TECHNOLOGY OFFER **PORTAL**

BREATHE FREE AIR OF COVID-19 IN INDOOR COMMON AREAS

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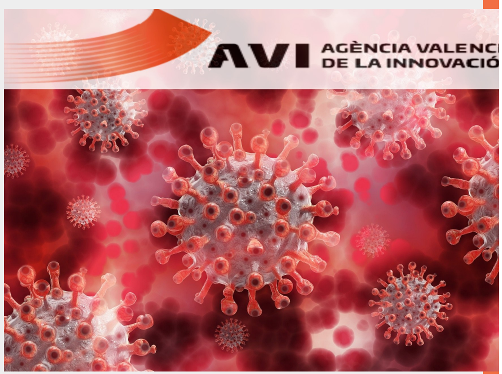
ABSTRACT

The *Institute of Chemical Process Engineering* of the University of Alicante has developed a system that allows the individual supply of disinfected air simultaneously to multiple users in closed spaces of common use.

This system is characterised by the fact that it can be easily installed in any place (classrooms, cinemas, theatres, means of transport, hospitals, offices, banks, etc.), it is very economical, it allows the safety distance to be reduced safely, and therefore, to complete the capacity at 100% with practically no risk of contagion by the inhalation of air contaminated with COVID-19 or other pathogens that are transmitted by air.

We are looking for companies interested in acquiring this system for commercial exploitation through utility model licensing agreements.



INTRODUCTION

The systems of air renewal or disinfection in closed spaces are well known. These systems guarantee the supply of clean air to a room, but they do not avoid the possible contact with contaminated air already used during the time that it passes from its emission until it is renewed.

In this sense, inhalation or contact with the air exhaled by other users cannot be avoided, as they all breathe the same air in the room, which means a high risk of contagion for those diseases that are transmitted through the air in the form of aerosols.

The COVID-19 pandemic has brought about a radical change in society. Health measures have had to be taken to reduce or prevent the spread of the virus, leading changes in customs and habits, in the economy and in social life.

Until an effective, safe and universally accessible vaccine appears and becomes widespread allowing recovery lifestyle and social relations, or prevention possible future similar risks, it is necessary to develop new air disinfection systems for shared closed spaces, which they allow individual use avoiding contact with the air exhaled by other users.

TECHNICAL DESCRIPTION

The present invention solves the problem described above, since **it guarantees the arrival of disinfected air to one or multiple users in a safe and individual manner**. Once the air has been used, it is channeled and disinfected, avoiding at all times the mixing of both air currents. In this simple way, possible contact with the air exhaled by other users is prevented, thus ensuring a practically n**ull risk of contagion and/or infectio**n.

The invention consists of an air circulation circuit where a series of individual masks can be connected (*see Figure 1*).

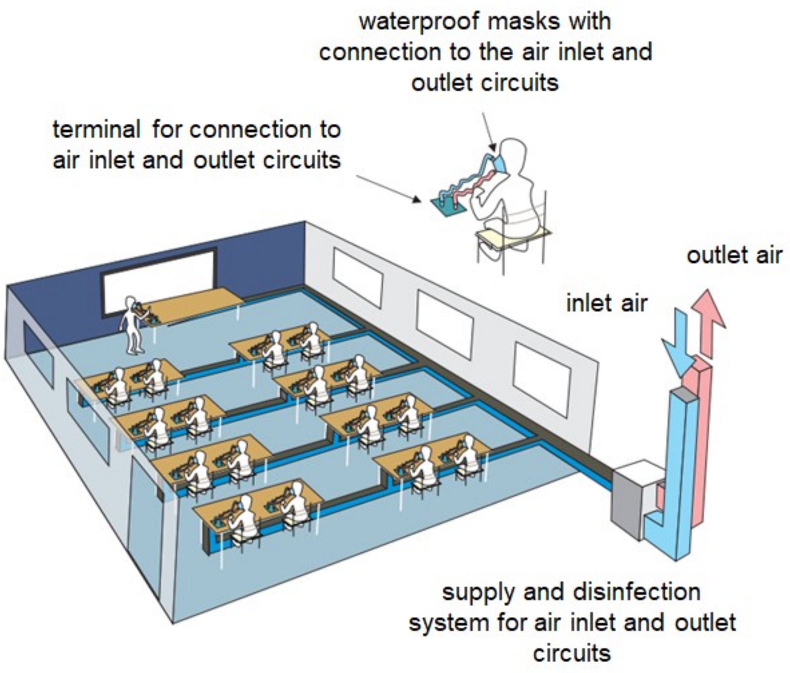


Figure 1: Illustration of the system applied to a classroom of 16 students

The technology consists of an air collector with a simple filtering system to prevent the entry of coarse particles and insects; a compressor or blower that allows the air to circulate through the entire circuit; a HEPA filter or similar behind the drive system; a sterilisation chamber; an air conditioning system to the distribution circuit (temperature and humidity); the distributed circuit itself with as many outlets as there are in the enclosure: each of these outlets will be connected to each individual mask by means of a nozzle (which may be equipped with a non-return valve). The individual mask will be fitted with another nozzle for connection to the exhaled air removal circuit. This circuit will be equipped with a disinfection chamber of the same type as that described for the inlet, and will conduct the air (again disinfected) to the outside for disposal. The masks shall be waterproof over their entire surface -except for the nozzles- and may be fitted with a conventional filter FPP1 or FPP2 type for when they not connected to the system.

This ensures the user can breathe disinfected air all time while is connected to the system.

The components of the invention are listed below:

1. A **collective air disinfection equipment**, consisting of:

    1.1. A means of disinfecting incoming air, and a means of disinfecting outgoing air.

    These means of disinfection may be:

        1.1.1. Ultraviolet radiation lamps (UV-C type) of appropriate wavelength, power and exposure time to the pathogen to ensure the complete disinfection of the air current circulating through them.

        1.1.2. Infrared radiation lamps that raise the temperature of the circulating air above the sterilisation threshold, and subsequently cool it to the appropriate temperature to be inhaled by users.

        1.1.3. Other heating/cooling mechanisms on the market.

        1.1.4. Bubbling mechanisms through disinfectant solutions.

        These means can be of the same nature as each other, or different.

    1.2. An air distribution circuit (linked to the inlet disinfection system).

    1.3. An air extraction circuit (linked to the outlet disinfection system).

    1.4. An inlet connection (to link the sterile air distribution circuit to the single-use device).

    1.5. Outlet connections (to connect the single-use device to the exhaust air circuit used).

    1.6. Filter media (HEPA or similar), both in the distribution circuit and in the exhaust circuit.

    1.7. It is also possible to enable some injection means for the dosage of compounds by means of aerosol, thus allowing the simple dosage of different components: aromas, essences, drugs (in hospitals), etc. -to do this, it is sufficient to inject the prescribed medicine into the corresponding pipe for each patient-.

    1.8. Anti-return valves can be included -in both the distribution and extraction circuits-.

The inlet air disinfection media are located before the inlet connections (according to the direction of air flow in the distribution circuit), while the outlet air disinfection media are located after the outlet connections (according to the direction of air flow in the extraction circuit).

Additionally, to facilitate the air flow, an impeller could be included in the distribution circuit, and an extractor or aspirator in the exhaust circuit (in this case, the inlet and outlet flows should be compensated to maintain breathing comfort). In this way, forced air circulation is guaranteed throughout the entire system.

The inlet and outlet connections are flexible tubes that allow supply the necessary air/oxygen at the appropriate pressure, as well as a certain mobility of the users (short trips, even longer ones).

Both circuits are conveniently marked to avoid confusion in the connection.

2. A **system of collective air disinfection**, formed by:

    2.1. Disinfection equipment.

    2.2. Distribution circuit.

    2.3. Extraction circuit.

This system has been designed to be installed:

- In a new installation.
- Taking advantage of any previously existing air duct system.

It can be implemented in the form of portable modules that they can be easily connected to each other, or to previously existing distribution/extraction circuits, and they can accept a multitude of designs.

3. **Devices for individual use of disinfected air** which they have been designed to be compatible with the disinfection system. These devices include inlet and outlet connections (e.g. nozzles that can be fitted with non-return valves) enabled to connect them to the inlet and outlet connections of the disinfection equipment.

These devices can also be equipped with different filtration media (HEPA filters or similar). It allows protection to be maintained when the user is not connected to the system, for example, before connection is made or when it is abandoned -in these cases, the nozzles giving access to the device for individual use must be closed-.

As an example of a single-use device, masks enabled for such use can be used (*see Figure 2*). These are full-surface waterproof masks that can be made as sophisticated as required to improve user comfort: for example, they can cover the eyes; they can include diffusers to avoid the discomfort of continuous airflow in the nose and mouth area; they can be bubble type with flexible attachment to the neck, or they can include non-return valves to ensure that exhaled air enters the extraction stream in the event of sneezing or coughing (although given the slight overpressure provided by the system, they are not necessary). It could also be arranged as a helmet, or even as a personal protective suit (diving suit type).

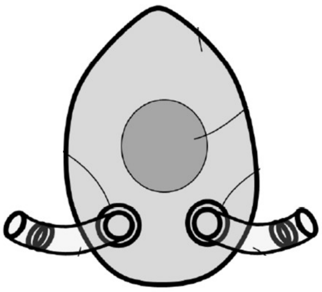


Figure 2: Schematic view of a preferred implementation mode of the single-use device

The connections should be sterilized with hydroalcoholic gel (or other system) before each user is connected.

As an example, below, it is an installation dimensioned for an office or a classroom of twelve workstations, and therefore twelve masks for individual use (*see Figure 3*).

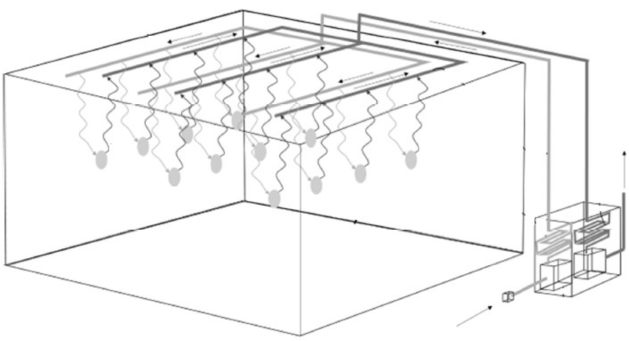


Figure 3: Schematic view of a preferred implementation mode of the communal air disinfection system. The arrows indicate the direction of the air flow

The mobility of individual workstations can be modulated to allow short trips, and they could even be designed for longer trips, as the connecting hoses allow for this.

For normal breathing, the average air requirement is in the order of twelve breaths per minute (a volume of approximately 500 millilitres/breath). It means a flow rate of 6 litres/minute per mask, i.e. 72 litres/minute in total. As this flow is not consumed uniformly, it would be necessary to increase it appropriately to guarantee comfortable breathing for all users. It has been estimated that multiplying it by two, it may be adequate to maintain breathing comfort. Therefore, a blower capable of supplying 150 litres/minute will be required.

To enable sterilisation, it would be sufficient to subject this inlet airflow to ultraviolet C (UV-C) radiation at a power of 200 watts for an exposure time of 15 seconds.

To do this, a conduit or tank of the order of 37.5 litres (about 5 metres of PVC pipe with an internal diameter of 10 centimetres, or a tank of this capacity) would be required in the input disinfection medium, uniformly lit with UV-C emitters of the specified power.

After the disinfection medium, the distribution circuit would be located, which would consist of a circuit with a capacity in the order of 50 litres of piping, 5 centimetres in diameter and a shape adapted to the geometry of the enclosure or room where it would be located (it could consist, for example, of a branch of three pipes, with four outlets in each pipe, one for each of the twelve masks for individual use).

4. **The procedure for collective air disinfection** comprises the following stages:

4.1. Pre-disinfection of the air in the distribution circuit.

4.2. Individual use/breathing of this air.

4.3. Subsequent disinfection of the used air in the extraction circuit.

TECHNOLOGY ADVANTAGES AND INNOVATIVE ASPECTS

ADVANTAGES OF THE TECHNOLOGY

At present, there are no individual multi-purpose respirators on the market in common areas.

This innovative system has the following **advantages**:

1) It guarantees the arrival of disinfected air to one or multiple users simultaneously in closed spaces of common use.

2) Air exhaled by the users is also disinfected.

3) At the time, both air currents are perfectly separated, thus avoiding their accidental mixing.

4) Risk of contagion/infection through airborne pathogens are minimised and even prevented.

5) Easy construction and installation.

6) Low implementation cost.

7) It can be easily adapted to existing air circulation infrastructures.

8) It is very versatile: it is able to be implemented readly and quickly in numerous closed spaces of common use.

9) Air ducts can be arranged on the ceiling, walls or floor of the enclosure -adapting them to the intended use- without impeding visibility or the necessary mobility in the enclosure.

10) It allows 100% of the capacity to be completed in places where there are restrictions: theatres, cinemas, means of transport, etc.

11) It allows a reduction in the safety distance in closed areas, drastically minimising the risk of infection.

12) It allows a personalised dosage of medication in aerosol form to patients who do not require intubation.

13) It is suitable for other broader uses: e.g. blow cleaning.

INNOVATIVE ASPECTS OF THE TECHNOLOGY

It is the unique system currently available on the market that guarantees the individual supply of disinfected air in closed spaces of common use.

To achieve this, both the air supplied to the users and the air breathed by them are disinfected using different means, and both currents are channelled independently, so that mixing is avoided at all times, thus minimising risk of contagion/infection by COVID-19 (or other pathogens transmitted via aerosols) in the air exhaled by other users in closed, communal use areas.

CURRENT STATE OF DEVELOPMENT

A prototype has been successfully developed at laboratory level and scaled up to a pilot plant (*see Figure 4*).

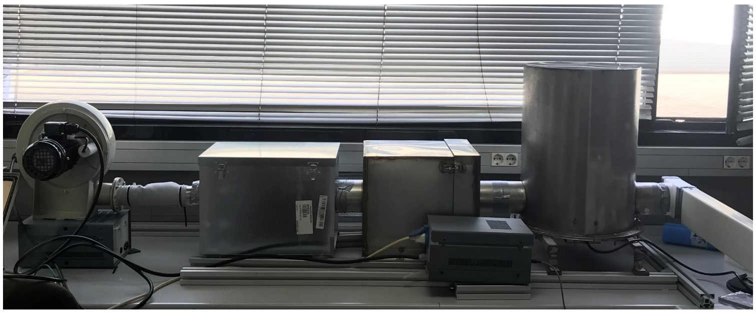


Figure 4: Photography of the prototype

The manufacturing of the prototype has been financed by *Generalitat Valenciana, Conselleria d'Innovació, Universitats, Ciéncia i Societat Digital [2020/3509]*, in an urgent call to finance scientific and innovative solutions directly related to the fight against Covid-19. Title of the project: "Nueva mascarilla con lecho filtrante y cerramiento para ampliar el uso de unidades de nebulización".

This technology is currently at TRL-5 (*Technology Readiness Level*) and it is available for **demonstration**.

Larger scale validation in a relevant environment is needed to increase TRL and to bring it closer to the market.

MARKET APPLICATIONS

This ingenious system makes it possible to supply disinfected air at an individual level in closed spaces of common use, such as:

- **Classrooms**: infant, primary, secondary, university, libraries, seminars, workshops, computer rooms, laboratories...
- **Places of leisure**: cinemas, theatres, television studios and other cultural disciplines.
- **Means of transport**: planes, trains, buses, undergrounds, trams, taxis, ferries...
- **Hospitals**, operating rooms, waiting and consultation rooms, and other facilities.
- **Offices**, meeting rooms and boardrooms.
- Banks and branches.
- Fixed locations in supermarkets and shopping centres: cash registers.
- Public administration services.
- Private homes.

In this way, the **safety distance can be reduced**, and therefore, the **capacity can be increased to 100%** with a practically null risk of contagion by inhalation of contaminated air.

This is a simple way to guarantee a healthy microenvironment in closed spaces commonly used in the fight against COVID-19 and other infectious diseases transmitted by air in the form of aerosols.

COLLABORATION SOUGHT

Companies interested in acquiring this technology for commercial exploitation through utility model licensing agreements are sought.

Company profile sought:

- Manufacturers of respirators.
- Manufacturers of air disinfection systems.
- Manufacturers of masks.
- Manufacturers of personal protective equipment (PPE).
- Other related companies.

INTELLECTUAL PROPERTY RIGHTS

This invention is protected through a **utility model application**:

- Title of the patent: "Sistema, equipo y procedimiento de desinfección de aire colectivo, y dispositivo de uso individual de aire desinfectado".
- Application number: U202230861
- Application date: 1st September, 2022

MARKET APPLICATION (2)

Medicine and Health
Chemical Technology