VITESY

Test Report

Natede

Test Report 2023 - Rev. 1 - 03.2023

Indice

Test report available only in Italian

ACRONYMS USED IN THE DOCUMENT:

- **IARC** = The International Agency for Research on Cancer
- **INAIL** = *Istituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro* ("National Institute for Insurance against Work-related Injuries"*;* Italian governmental body)
- **ISO** = International Standards Organization
- **PCO** = Photo-Catalytic Oxidation (purification technology used in Natede and other Vitesy Air Purifiers)
- **PPM** = Parts per million
- **VOC(s)** = Volatile Organic Compound(s)
- **WO_3** = Tungsten Trioxide (substance used for coating of Vitesy's photocatalytic filters)
- **UFC** = *Unità formanti colonia*, Colony Forming Units (measurement used to estimate the number of viable bacteria or fungal cells in a sample)

Insight

Pollutant	Tested Area	% of Abatement	Time
VOC (MEK)	0.5 m^3	99,49 %	2 hours
	33 m^3	75 %	24 hours
COV (Formaldehyde)	4 m^3	85 %	24 hours
Bacteria	4 m^3	99,9 %	1 hour
	33 m^3	93 %	1 hour

Mode	Air flow	Noise level
Silent	11 m^3/h	34 dB
Performance	21 m^3/h	44 dB

*It is estimated that the effect NATEDE SMART can exert is equivalent to the action performed by about **7 plants**.*

Volatile organic compounds

Methyl ethyl ketone (MEK)

What. VOCs (Volatile Organic Compounds) make up a wide range of dangerous substances and are the main indoor pollutant. Methyl ethyl ketone, also known as butanone, is an organic compound with the formula Ch3C(O)CH2CH3. This colourless liquid ketone has a sharp, sweet odour similar to acetone.

Where. The main emission sources are: paints, lacquers, insect sprays, deodorants, wood treatment products, household cleaning products, scented candles. Methyl ethyl ketone is used in many sectors, as a solvent and in the production of synthetic rubber, paraffin wax, as a solvent during wood processing and for the manufacture of other chemicals.

Effects on health. This compound is irritating to the eyes. Acute (short-term) inhalation exposure to methyl ethyl ketone in humans causes irritation to the eyes, nose and throat.

Kinetics of pollutant abatement (VOCs-MEK) in box of Natede Smart purification system

PURPOSE

The purpose of this research is to define the capacity of the Natede Smart air purification system to abate chemical pollutants by means of phytocatalytic activity implemented by the phyto-purification activity of a particular plant species, namely the “Sansevieria Trifasciata”. The system, thanks to the presence of a ceramic filter coated with photocatalytic tungsten trioxide (WO_3) and a system of LED lights (visible spectrum) below the filter, activates a series of photocatalytic reactions on environmental micropollutants.

SET-UP

The indoor pollution abatement tests were carried out in a sealed chemical box with dimensions *200cmx50cmx45cm*. The device was placed inside the box. In the immediate vicinity, a VOCs contaminant was evaporated by suffusing the air inside the beaker containing the contaminant. In the specific case of this study, Methyl Ethyl Ketone (MEK) was used. Once the contaminant has evaporated completely, it is left for 30 minutes so that it saturates the investigation chamber. Sampling is carried out at T0 h and T1 h and T2 h according to the **NIOSH 2500 issue 2**, using an automatic sampler and an absorbent vial of activated carbon. Subsequently, the analysis is carried out using **UV-Vis spectrometry**.

RESULTS

The data analysis showed that **after 2 hours** of operation of the Natede Smart system in a condition of medium initial contamination (5 ppm), **the abatement is 99.49%**. It should be pointed out that in indoor ambient air the concentrations of a pollutant within the various exposure limits indicated by the Community and international articles on VOCs are around the 0.5 - 5 ppm limits, depending on the volatility. The Natede Smart system, as a result of what has been said, is a product with excellent indoor air depolluting capacities.

Fig.1

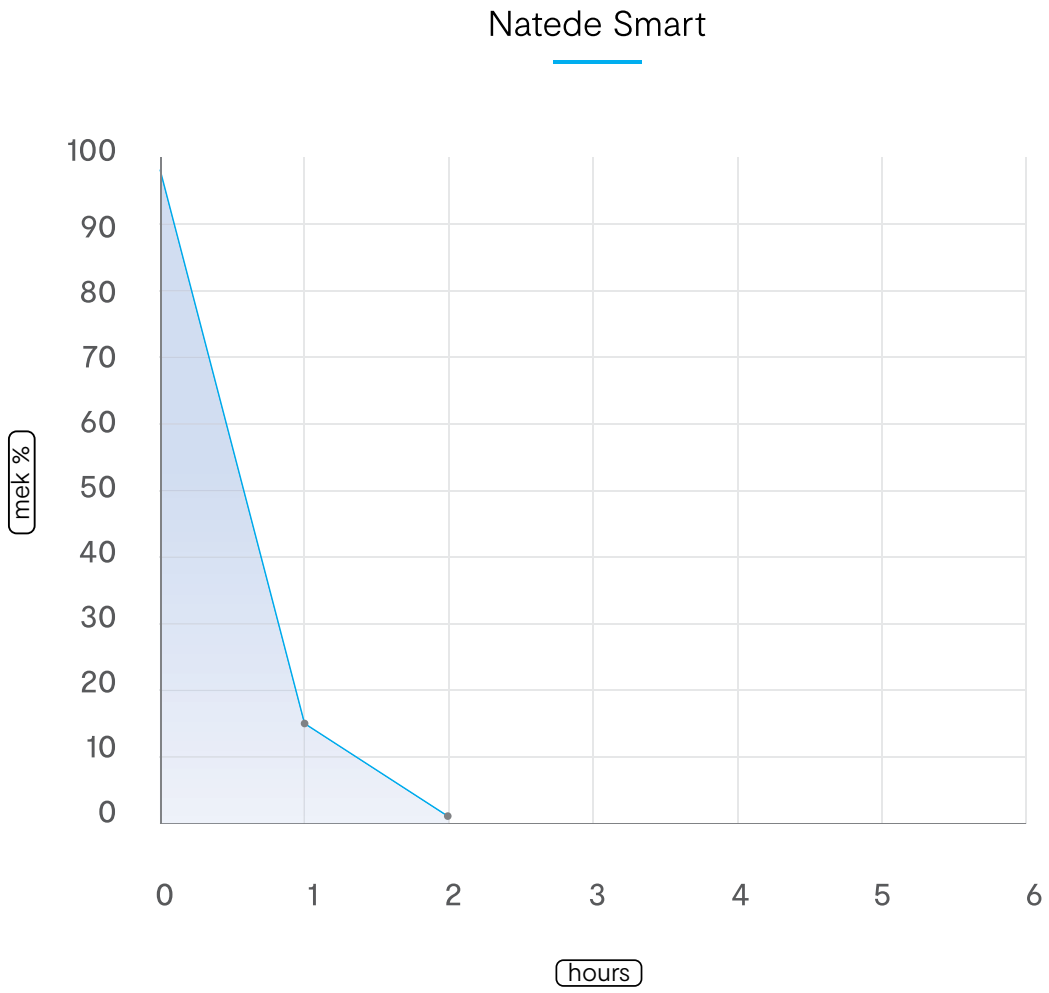

Fig. 1 - MEK concentration [mg / m3] expressed in% at times t0, t1 and t2 hours.

Kinetics of pollutant abatement (VOCs-MEK) in real-life environment of Natede Smart purification system

PURPOSE

The purpose of this research is to define the capacity of the Natede Smart air purification system to abate chemical pollutants by means of phytocatalytic activity implemented by the phyto-purification activity of a particular plant species, namely the “Sansevieria Trifasciata”. The system, thanks to the presence of a ceramic filter coated with photocatalytic tungsten trioxide (WO3) and a system of LED lights (visible spectrum) below the filter, activates a series of photocatalytic reactions on environmental micropollutants.

SET-UP

The indoor pollution abatement tests were carried out in a closed room of 12 m2 (33m3) with non-opening windows and entrance door with low pollutant loss. The device was placed on a counter close to the light. In the immediate vicinity, a container was placed with the contaminant subjected to forced evaporation by air blast at variable flows. In the specific case of the study, a container with 30 millilitres of Methyl Ethyl Ketone (MEK) was used. Sampling is carried out at T24 h and T48 h according to the **NIOSH 2500 issue 2**, an automatic sampler and an absorbent vial of activated charcoal.
This is followed by analysis using **UV-Vis spectrometry**.

RESULTS

Data analysis showed that **in 24 hours** Natede Smart was able to **remove more than 75%** of VOCs, whereas a plant in a standard pot only 11%. **In 48 hours** Natede Smart almost **removed 94%** of VOCs.

Fig.2

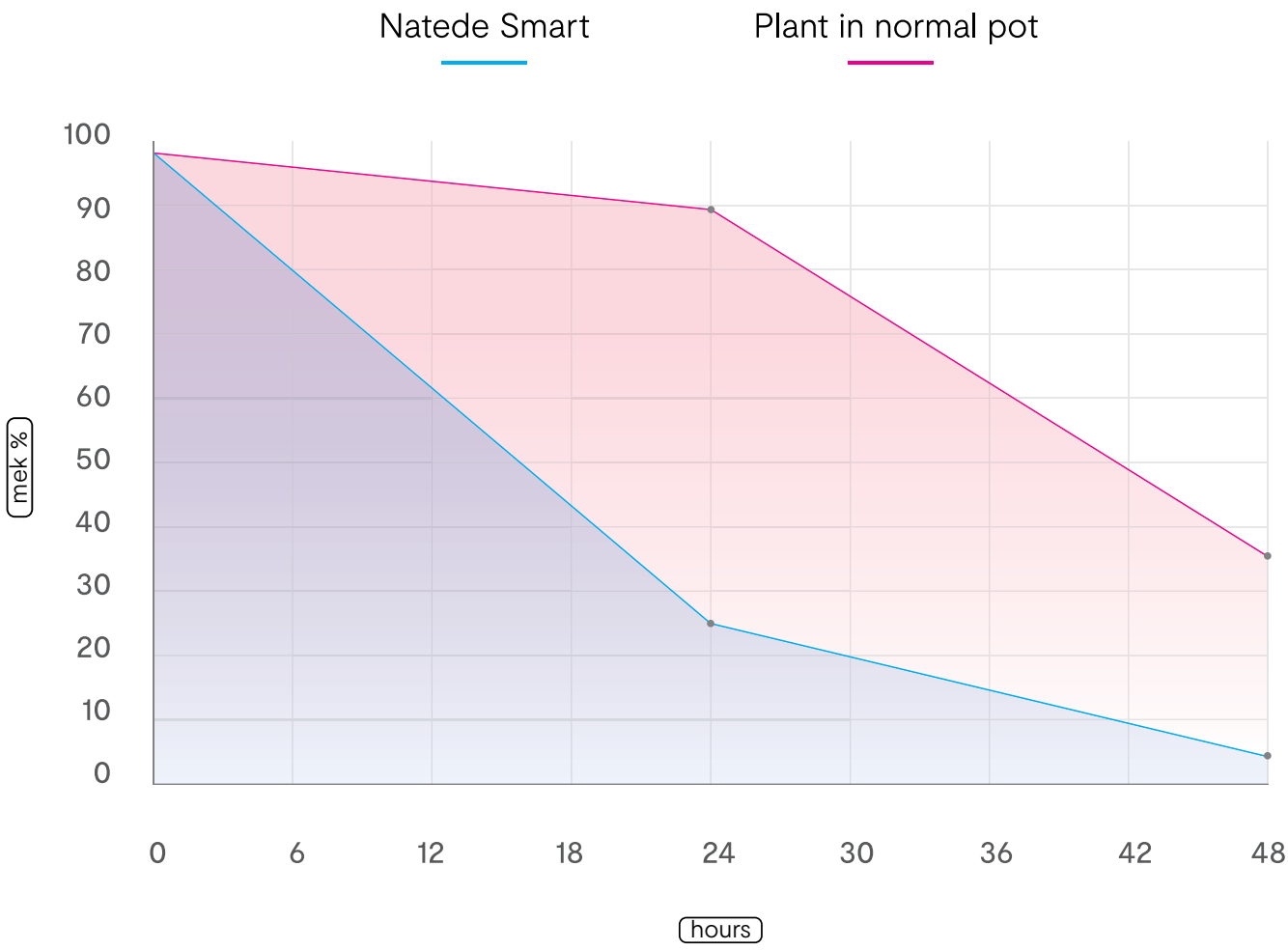

Fig.2 - Concentration of MEK [mg / m3] expressed in% at times t0, t24 and t48 hours present in the room with the plant grown in the standard pot (red) and in NATEDE SMART (blue).

Biological contaminants

Total Bacterial load

What. In an indoor environment we speak of Total Bacterial Load, meaning both the bacterial load and the fungal load made up of moulds and yeasts.

Where. 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: airborne biological agents from human or animal sources, heating systems, air conditioning, mould, dust.

Effects on health. The health effects caused by the presence of biological contaminants can be classified into three types: infectious, toxic and allergic and can manifest themselves with different intensity depending on various factors including the physical condition and susceptibility of each individual.

Natede Smart's ability to break down airborne microbial contamination, Gram + and Gram - (1000x106 UFC)

PURPOSE

The purpose of this research is to define the capacity of the Natede Smart air purification system to abate chemical pollutants by means of phytocatalytic activity implemented by the phyto-purification activity of a particular plant species, namely the "Sansevieria Trifasciata". The system, thanks to the presence of a ceramic filter coated with photocatalytic tungsten trioxide (WO3) and a system of LED lights (visible spectrum) below the filter, activates a series of photocatalytic reactions on environmental micropollutants.

SET-UP

The indoor pollution abatement tests were carried out in a closed room of 12 m2 (33m3) with non-opening windows and entrance door with low pollutant loss. The device was placed on a counter close to the light.. In particular, a container containing 150 ml of an aqueous mixture of Gram + and Gram - bacteria (at a concentration of 1000x106 CFU) was placed on the plant. The mixture was left for 1 day under stirring. After two days of exposure, passive sampling of the bacteria was carried out in order to define their contamination at time zero. The passive sampling plate was left exposed on the plant for 12 hours. After the first sampling, Natede was set with LEDs on and the fan switched on at standard speed, and after 24 hours and 48 hours two passive bacterial samplings were carried out, each lasting 12 hours. **The INAIL** *(Italian National Institute for Occupational Accident Insurance)* **guidelines** for indoor microbiological agents were followed.

RESULTS

In 24 hours Natede Smart **eliminated 93%** of bacteria, while a plant in a standard pot only 36%. **In 48 hours** Natede Smart **removed 99.4%** of the bacteria present in the test room.

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LEBSC S.r.l.
Laboratory for Environment Biotechnology Structural engineering and Chemistry

Fig.3

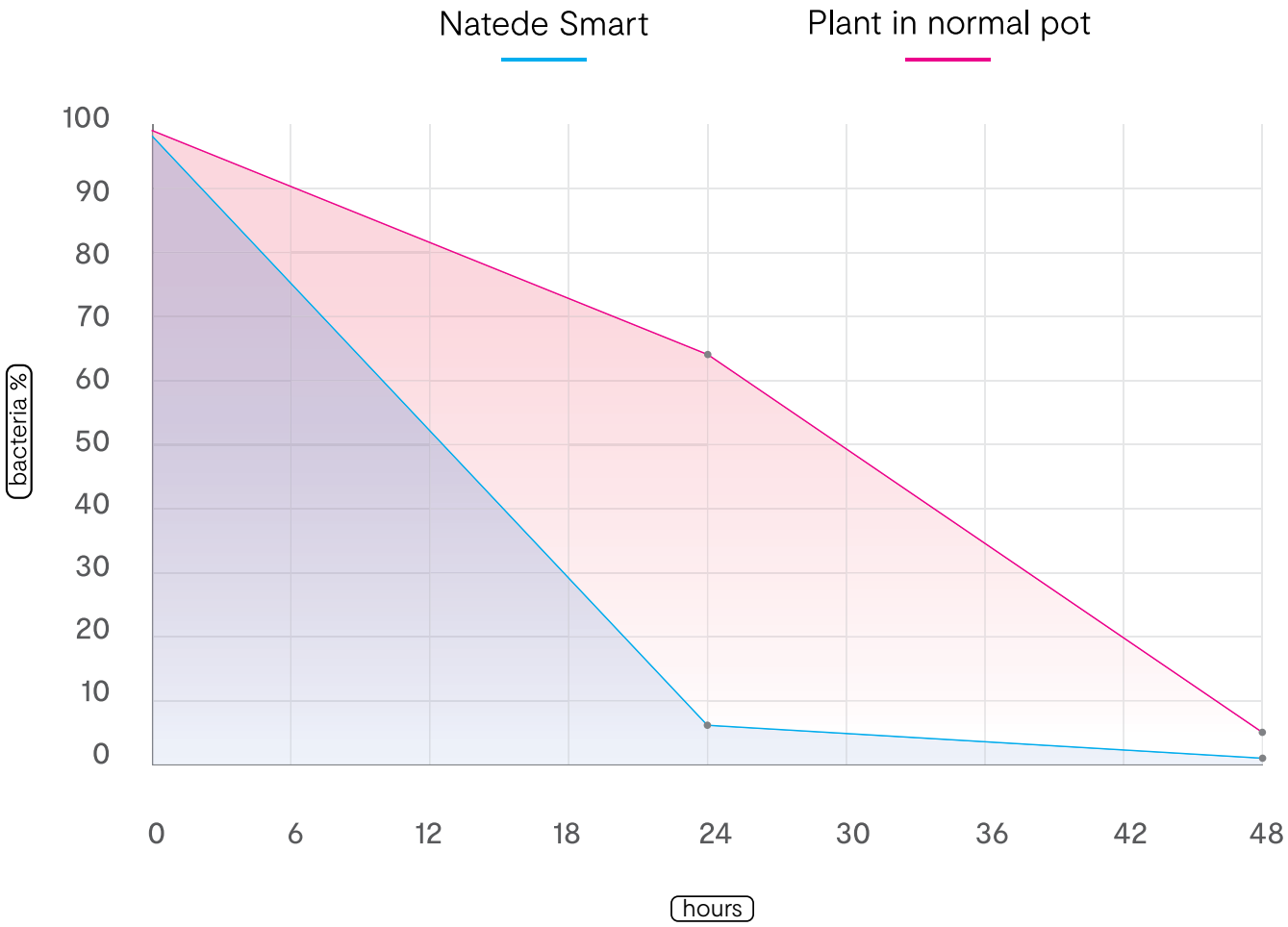

Fig. 3 - Performance reduction of the microbial load expressed in% at times t0, t24 and t48 hours present in the room with the plant grown in the standard pot (red) and in NATEDE SMART (blue).

Airborne bacteria abatement test with WO_3 photocatalytic system

PURPOSE

This research aims to carry out a functional verification of the Vitesy photocatalytic system, based on tungsten trioxide (WO_3), to decontaminate air contaminated by airborne bacterial charges passing through the system.

SET-UP

In a room of about $4m_3$, the tested device called “Photocatalytic Aspirator” was positioned. Sampling was carried out with an instrument called “Bio Sampler” consisting of a test tube containing sterile water in which the air sucked in to be tested was bubbled, using a specific external pump in such a way as to transfer the bacterial charge in the air to the sterile liquid contained in the test tube; pump flow rate lt/ min.17. Four samplings were carried out, each lasting 60 minutes, equal to 1,020 litres of aspirated air: a) In the “blank” test the air in the room was sampled to test the baseline bacterial load used for verification of any subsequent abatement, no sanitisation - ZERO POINT; The second sampling was done following INITIAL CONTAMINATION, by taking AMBIENT air with a DEACTIVATED photocatalytic system; c) The third sampling was carried out following the 1st SANIFICATION TREATMENT, taking ambient air after activated photocatalytic treatment for 60 minutes. d) The fourth sampling was carried out following a 2nd SANITIZATION TREATMENT, to check the ambient air after photocatalytic treatment activated for 120 minutes. **Standard UNI EN ISO 6222 : 2001.**

RESULTS

The results obtained in this case showed that the natural decay of the contamination carried out is very slow and is around 20-30 % of the initial contamination after 6 hours, compared to **80-100% after only 1 hour** of treatment with the activated photocatalytic system.

Fig.4

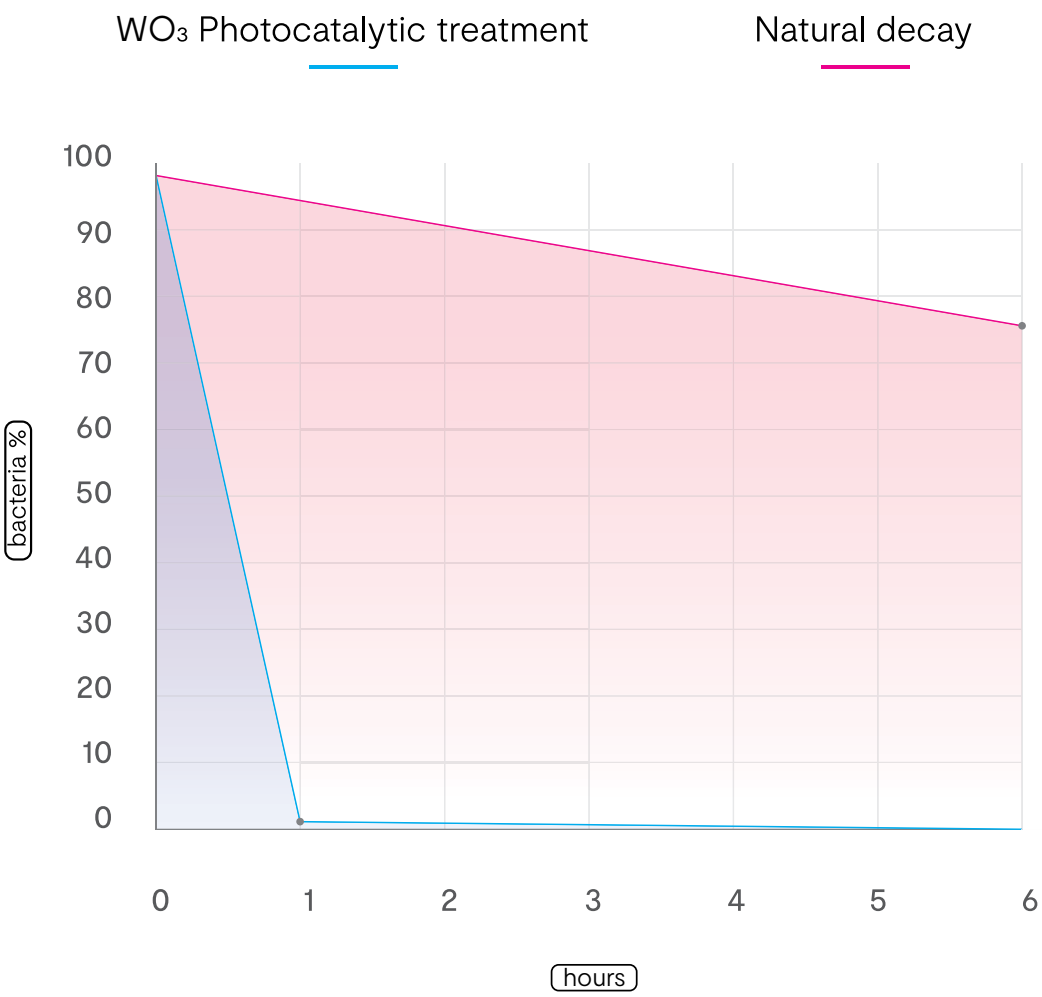

Fig. 4 - Performance of the reduction of the airborne microbial load in%, evaluating the natural decay (red) and the abatement capacity of the Vitesy photocatalytic system (blue).

Formaldehyde

Aldehyde family

What. Formaldehyde is a volatile organic compound (VOC) of the aldehyde family. It is also known as formalin, formic aldehyde, methylene oxide, oxymethylene methylaldehyde. At room temperature it is gaseous, colourless, has a penetrating odour and is soluble in water. The IARC (The Inter- national Agency for Research on Cancer) has placed formaldehyde in Group 1, which includes the most carcinogenic agents.

Where. Formaldehyde mainly accumulates in conditions of low temperature and low humidity. It is then released over time, contributing to unhealthy home environments. It can be found in enamels, pressed wood products, plywood, fibreboard, glues and insulation coatings. It is used as an adhesive varnish on particle board and is contained in acoustic ceiling panels.

Effects on health. Prolonged exposure to this pollutant can cause irritation to the eyes, nose, throat and lungs and lead to the development of asthma.

Test abatement of airborne Formaldehyde contamination with WO_3 photocatalytic system

PURPOSE

The aim 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 as it passes through the system.

SET-UP

In a room of about 4m3, the tested device called “Photocatalytic Aspirator” was positioned. Sampling was carried out using an instrument called the “Uniphos precision air sampling pump”, consisting of a high-precision manual pump into which are inserted colorimetric vials that are coloured proportionally according to the quantity of the analyte to be detected present in the air sucked in. Four samplings were carried out to verify the presence of the substance: The first sampling, was carried out following the INITIAL CONTAMINATION, with the substance to be tested by taking the ENVIRONMENTAL air and photocatalytic system DEACTIVATED; the second sampling was carried out 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 DECAY at diverse hours.
Standard EN ISO 17621:2015.

RESULTS

The abatement percentages obtained are very significant, even **after just 1 hour of activation**, reaching an efficiency of **85%**. This demonstrates the effectiveness of using the photocatalytic system to improve ambient air contaminated by airborne formaldehyde.

Fig.5

Fig. 5 - Performance of airborne formaldehyde abatement in%, evaluating the natural decay (red) and the abatement capacity of the Vitesy photocatalytic system (blue).

Evaluation of the performance of a plant in Natede Smart compared to a plant in a common pot

PURPOSE

The aim of this test is to find out how much better (in terms of VOC removal) a plant in Natede Smart performs compared to a plant in a common pot.

SET-UP

The indoor pollution abatement tests were carried out in a closed room of 12 m2 (33m3) with non-opening windows and entrance door with low pollutant loss. The device was placed on a counter close to the light. In the immediate vicinity, a container was placed with the contaminant subjected to forced evaporation by air blast at variable flows. In the specific case of the study, a container with 30 millilitres of Methyl Ethyl Ketone (MEK) was used. Sampling is carried out at T24 h and T48 h according to the **NIOSH 2500 issue 2**, an automatic sampler and an absorbent vial of activated charcoal.

RESULTS

Natede Smart is able to amplify the purifying power of the plant. Thanks to the enhanced flow of air through the cultivation substrate, which forces pollutants to come into contact with the rhizosphere, and the synergy with the photocatalysis phenomenon, it is estimated that **the effect NATEDE SMART can produce is equivalent to the action of about 7 plants**. This is a considerable improvement, both in terms of maintenance and of space occupied, having to manage one plant instead of seven.

Fig.6

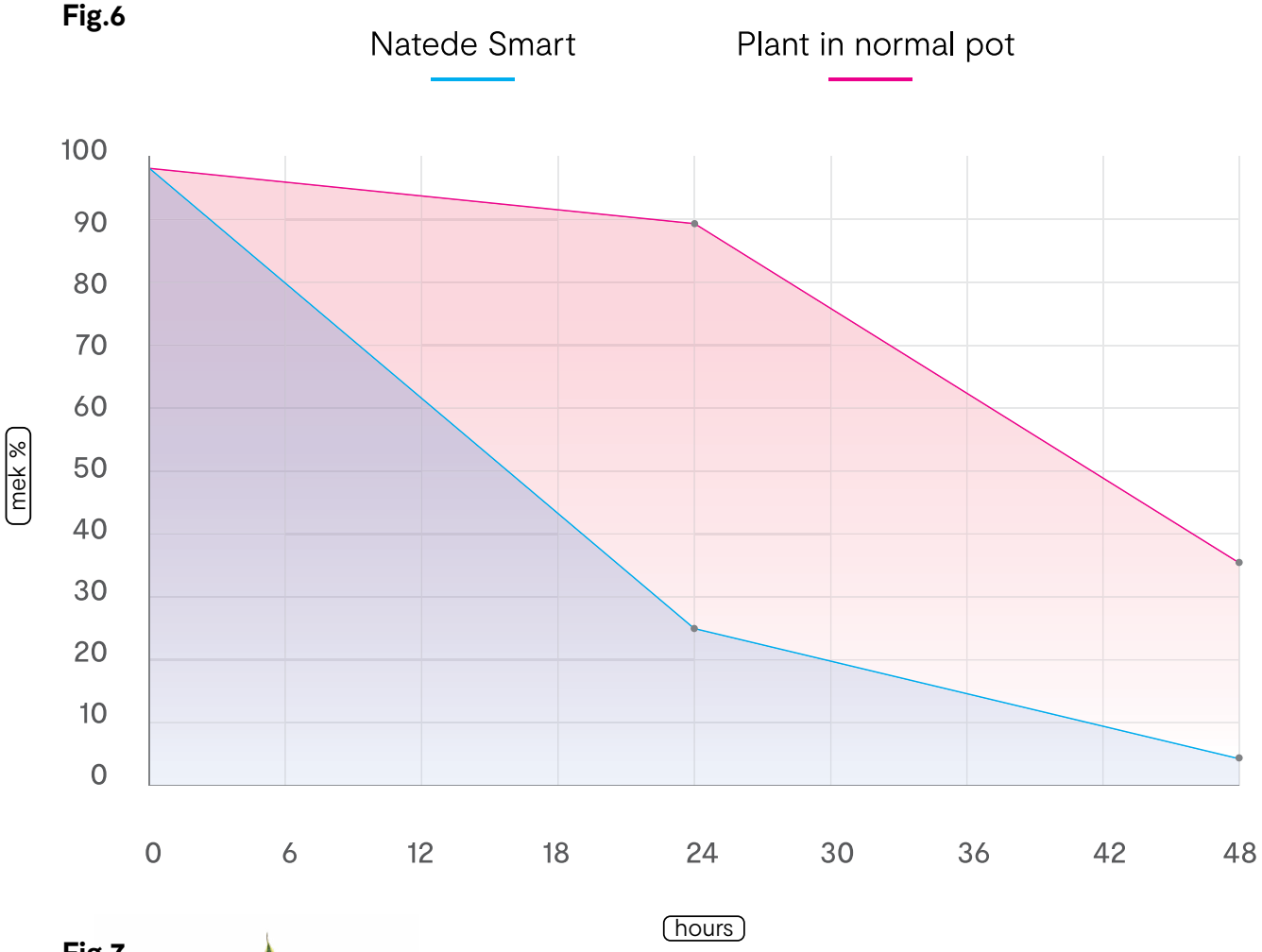

Fig.7

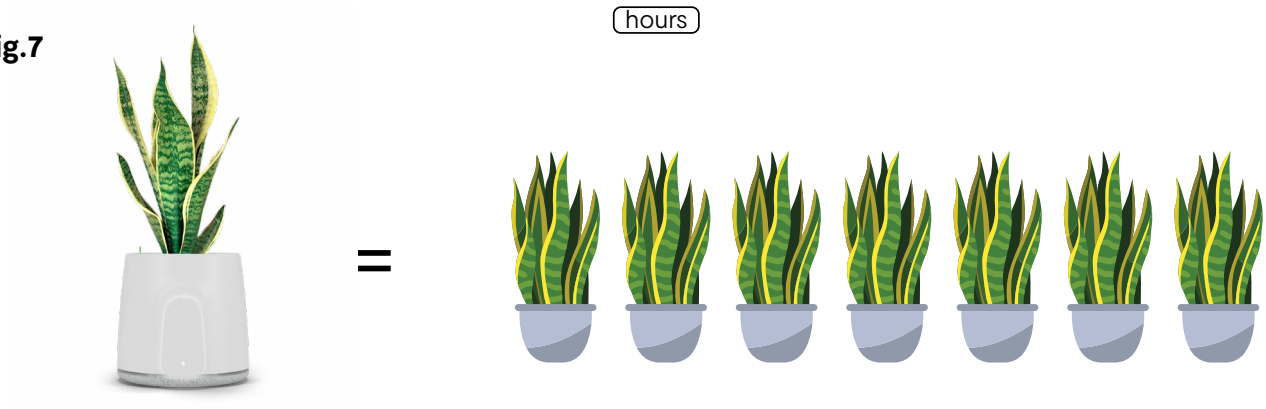

Fig. 6 - Concentration of MEK [mg / m3] expressed in% at times t0, t24 and t48 hours present in the room with the plant grown in the standard pot (red) and in NATEDE SMART (blue).

Fig. 7 - Plant proportion in Natede Smart vs common potted plant.

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