AIR Series

Bactericidal activity evaluation

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INDICE

1 INTRODUCTION

As part of the design of the iJen series products, we wanted to evaluate the bactericidal efficiency of our iJen Air product, at the µBioMI LAB of the "Giulio Natta" Department of Chemistry, Materials and Chemical Engineering of the Politecnico di Milano.

All activities were carried out by qualified µBioMI LAB personnel and under the supervision of Prof. G. Candiani.

The model used for the tests was the iJen Air PLUS, consisting of the following main components:

- 2 UVC lamps (λ = 254 nm) with mercury vapor both without and with generation of ozone
- Axial fan (model AC 8P)
- Power system with integrated control

2 METHOD

The tests were performed on the iJen Air Plus device in three different configurations:

- **UV** config.: OF lamp on, OG lamp off, fan on
- **CTRL** config.: OF lamp off, OG lamp off, fan on
- **PRE-FILTER** config.**:** same as CTRL configuration, with pre-filtre mounted

During the tests, 100 µL of a pure suspension of Escherichia coli JM109 bacteria (E. coli, Gram-negative bacteria; biosafety level) was nebulized for 1 min at a concentration equal to 1.2x103 bacteria / mL (called bacterial challenge).

During **UV** configuration**,** the *bacterial challenge* was introduced into the device thanks to the fan of the same device that works in suction, and was subjected to irradiation during the entire duration of the nebulization (1 min).

During **CTRL** configuration, the *bacterial challenge* was not irradiated by UVC.

In both configurations, the device was kept on for 2 min (1 min during nebulization and for the next min in order to recover the bacteria).

During and in the minute following the nebulization, the bacteria present at the exit from the device were recovered using a microbiological sampler DUO SAS 360 (VWRTM, Italy) loaded with special Petri dishes containing agar medium for culture of microorganisms (PCA).

At the end of the sampling operations, the PCA plates were removed from the sampler and incubated at 37° C for 24 hours in order to evaluate the number of viable bacteria in terms of Colony Forming Units (CFU).

In **PRE-FILTER** configuration, a filter (Replacement filter, 119mm, 45PPI, PK5, see image below) was mounted at the device inlet in order to assess whether the efficiency in the reduction of the airborne bacterial load could be affected by the presence of this filter. This configuration made it possible to evaluate the percentage of bacterial load blocked in the filter and not treated by UV light.

At the end of the incubation, the airborne bacterial load was then quantified by counting the CFUs grown on the surface of the PCA Petri plates.

The bactericidal efficiency of the device was calculated as a percentage of viable bacteria (CFU) following exposure to irradiation (UV configuration) or after passing through the device with an inlet filter (PRE-FILTER configuration) compared to the number of viable microorganisms recovered from the device kept running but with the UV lamp off (CTRL configuration), in accordance with the following equation:

$$bactericidal\ efficiency\ (\%) = 100 - \left(\frac{CFU_t}{CFU_{CTRL}} \times 100\right)$$

where

CFU_t the number of viable CFUs counted on the PCA plates (taking into account the correction factor) in the **UV** or **PRE-FILTER** configurations;

CFU_{CTRL} he number of viable CFUs counted on the PCA plates (taking into account the correction factor) in the **CTRL** configuration.

In the tests performed in CTRL configuration, the recovery efficiency of the airborne bacteria was also calculated, given by the ratio between the bacteria sampled at the exit of the device and the number of airborne bacteria in the bacterial challenge (at the entrance):

$$recovery\ (\%) = \frac{CFU_{CTRL}}{CFU_{challenge}} \times 100$$

where

$CFU_{challenge}$ the number of atomized CFUs entering the **iJen AIR Plus** device.

3 RESULTS

The number of CFUs was determined by the plate bacterial count method

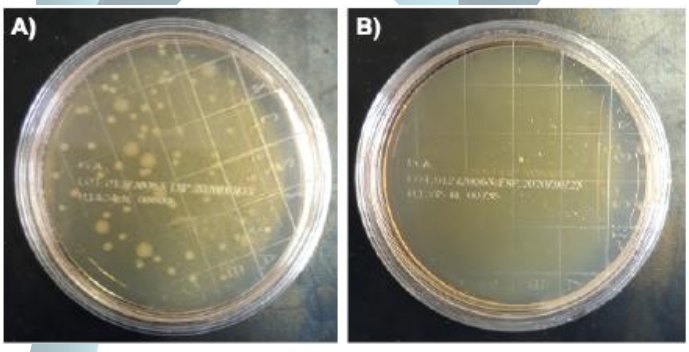
For each condition tested, the number of CFUs counted was subsequently updated taking into account a correction factor derived from the theory of positive hole correction [1].

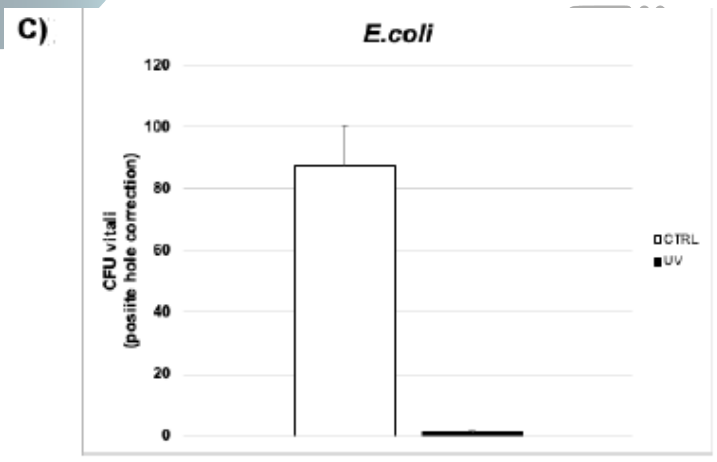
The tests performed in the **CTRL** configuration showed a **recovery efficiency of ~ 75%**, i.e. the set up adopted ensured optimal sampling of the generated bioaerosol.

As for the tests performed in UV configuration, the iJen Air device used showed a **bactericidal efficiency of 98.6%**.

It is interesting to underline that the test performed in **PRE-FILTER** configuration caused a reduction of the atomized bacterial load of 43%. This means that the filter blocks a high percentage (43%) of pathogenic microorganisms inside which are not then inactivated by UV light. The bacterial load trapped in the pre-filter may remain active and could be re-released into the environment if the filter is not removed and sanitized very frequently.

By way of example, below is the count on the plates obtained from the tests with the device in the **CTRL** (A) and **UV** (B) configuration and the average value and standard deviation of the counts in the two **CTRL** and **UV** (C) configurations





4 CONCLUSION

This study was performed in order to evaluate the bactericidal efficiency of the **iJen Air Plus** device on a bacterial bioaerosol. The results were compared to those obtained by keeping the device in **CTRL** configuration, or in the same operating conditions, except for irradiation with a UV-C lamp.

Under the experimental conditions reported above, the iJen Air Plus device led to an inactivation of almost all of the airborne bacterial load.

Furthermore, the test performed in the PRE-FILTER configuration has shown that the presence of the pre-filter at the inlet of the device has a non-negligible effect on the abatement of the atomized bacterial load, in fact 43% of the airborne bacteria is retained on the filter entering the device and is therefore not subjected to UV radiation.
This effect could therefore result in a less effective sanitization of the air linked to UV radiation of the airborne microbiological component (also considering that this bacterial load "trapped" in the filter could be airborne again in the environment).

For this reason, in the design of the **iJen Air series** devices, it was decided **not** to insert any type of pre-filter at the entrance as it is a detrimental factor in the sanitation process.
The absence of this pre-filter allows all the air entering the device to pass in front of the UVC lamp and therefore undergo the germicidal treatment.

References

[1] Macher JM.-Positive-hole correction of multiple-jet impactors for collecting viable microorganisms. Am Ind Hyg Assoc J. 1989;50(11):561-568. doi: 10.1080/15298668991375164)

[2] Prof.Gabriele Candiani (µBioMI LAB) - Valutazione dell'attività battericida di un sistema prototipo di sanificazione dell'aria mediante irraggiamento UV-C in ambiente controllato