to eliminate bioaerosols, and reduce their concentration in the room. The UV-C lamp emits 254 nm wavelength light rays inside the lamp holder, which was designed to prevent UV-C exposure.
5) **Revitalizing negative-ion chamber:** Before the pure, clean air is circulated back into the room, it is revitalized with negative ions.

Additional functions:

- Remote control
- Plug and play
- Hands-free operation with child lock
- Four speeds – Low, Medium, High, Turbo
- Steel construction
- Filter change indicators
- Real-time air-quality monitoring
- Tool-free filter change
- HEPA filtration
- Minimal set-up
- Off-timer – 2-4-6-8-10-12 hours
- Single-point power connection
- Optional accessories – Castors, a 15-ft. extension cord, a four-outlet power bar with surge protection, and a cord trip cover

Metrics

The performance of SCA air purifiers and their filters were assessed in controlled conditions at third-party laboratories following the standard testing procedures, as well as real conditions in different settings, including healthcare, and general office environments.

The key metrics for evaluating the air cleaners, including filtration performance, air-cleaning delivery rate (CADR and Bio-CADR), sound level, and energy consumption, are discussed below.

1. Filtration performance

Jade 2.0 HEPA-Rx™ flat media was tested by a third-party lab. The test results demonstrated a minimum collection efficiency of 99.98% of 0.3-micron particles.

The filtration efficiency of the Jade 2.0 HEPA-Rx filter was measured while it was challenged with neutral aerosols and bioaerosols. The filter was tested according to IEST-RP-CC007.3, EN1822 and JISB 9908-2011 standards.

The filtration efficiency of the Jade 2.0 HEPA-Rx filter was measured at LMS Technologies, Inc. while it was challenged with bioaerosols. A concentration of three types of microorganisms, including

MS-2 bacteriophage (virus), *Aspergillus niger* (fungus), and *Staphylococcus aureus* (bacteria) upstream was compared with the concentration downstream of the filter to calculate the filtration efficiency. The Jade 2.0 HEPA-Rx filter captured more than 99.9% of challenged aerosols.

2. Air-cleaning delivery rate (CADR and Bio-CADR)
The performance of Jade is demonstrated by a clean-air delivery rate (CADR) free of neutral particulate matters and the bioaerosol-free and clean-air delivery rate (Bio-CADR).

The CADR of Jade 2.0 was measured at Intertek laboratory based on ANSI/AHAM AC-1-2020 standard. The CADR was measured while the Jade 2.0 was running at turbo speed, which is the highest fan speed. The CADR values are obtained based on measurements of various types of neutral aerosols, including smoke, dust, pollen and PM2.5. CADRs are listed in Table 2.

The Bio-CADR is determined by the extended AHAM AC-5 method to obtain CADR when the device is challenged by bioaerosols. Chamber test measurements were conducted at a third-party lab. MS-2 bacteriophage (ATCC 15597-B1) was used as the challenge aerosol contaminants. The MS-2 bacteriophage was selected to represent a surrogate for the human viruses of similar and larger size and shape, which cause disease by airborne transmission. The performance of Jade 2.0 was evaluated while it was running at Turbo mode (448 CFM). The Bio-CADRs for Jade 2.0 is 420 CFM.

3. Sound level
The sound level of Jade 2.0 was measured at the rating distance defined in AHAM AC-2-2006 (R2016), Method for Sound Testing of Portable Household Electric Room Air Cleaners. According to this standard, the sound pressure level must be expressed at a stated distance from the air cleaner. The rating distance is 1m away in a spherical-free field. The sound level of Jade 2.0 has a 52 dB(A) at high fan speed, and a 58 dB(A) at turbo speed (Table 3).

4. Energy efficiency
The annual energy consumption of Jade 2.0 is 398.94 kWh/year while it is operating at turbo speed. Assuming an average energy cost of 0.18 CAD/kWh in Canada, the annual energy cost of Jade 2.0 would be CAD71.81 (Table 4).

Previous quantitative research
The effectiveness of Jade 2.0, an indoor air purifier, was assessed on dental aerosol dispersion in dental offices. This research was conducted in cooperation with the University of Waterloo, and a dental clinic located in Toronto. Aerosols generated during dental procedures are one of the most significant routes for infection transmission. In addition to the disease transmission through aerosol, exposure to non-biological aerosol particles in dental offices, and laboratories adversely affects human health.

In this study, Jade 2.0 intended to remove both biological and non-biological aerosols from the air in the dental office. Aerosols were generated from continuous drilling operation on a pig jaw using a high-speed handpiece. The spread and removal of aerosol were quantified at different locations of the dental office.

Table 1: Filtration efficiency of HEPA-Rx™ filter to capture bioaerosols (LMS Technologies, 2021)

Challenge aerosol	Filtration efficiency (%)
MS-2 bacteriophage (Virus)	>99.9
Aspergillus niger (Fungus)	>99.9
Staphylococcus aureus (Bacteria)	>99.9

Table 2: Clean-Air Delivery Rate or CADR of Jade 2.0

Aerosol type	CADR (CFM)
Bioaerosol-MS-2 bacteriophage	420.6
Neutral aerosol-smoke	344.5
Neutral aerosol-dust	354.6
Neutral aerosol-pollen	377.8
Neutral aerosol-PM2.5	349.5

Table 3: Sound level of Jade 2.0

Speed setting	Noise level db(A) Distance: 1 m
Speed 1-135 CFM	37.3
Speed 2-223 CFM	45
Speed 3-330 CFM	52
Speed 4-448 CFM	58

Table 4: Energy consumption of Jade 2.0

Air purifier	Power at turbo speed (W)	Annual energy use (kWh/year)	Energy cost, canada average (CAD/kWh)	Annual energy cost (CAD)	Annual cost per CADR (CAD/CFM)
Jade 2.0	68.50	398.94	0.18	71.81	0.16

The results show that in the worst-case scenario, with no protection system in the closed-door office, and continuous high-speed drilling, it takes 95 minutes for 0.5 μm particles to return to the background level, and it takes a shorter time for particles larger than 0.5 μm to be removed from the air. Technologies that combine all of them are the most effective in air cleaning. The air purifier expedited the removal time at least 6.3 times faster than the case with no air purifier in the generation zone.

Our results have important implications for infectious disease transmission in closed settings, such as dentists' and doctors' offices. Our study documents the time taken for airborne particles to settle down, as well as the utility of air purifiers, which highlights the importance of air circulation and filtration in closed settings. In the context of the COVID-19 pandemic, our study findings can assist in developing guidelines for air circulation and filtration, which can significantly reduce the chances of disease transmission.

Implementation

The portable air purifiers can be located at the corners of dental offices, and they cause much less inconvenience during dental operations than extra-oral high evacuators do. In addition, these portable air purifiers do not require modification to existing ventilation systems. To enhance air-cleaning performance, it is recommended to place the air purifier close to the dental operation and the patient's mouth. ■