VITESY

Test Report

Eteria

Test Report 2023 - Rev. 2 - 03.2023

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Odor abatement test
Product tested → Eteria
Test conducted by LEBSC SRL

Fine (PM10) & Ultrafine (PM2.5) dust abatement test
Product tested → Eteria
Test conducted by LEBSC SRL

Ozone emissions assessment
Product tested → Eteria
Test conducted by LEBSC SRL

ACRONYMS USED IN THE DOCUMENT:

- **CONTARP** = *Consulenza Tecnica Accertamento Rischi e Prevenzione* ("Technical Consultancy for Risk Assessment and Prevention"; specialized department of INAIL - *see acronym below*)
- **D.lgs.** = *Decreto legislativo* ("Legislative Decree"; law of the Italian state)
- **INAIL** = *Istituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro* ("National Institute for Insurance against Work-related Injuries"*;* Italian governmental body)
- **IARC** = The International Agency for Research on Cancer
- **ISO** = International Standards Organization
- **PCO** = Photo-Catalytic Oxidation (purification technology used in Eteria and other Vitesy Air Purifiers)
- **PM** = Particulate Matter (PM2.5 = Ultrafine PM; PM10 = Fine PM)
- **VOC(s)** = Volatile Organic Compound(s)
- **WO_3** = Tungsten Trioxide (substance used for coating of Vitesy's filters)
- **WHO** = World Health Organization

Insight

Pollutant		% of abatement	Time
Microbiological agents	Bacteria	95,76 %	24 hours
	Molds and Yeasts	99,95 %	24 hours
	SARS-CoV-2 virus	97,18 %	20 minutes
Nitrogen compounds	NOx	97,8 %	1.5 hours
Smells	Benzyl mercaptan	> 97,76 %	1.5 hours
COV	Pyrazine	80 %	1 hour
	Limonene	70 %	1 hour
	BTEX	86 %	1 hour
	Formaldehyde	85 %	1 hour
Particulate	PM2.5	72,0 %	3 hours
	PM10	52,4 %	1 hour

Mode	Air flow	Noise level
Silent	11 m^3/h	30 dB
Performance	34 m^3/h	52 dB

Ozone emissions < 100 times regulatory limits.

Gram +/- bacteria

Microbiological pollutants

What it is. Microbiological pollutants are bacteria, viruses, and fungi. Both **Gram-positive** (*Lactobacillus acidophilllus, Lactobacillus bulgaricus, Streptococcus thermophilus*) and **Gram-negative** (*CP Acinetobacter Baumannii, CP P. Aeruginosa*) bacteria were evaluated in this test, typically of the two species **Gram-negatives** are the **most dangerous to humans.**

Where it is found. Microorganisms dispersed in indoor air can be carried by natural ventilation (air entering through windows and doors) but their natura and concentration depend on outdoor air and therefore vary according to seasonality and geographical location. The main sources of pollution are: **occupants of indoor spaces (people or animals)**, heating systems, air conditioning, dust. In certain environmental contexts (e.g. high humidity), even wood or upholstery can become a breeding ground for microorganisms.

Health effects. Health effects caused by the presence of biological contaminants can be classified into **three types: *infectious*, *toxic*, and *allergic,*** and can occur with varying intensity in relation to various factors including the physical condition, health, and susceptibility of each person.

Eteria abatement capacity of aeriform bacterial contamination

PURPOSE The purpose of this research is to define the capacity of the Eteria air purification system to abate bacterial pollutants through photocatalytic activity. The system, thanks to the presence of a photocatalytic ceramic filter coated with tungsten trioxide (WO_3) and a system of LED lights (visible spectrum type) below the filter, activates a series of photocatalytic reactions on environmental micropollutants.

SET-UP The air in a **33 m^3 sealed room** was contaminated with a mixture of both Gram-positive and Gram-negative lactic acid bacteria. Specifically, a container containing an aqueous mixture of both Gram-negative and Gram-positive bacteria was placed on a table and the solution was allowed to evaporate into the air for two days. Following the two days of exposure, passive sampling of the bacteria was performed for two hours to define their contamination at time zero according to **INAIL 2010 ISBN 978-88-7484-162-2 protocol**. The sampling plate was left exposed for 2 hours. After the 1st sampling, the ETERIA device was set in performance mode for 5 hours and 24 hours during which passive sampling was carried out for 2 hours each. Two-hour passive sampling was performed during the 5 hours of Eteria operation and after the 24 hours of operation.

RESULTS The microbiological abatement tests showed a high reduction of the total microbial load after **24 hours**, equal to **91.7%** for Gram **positive** and **99.9%** for **Gram negative**. Even **after only 5 hours** there is a **significant reduction,** as Eteria is able to act on **58%** of the microbial load present. By comparing these results with the guidelines of CONTARP (*Technical Consultancy for Risk Assessment and Prevention*) of INAIL (*National Institute for Insurance against Work-related Injuries*), it can be said that Eteria is able to bring the category of **bacterial microbiological pollution** (specifically, Gram negative) **from** a category tending to ***intermediate*** to one in which the bacterial load is ***very low***.

Fig. 1

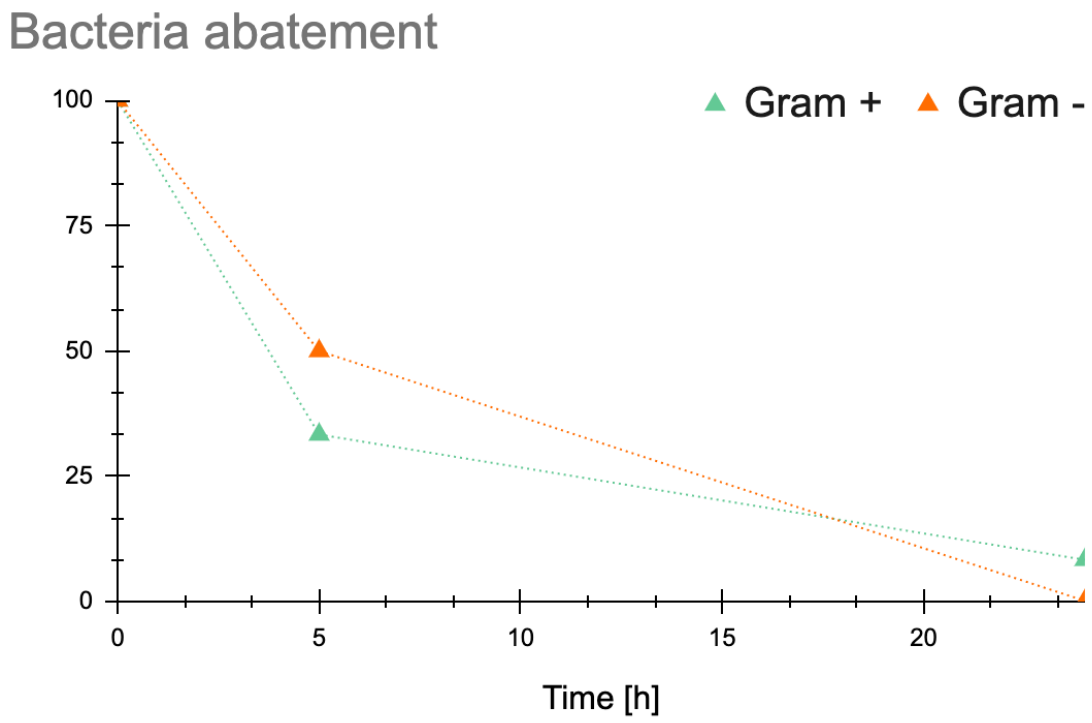

Fig. 1 - Abatement performance of airborne Gram positive (in green) and negative (in orange) bacteria, expressed in %.

Molds and yeasts

Microbiological pollutants

What it is. Microbiological pollutants are bacteria, viruses, and fungi (molds, yeasts). In this test, **molds and yeasts of the *Aspergillus* family** were evaluated**.** Species belonging to this genus are strongly aerobic and grow in almost any oxygen-rich environment, usually on the surface of a substrate. Many species grow on starchy foods, such as cereals and potatoes. Several species also exhibit the phenomenon of oligotrophy, that is, they are able to grow in environments that are poor or even lacking in basic nutrients - for example, *Aspergillus Niger* grows on wet walls.

Where it is found. Microorganisms dispersed in indoor air can be carried by natural ventilation (air entering through windows and doors) but depend on outdoor air and therefore vary according to seasonality and geographical location. The main sources of pollution are: **occupants of indoor spaces (people or animals)**, heating systems, air conditioning, dust. In certain environmental contexts (e.g. high humidity), even wood or upholstery can become a breeding ground for microorganisms.

Health effects. Health effects caused by the presence of biological contaminants can be classified into **three types: *infectious*, *toxic*, and *allergic,*** and can occur with varying intensity in relation to various factors including the physical condition, health, and susceptibility of each person.

Eteria abatement capacity of aeriform mycetic/fungal contamination

PURPOSE The purpose of this research is to define the abatement capacity of mycetic/fungal pollutants of the air purification system Eteria, through photocatalytic activity. The system, thanks to the presence of a photocatalytic ceramic filter coated with tungsten trioxide (WO_3) and a system of LED lights (visible spectrum type) below the filter, activates a series of photocatalytic reactions on environmental micropollutants.

SET-UP The air in a **33 m^3 sealable room was** contaminated with molds of the Aspergi family. Specifically, a container containing an aqueous mixture was placed on a table and the solution was allowed to evaporate into the air for two days.

Following the two days of exposure, passive sampling of bacteria was performed for two hours to define their contamination at time zero according to **INAIL 2010 ISBN 978-88-7484-162-2 protocol**. The sampling plate was left exposed for 2 hours. After the 1st sampling, the ETERIA device was set in performance mode for 5 hours and 24 hours at which time passive sampling each of 2 hours was performed. Two-hour passive sampling was performed during the 5 hours of Eteria operation and after the 24 hours of operation.

RESULTS Microbiological abatement tests showed a high reduction of the total mycetic/fungal load after **24 hours**, equal to **99.99%** of **molds and yeasts**.

Fig. 2

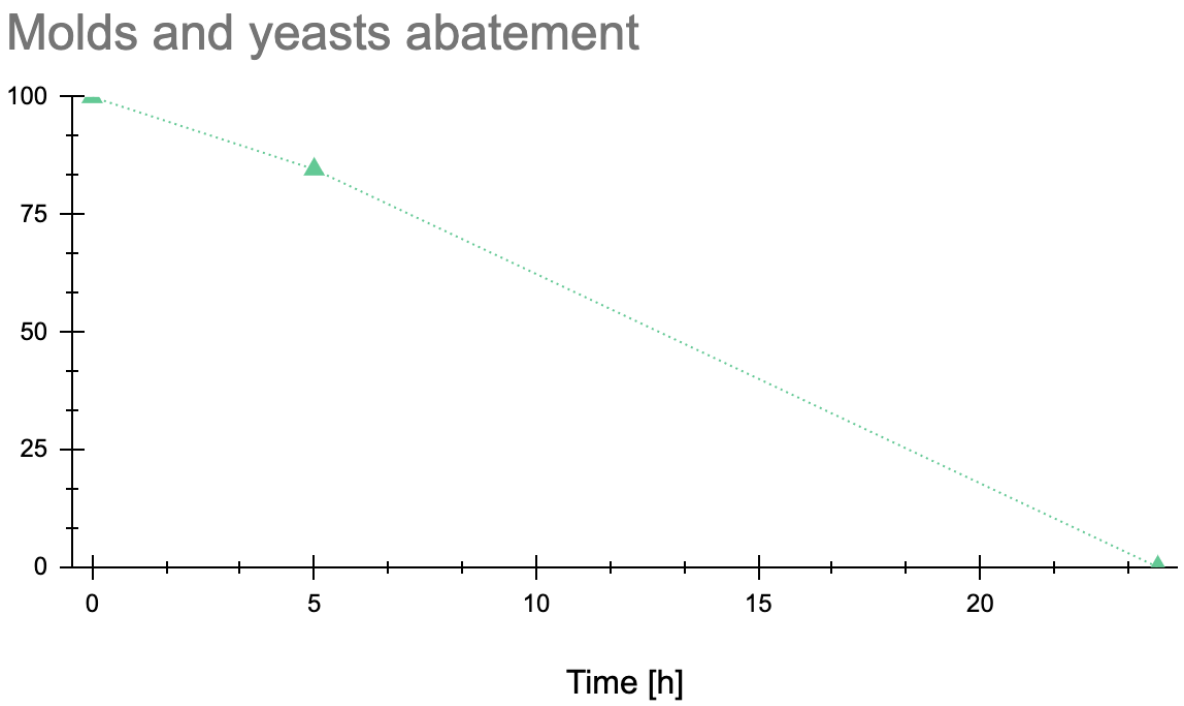

Fig. 2 - Performance of the abatement of aeriform mycetic/fungal load in %.

SARS-CoV-2 virus

Microbiological pollutants

What it is. Microbiological pollutants are bacteria, viruses, and fungi (molds, yeasts). In this test, **SARS-CoV-2**, which is the viral strain responsible for **covid-19** disease, was evaluated.

Where it is found. The SARS-CoV-2 virus is **transmitted primarily by droplets and aerosols from an infected person** when sneezing, coughing, talking, or breathing and is in close proximity to other people. The virus has also been isolated from the feces of infected cases, indicating that fecal-oral transmission could also be a route of infection. **Droplets can be inhaled or can rest on surfaces**, with which others come into contact and are, therefore, infected by touching their nose, mouth, or eyes.

Health Effects. Symptoms of COVID-19 vary based on the severity of the disease, from no symptoms (being asymptomatic) to presenting with fever, cough, sore throat, weakness, fatigue, and muscle pain. More severe cases may present with pneumonia, acute respiratory distress syndrome, and other complications, all of which can be life-threatening. Sudden loss of sense of smell (anosmia) or decreased sense of smell (hyposmia), loss of taste (ageusia), or altered taste (dysgeusia) have been recognized as symptoms of covid-19.

Antiviral capacity of the WO_3 photocatalytic system + visible light LED against SARS-CoV-2 virus

PURPOSE The aim of the study is to determine the antiviral activity of a photocatalytic filter (PCO), a ceramic sponge (open-foam) coated with a nanostructured photocatalytic coating based on tungsten trioxide (WO_3). The system under analysis consists of a photocatalytic filter and visible light LEDs placed at a distance from the filter to provide an illuminance of at least 300 lux on it.
The **virus is placed on the sample filters** and irradiated with at least 300 lux via visible light LEDs placed at the appropriate distance, during the entire contact time.

SET-UP 50µL of viral suspension is inoculated onto the samples, and the samples are placed at the appropriate distance from the LED lights. The test is performed in parallel on three similar systems. The amount inoculated is much greater than the viral load required for contagion between two organisms, as we wanted to test an extreme situation to be sure of the effectiveness of the system. After the indicated contact times of 20 minutes, 1 hour and 4 hours, the suspensions are recovered and the residual virus activity is tested (see TCID50 method referred to in **ISO 21702**). The activity of the virus is detected on appropriate types of cells, expressing it in terms of TCID50 (reference value for the definition of viral concentrations).

RESULTS The average reduction in viral titer is **97.18% in just 20 minutes** of contact with the viral suspension inoculated on the filter itself, and is **99.10% in 4 hours**.

Fig. 3

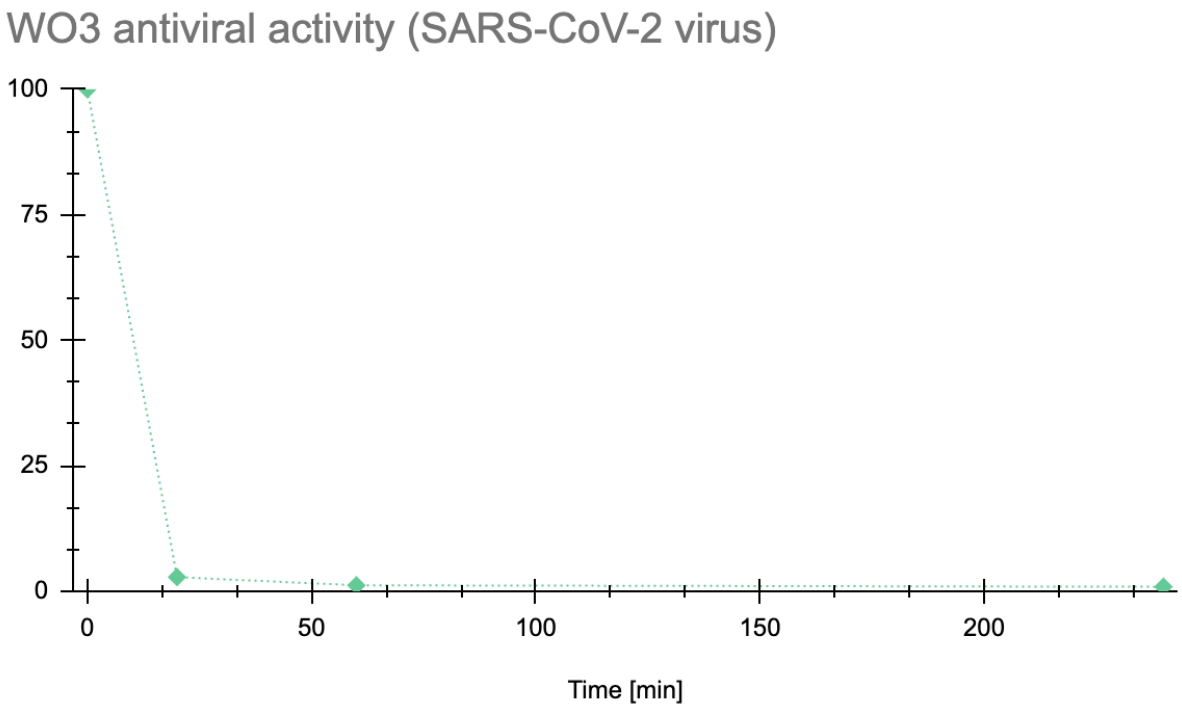

Fig. 3 - SARS-CoV-2 abatement performance in 4 hours.

NOx

Nitrogen oxides

What it is. NOx are identified as the **sum of the nitrogen oxides** that are produced as **byproducts during a combustion.** Nitrogen oxide is a primary pollutant that is generally formed from high-temperature combustion processes. Nitrogen dioxide, NO_2 , is an irritant gas with acute toxicity and has a strong, pungent odor and a yellow/red color. It is one of the gases responsible for the so-called “photochemical smog”, as it is the basis for the production of a series of dangerous secondary pollutants such as ozone or nitric acid. It contributes about one third to the formation of acid rain. According to **D.lgs. 155/2010**, in indoor environments the **limit value** for the gas Nitrogen Dioxide (NO_2) **is 0.04 mg/m³** .

Where it is found. The main sources are kerosene-fired radiators, gas stoves and radiators without exhaust, and tobacco smoke. Concentrations of less than 0.1 mg/m³ are generally found in homes, however higher levels (greater than 0.2 mg/m³) may occur, especially during cooking of food with gas stoves or when kerosene stoves are used.

Health Effects. Nitrogen dioxide has a pungent odor and may cause **eye, nasal, or throat irritation and coughing.** Alterations in respiratory function may occur in sensitive individuals, such as children, people with asthma or chronic bronchitis. Early airway symptoms in persons with pulmonary disease may occur at concentrations as low as 0.2 mg/m³ .

NOx abatement capacity by Eteria

PURPOSE The purpose of this research is to define the NOx abatement capacity of the Eteria air purification system through photocatalytic activity. The system, thanks to the presence of a photocatalytic ceramic filter coated with tungsten trioxide (WO_3) and a system of LED lights (visible spectrum type) below the filter, activates a series of photocatalytic reactions on environmental micropollutants.

SET-UP A sealable hood was contaminated with 500 cc of 68% NOx gas for approximately thirty minutes. Once the air contained in the box has been homogenized, the first air survey is performed to check for the presence of NOx and set its concentration at time zero. Subsequently, the Eteria photocatalytic device was turned on and NOx trends were monitored over time.

RESULTS It is observed that the abatement of the gas in ambient air is linearly descending and within **90 minutes** an **almost complete extinction of** the gas in air by the Eteria device is observed (**97.8 %**).
The reactions are very fast as they are strongly enhanced by the presence of ions and/or ionizable substances having hydroxyl and/or hydroxyl ions. In addition, photocatalytic reactions in gaseous form exhibit higher speed than photocatalytic reactions in aerosol phase (droplets and/or particles).
It can thus be said that the device tested has an excellent efficiency in the abatement of NOx, almost bringing it down to zero value over time, since according to current scientific literature **these gases are very persistent in ambient air**.

Fig. 4

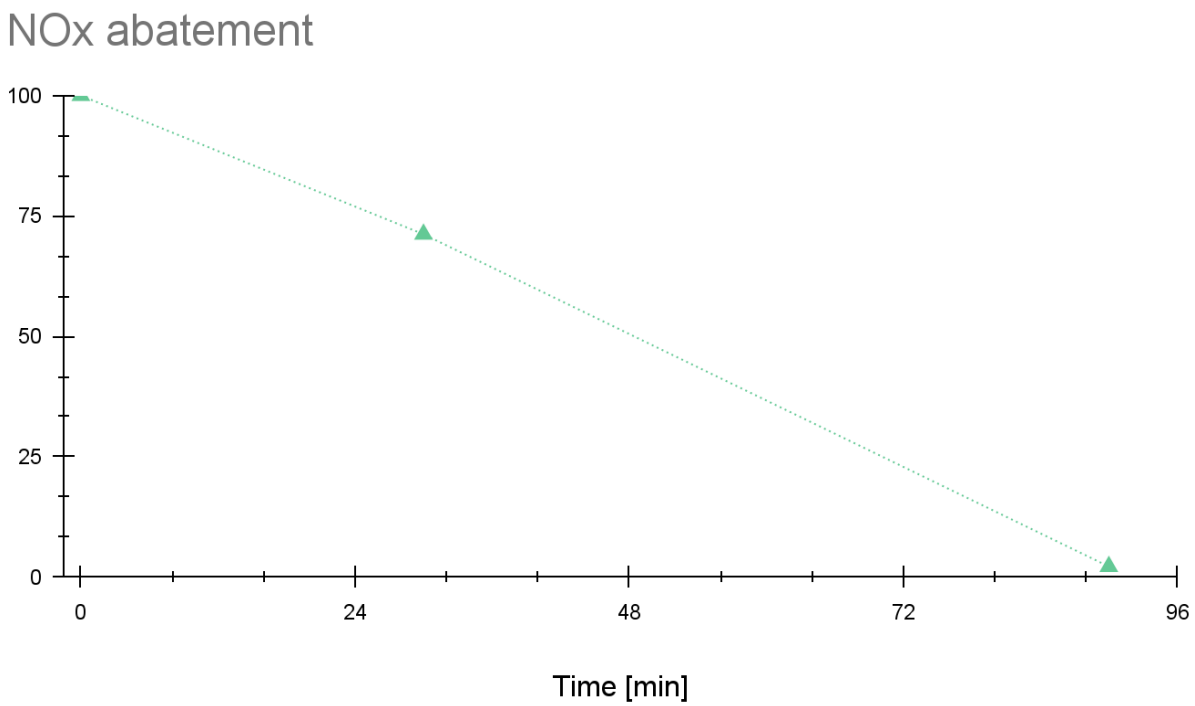

Fig. 4 - NOx abatement performance in 90 minutes.

Mixture of VOCs

Volatile Organic Compounds

What it is. Volatile Organic Compounds (VOCs) are defined as those organic compounds that have a vapor pressure of 0.01 KPa or greater at 293.15 K (20°C). In the test the following VOCs were tested simultaneously: **1) Pyrazine**, as an example of a heterocyclic aromatic compound; **2) Limonene**, as an example of cyclic terpenes; **3) BTEX** (Benzene, Toluene, Ethylbenzene, and Xylene), aromatic **carcinogenic** compounds. Considering for example **benzene**, no safe level of indoor exposure can be recommended. The legislation (**Legislative Decree 155/2010**) defines an **annual outdoor threshold value** for the protection of human health equal to **5.0 µg/m^3**.

Where it is found. There are various sources of VOC pollution in the air of indoor environments: **occupants of indoor spaces (people or animals)** through breathing and body surface, cosmetic or deodorant products, heating devices, cleaning materials and various products (e.g. glues, adhesives, solvents, paints), clothes recently treated in laundries, cigarette smoke and work tools (in the case of offices, especially *printers* and *photocopiers* but also *LCD displays* with TFT technology). Other important sources of pollution are building materials and furnishings (e.g. furniture, carpeting, upholstery) that can result in continuous emissions lasting over time (weeks or months).

Health effects. VOCs can cause a **wide range of effects,** from sensory discomfort to serious alterations in the state of health; at high concentrations in indoor environments, they can cause effects on numerous organs or apparatuses**, in particular on the central nervous system.** Some of them are recognized carcinogens for humans (e.g., benzene and formaldehyde) or animals (carbon tetrachloride, chloroform, trichloroethylene, tetrachloroethylene). It has been hypothesized that indoor pollution by VOCs may constitute a carcinogenic risk for individuals who spend a lot of time in confined environments, although the insufficient characterization of this pollution makes these assessments not yet conclusive.

Ability of Eteria to abate Pyrazine, Limonene and BTEX

PURPOSE The purpose of this research is to define the capacity of abatement of a mixture of airborne pollutants by a device named ETERIA that uses a photocatalytic system. The system, thanks to the presence within it of a ceramic filter coated with photocatalytic Tungsten Trioxide and a system of LED lights below the filter, which activate a series of photocatalysis reactions on environmental micropollutants. In particular, the following study analyzed the abatement kinetics of BTXE, Limonene, and Pyrazine aero dispersed simultaneously in air.

SET-UP The test was performed in a sealed hood of dimensions WxHxD (1.70m x 45cm x 75cm) under controlled temperature and pressure, where a hexane mixture (25 ml) of 20% (m/m) BTEX, 20% (m/m) Limonene, and 20% (m/m) Pyrazine was evaporated at room temperature. Once the mixture was evaporated under nitrogen flow, sampling with an activated carbon vial and an XAD2 vial was performed to verify the initial concentration of contaminants within the hood.
Once the contamination background was defined, the ETERIA device was set in "performance" condition, i.e. with LED light on and fan running at maximum speed, and sampling was carried out, as for the background, after 1 hour, 5 hours and 24 hours of device activity. All sampling was performed according to two specific methods namely **SNPA:2018** and **NIOSH 1613**, both performed in activity mode with absorbent vials. A total of 600 liters of air were sampled for all contaminants.

RESULTS A drastic reduction is observed **after the first hour of activity** of the Eteria device against the mixture: **87%** of **BTEX**, **71%** for **Limonene** and **80%** of **Pyrazine**. In 24 hours there is a complete degradation **(>99.99%**) of pyrazine and BTEX and **92%** for limonene, this study also highlights the ability of the Eteria device to act simultaneously on multiple pollutant molecules in the air.

It should be noted that Eteria also acts effectively on BTEX, molecules that are extremely *persistent* and *stable*, as well as carcinogenic to humans, which have a **very high half-life in the atmosphere**, calculated to be 3-4 days as in the case of benzene (source: APAT document - Reports 29/2003 emissions).

Fig. 5

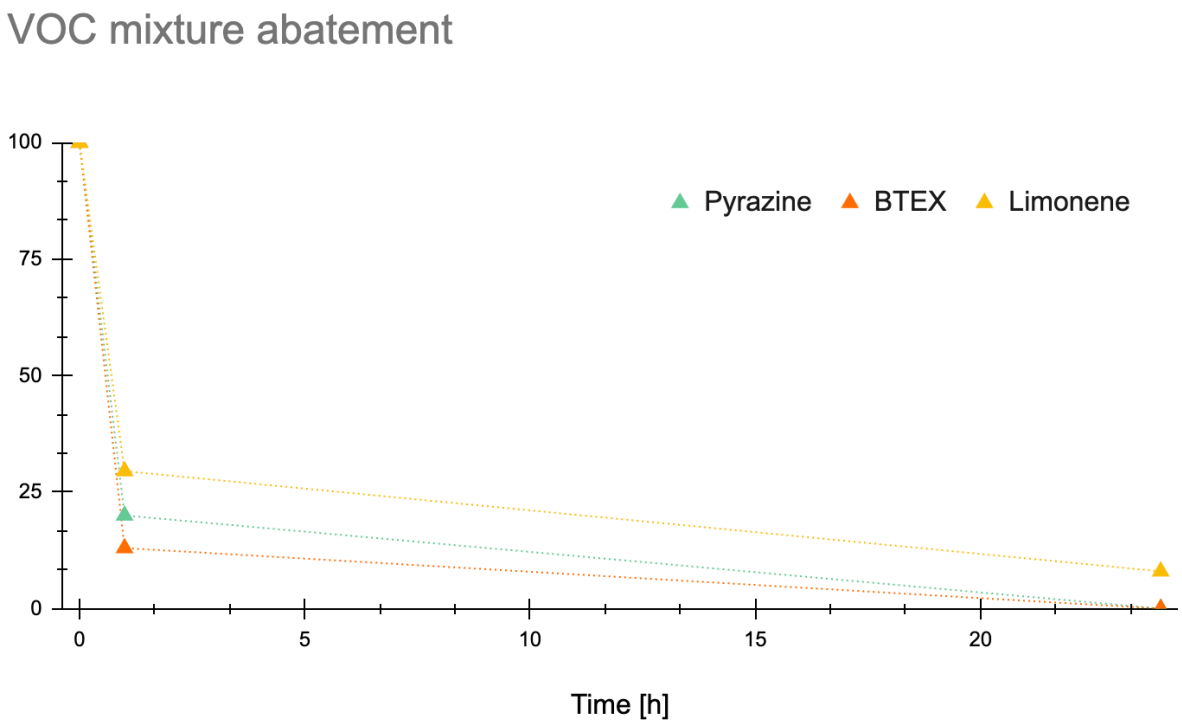

Fig. 5 - Abatement performance of the VOC mixture at 1 and 24 hours, specifically of Pyrazine (in green), BTEX (in orange) and Limonene (in yellow).

Carcinogenic VOCs: Formaldehyde

Aldehydes family

What it is. Formaldehyde is a volatile organic compound (VOC) of the aldehyde family. Also known as formic aldehyde, at room temperature it is gaseous, colorless, has a penetrating odor and is soluble in water. The **IARC** (*International Agency for Research on Cancer*) has placed formaldehyde in **group 1**, that is, the one that includes **agents that are *definitely* carcinogenic**. Formaldehyde is a chemical compound with a great bactericidal power, used in different sectors as bactericide and/or preservative. The World Health Organization (**WHO**) recognizes the maximum **limit of** acceptable concentration of formaldehyde in the home, equal to **100 micrograms / m^3** (or 0.1 ppm - 0.123 mg / m^3), also recognized at the occupational level according to **Legislative Decree 81/08**.

Where it is found. Formaldehyde mainly accumulates in low temperature and low humidity conditions. It is then released over time, contributing to unhealthy home environments. It can be found in glazes, pressed wood products, plywood, fiberboard, glues, and insulation coatings. It is used as an adhesive varnish in particleboard and is contained in soundproofing ceiling panels.

Health Effects. Prolonged exposure to this pollutant can cause **irritation to the eyes, nose, throat, and lungs and lead to the development of asthma.** It is included on the list of substances considered with certainty to be carcinogenic to the human species.

Abatement test of aeriform Formaldehyde contamination with photocatalytic system

PURPOSE The purpose of this research is to conduct a functional verification of the Vitesy photocatalytic system, based on tungsten trioxide (WO_3), to decontaminate air contaminated by airborne concentrations of formaldehyde, in transit through the system.

SET-UP In an environment of about $4m^3$, the equipment under test (called "Photocatalytic Aspirator") was placed. The sampling was carried out with an instrument called "Uniphos precision air sampling pump" consisting of a high-precision manual pump, in which colorimetric vials are inserted. The vials are colored proportionally to the amount of analyte to be detected present in the air sucked. Four samplings were carried out to verify the presence of the substance: The first sampling, was performed following the INITIAL CONTAMINATION with the substance to be tested, by taking the ENVIRONMENTAL air while the photocatalytic system was DEACTIVATED; the second sampling was performed following the 1st TREATMENT by taking the ambient air after 60 minutes of photocatalytic treatment; the third sampling was carried out following the 2nd TREATMENT by taking a sample of the ambient air after 120 minutes of photocatalytic treatment; the fourth sampling was carried out following the 3rd TREATMENT by taking a sample of the ambient air after 180 minutes of photocatalytic treatment. Further sampling was carried out to verify the NATURAL DEADLINE at several hours. **Standard followed: EN ISO 17621:2015**

RESULTS The abatement percentages obtained are very significant, even after only **1 hour** of activation, reaching an efficiency of **85%**. Therefore, the test showed the effectiveness of the photocatalytic system in improving ambient air contaminated by airborne formaldehyde.

Fig. 6

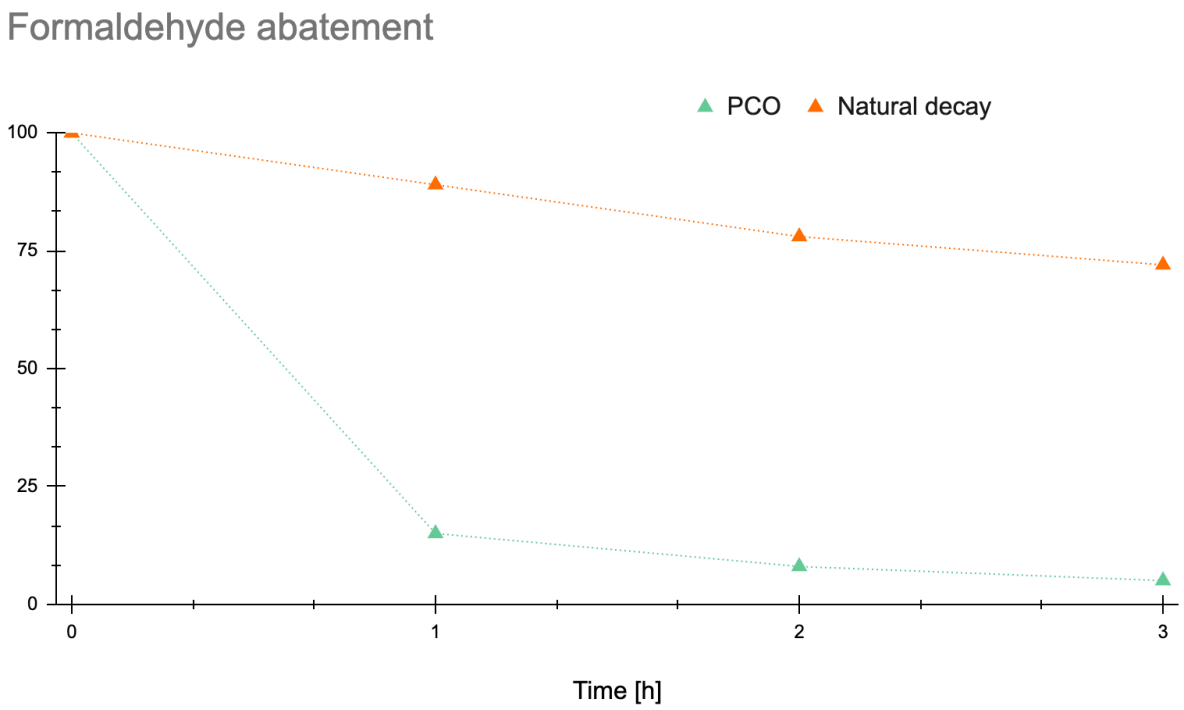

Fig. 6 - Abatement performance of airborne formaldehyde in %, evaluating the natural decay (orange) and the abatement capacity of the Vitesy photocatalytic system (green).

Benzylmercaptan

Odorous compounds

What it is. Mercaptans are organic substances containing a thiol functional group (-SH) that are widely used to produce plant protection products and/or pesticides. Mercaptans tend to have the typical odor of rotting organic substances and/or stagnant water. This family of molecules was chosen to **define** ETERIA's **ability to eliminate unpleasant odors.** Gaseous mercaptans have an **occupational exposure limit of 0.5 ppm (2 mg/m^3)**. Since some mercaptans are extremely annoying and not representative of the odors typically present in an indoor environment, a specific variant was chosen for the odorigenic analysis: benzyl mercaptan, an odorigenic substance present in some wines and in the aroma of coffee that is more representative of the odors present in indoor environments.

Where it is found. Smell that can be found in cooking, wines, and coffee aroma.

Health Effects. Health effects caused by the presence of this gas may be eye discomfort and irritation of the upper respiratory tract. Contact may cause a burning sensation, coughing, asthmatic breathing, laryngitis, shortness of breath, headache, nausea, and vomiting.

Ability of Eteria to abate benzyl mercaptan

PURPOSE The purpose of this research is to define the abatement capacity of odorigenic pollutants of the air purification system Eteria, through photocatalytic activity. The system, thanks to the presence of a photocatalytic ceramic filter coated with tungsten trioxide (WO_3) and a system of LED lights (visible spectrum type) below the filter, activates a series of photocatalytic reactions on environmental micropollutants.

SET-UP To perform the test, a sealed hood of size WxHxD (1.70 m x 45 cm x 75cm) was contaminated with a 10 mg/l solution of benzene thiol. The concentration with which it was decided to perform the test is **almost 10 times the occupational exposure limit**, equal to 0.5 ppm (2 mg/m^3), so as to place the Eteria system in the most unfavorable condition possible. The whole solution was evaporated under nitrogen flow and after homogenization of the contaminant in air, sampling was performed according to the **NIOSH 2542** method, to define the T0 concentration in air. The concentration of the contaminant was then followed over time, identifying the kinetics of photocatalytic degradation at 1 hour and 3 hours.

RESULTS A continuous decay of the air concentration of mercaptan is observed over time. Specifically, **in as little as 1.5 hours,** no more mercaptan is observed (**>97.64%** abatement), as the concentration falls below the instrument's detection limit.

Fig. 7

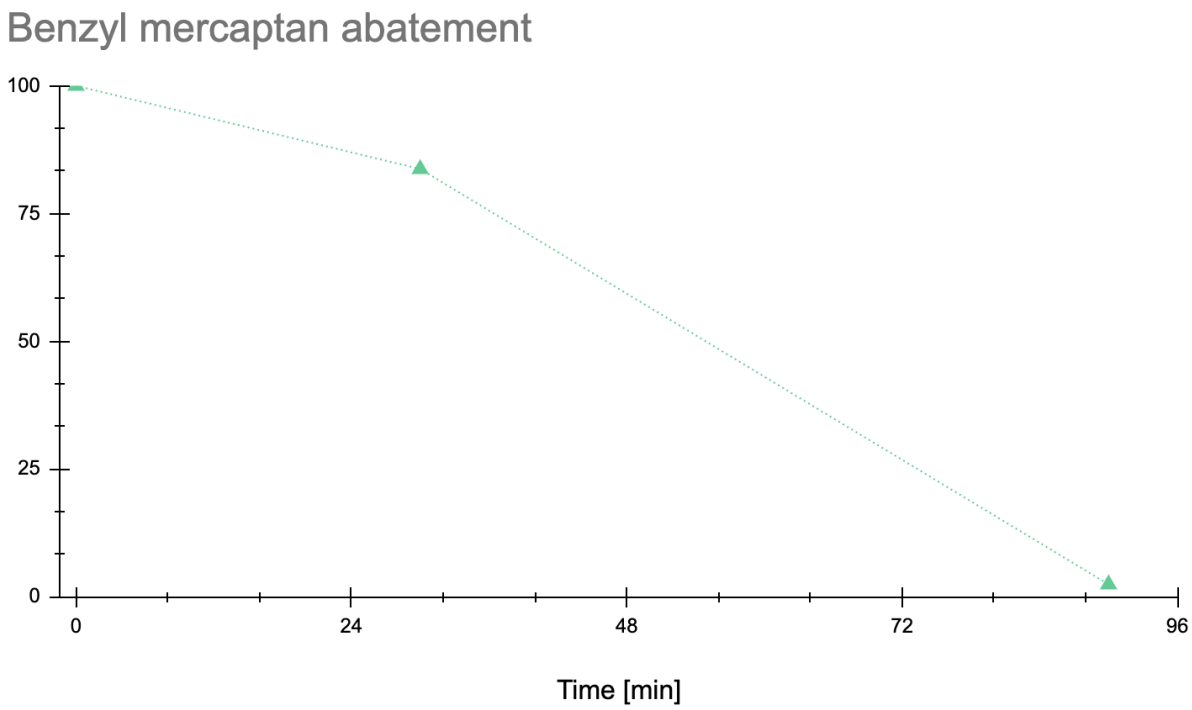

Fig. 7 - Benzyl mercaptan abatement performance in 90 minutes.

PM2.5 and PM10

Fine Powders

What it is. Fine particles are particles of organic or inorganic nature with an aerodynamic diameter of less than 10 μm (PM10) and 2.5 μm (PM2.5). According to the **regulations** in force **in Italy**, the **annual average limits** for fine dust are **25 μg/m^3 for PM2.5 and 40 μg/m^3 for PM10** in ambient air. Vice versa, at the level of **occupational exposure**, according to **D.lgs. 81/08** and subsequent modifications and additions ,the limits **depend on the type of material** taken into consideration: for example, crystalline silica has a limit of 0.025 mg/m^3 , while for inhalable PNOC category ("Polveri non altrimenti classificate" – *Dusts not otherwise classified*) the limit is 10 mg/m^3 .

Where it is found. Particulate matter can come from natural or anthropogenic sources, that is, man-made. Specifically, in the first category there are forest fires and volcanic activity. Among the main sources of particulate matter derived from human activity there is vehicular traffic and heating systems (boilers, pellet stoves and chimneys), which disperse into the atmosphere fumes and soot. In general, **any type of activity involving combustion** releases particulate matter into the air.

Health effects. The size of fine dust (< 10 μm) allows these microparticles to **overcome the natural defenses of our body.** The smaller these particles are, the more they can enter the body, until they reach the lungs and even the bloodstream. The concentration and consequent inhalation of particulate matter can have an impact on our body manifesting immediate effects such as **eye, nose and throat irritation and breathing problems, headaches, fatigue and low concentration.** The International Agency for Research on Cancer (**IARC**) has placed fine dust in **group 1**, that is, **agents *definitely* carcinogenic to** humans.

Ability of Eteria to retain particulate matter

PURPOSE The purpose of this test is to verify the effectiveness of abatement of particulate matter (PM2.5 and PM10) in the ambient air using the Eteria air purification system.

SET-UP Since the exposure limits for inorganic dust are lower, a 50:50 mixture of silica dust and carbonates, respectively, of micrometer size in the range of PM10 and PM2.5 was chosen for test formulation. The test was performed in a sealed fume hood of dimensions LxHxD (1.70m x 45cm x 75cm); the mixture was air-flown by flushing 10 grams of dust at particle sizes of 2.5 µm and/or 10 µm for approximately 1 hour. We then proceeded to measure the contamination at time T0 and followed the trend of the kinetics of dust removal over time (1 hour, 3 hours and 24 hours) according to **UNI 689/484** and **UNI 12341** with sampling at identical times according to the indications of strategies for sampling of indoor pollutants in the **UNI 16000-1:2006** standard. In this case, for comparison purposes, the natural decay of the dusts was also studied, as scientific data and/or regressed studies of abatement activities did not extrapolate the exclusive reference value for the nature of the chosen dusts.

RESULTS The decay trend of PM2.5 particulate matter is downward throughout the monitoring time. On the contrary, in the decay trend of PM10, first a reduction and then a stabilization of the dust concentration is observed. In the case of fine dust, PM2.5, the percentage reduction of the airborne pollutant in **3 hours** is **72%**, while for PM10 dust the reduction is **52.4%** in **1 hour.** Since the limit of exposure to PM10 on annual average is 40 $\mu g/m^3$, our tests show that if the indoor level of PM10 was 58 $\mu g/m^3$, for example due to vehicular traffic, Eteria would be able in just 30 minutes to **bring the value to a concentration much lower than the threshold.** This data is particularly useful if the environment where people spend most of their time is **close to a busy street** or in the **city center.**

Fig. 8 and 9

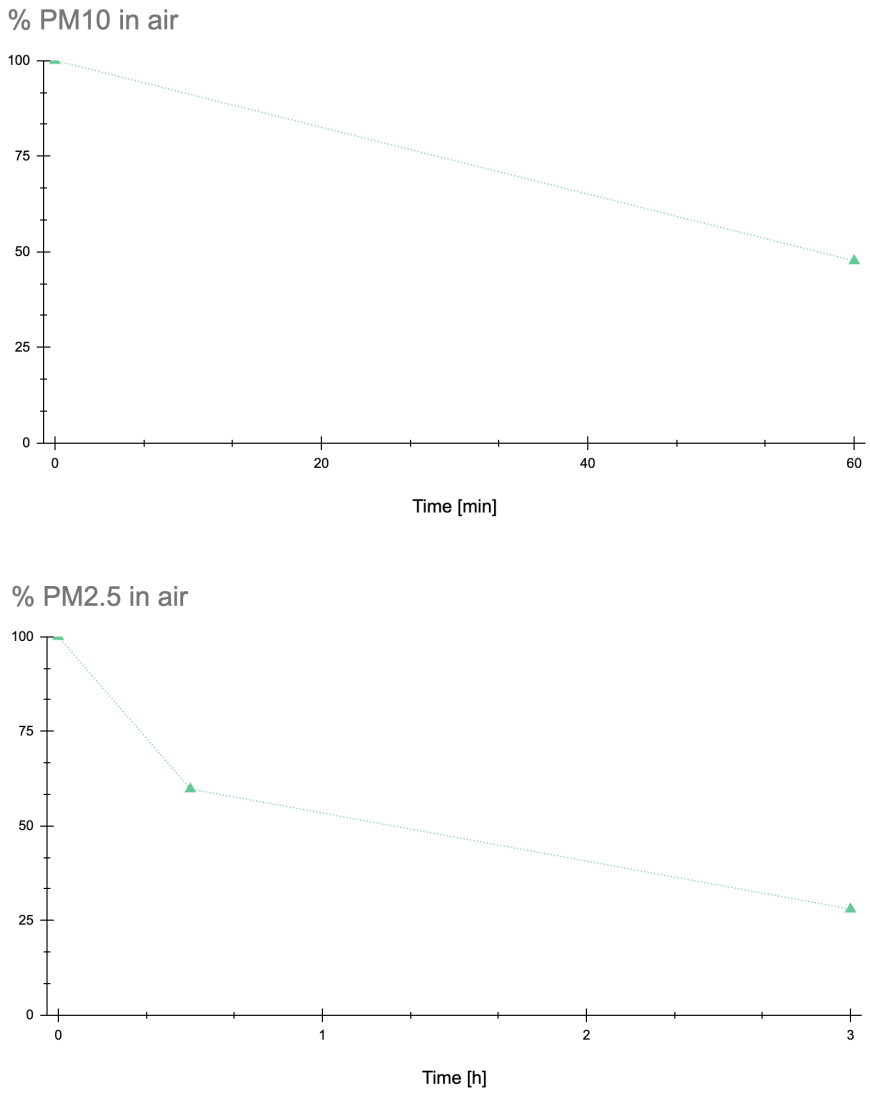

Fig. 8 and 9 - performance of PM10 and PM2.5 reduction in air.

Ozone

O_3

What it is. Ozone is a gas formed by three oxygen atoms, bluish in color and with a characteristic pungent and irritating odor. It is **produced in the atmosphere** by the **reaction between nitrogen oxides, volatile organic compounds and sunlight.**

Where it is found. In a confined environment, the main sources of emissions of ozone precursor compounds are: road transportation, civilian heating, power generation, tobacco smoke, high-voltage electrical tools (e.g., electric motors, laser printers, and fax machines), equipment that produces ultraviolet radiation, electronic air cleaners (if not properly installed and maintained), sprays, and fumes from cooked foods.

Health Effects. The presence of high levels of ozone damages human health, that of animals and plants (it affects their photosynthesis and growth) and produces the deterioration of materials. The main effects it has on humans are: **irritation to the eyes, nose, throat and respiratory system, sense of pressure on the chest and coughing** (strong irritant action against the mucous membranes). The risks depend on the concentration of ozone present and the duration of exposure. Studies conducted on **urban populations** exposed to ozone have revealed **irritative symptoms** on the mucous membranes of the eyes and the first respiratory tract for **exposures of several hours** to ozone levels **starting from 0.2 mg/m^3 (hourly average)**. Transient reductions in respiratory function have been observed in children and young adults at lower ozone levels as low as 0.12 mg/m^3 (hourly average).

Ozone emissions assessment of Eteria

PURPOSE Photocatalytic processes generally include chemical reactions mainly on two chemical reagents, i.e. on molecules having hydroxyl groups (OH) or on oxygenated radical species (ROS). In this case, the Eteria device works with a light source that emits in the visible spectrum and therefore with a lower energy charge than the ultraviolet light used for other types of photocatalysis. At the same time, once triggered the photocatalytic reactions, the nature of the reactions remains similar, so you can have the formation of ozone that if kept at a very low level do not negatively affect the healthiness of the air.
In this test, ozone concentrations were tested at 5 and 24 hours; specifically, we wanted to verify that ozone formed over time is typically below the **legal limit for healthy air, i.e., 0.2 mg/m³** (value indicated by WHO: 150 - 200 µg/m^3 for 1-hour exposure).

SET-UP The Eteria device was turned on for 5 hours and 24 hours in a sealed hood of size LxHxD (1.70m x 45cm x 75cm) inside which there was only ambient air. Subsequently, active sampling was performed by taking air inside an impinger solution characterized by iodine ions that capture ozone to form iodized ions, as reported in the scientific article "*Determination of Ozone in air by Neutral and Alkaline Iodie procedures*" - DH Byers&BE Satzman (1958) - American Industrial Hygiene Association Journal.

RESULTS It is observed that in the short term there is **no ozone emission.** There is a low presence of ozone **after 24 hours** of operation, probably due to the heat released by Eteria in 24 hours of continuous operation in performance mode in a sealed hood of less than one cubic meter (0.57 m^3). The recorded value is well **below the threshold value** indicated by WHO of 0.2 mg/m^3 (**more than 100 times lower**).

Fig. 10

Fig. 10 - Ozone emissions in 24 hours compared to the threshold value imposed by WHO.

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