Whitepaper

Understanding the Relationship Between Room Volume, Target Dosage and Operating Time

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1 Introduction

One of the first questions asked by new users of the CleanCube is remarkably simple:

Why does the operating time change from one room to another?

A small treatment room may require only 15 minutes of aerosolization, while a larger production area may require more than one hour. Although the same equipment, the same disinfectant and the same operating procedure are used, the calculated operating time can differ significantly. The reason is neither random nor software-specific.

It is the direct result of a deterministic engineering model.
The CleanCube does not operate according to a predefined runtime. Instead, it calculates the quantity of disinfectant required to establish a predefined dosage throughout the entire treatment volume. The operating time is then derived automatically from the known pump delivery rate.
Understanding this relationship is essential for understanding how modern airborne disinfection systems operate.

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2 The Engineering Principle

Airborne room disinfection is considerably more sophisticated than simply dispersing disinfectant into the air.
A successful process requires the interaction of aerosol generation, optimized droplet size, airflow management, homogeneous spatial distribution and validated microbiological process parameters.
Together, these disciplines determine whether the disinfectant is distributed consistently throughout the treatment volume.
Within this overall process, **volume-based dosing** provides the engineering foundation.

It answers one fundamental question:

How much disinfectant should every cubic metre of room volume receive?

This target value is expressed in **millilitres per cubic metre (ml/m³)** and represents the primary engineering parameter of the entire aerosolization process.
The objective is not to maximize the amount of disinfectant dispersed.
The objective is to establish a reproducible aerosol environment in which every cubic metre of room volume is exposed to the same predefined process conditions.
Only then can a validated process be reproduced consistently.

Although the operating time can be calculated using a simple equation, the underlying process is based on advanced aerosol engineering.
Droplet size distribution, airflow dynamics, volumetric dosing and homogeneous spatial distribution all contribute to the quality of the disinfection process.
The calculations presented in this document describe the volumetric dosing model, which forms one essential part of the overall engineered system.

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3 From Engineering Principle to Operating Time

The CleanCube requires only three engineering parameters to determine the operating time.

1. **Room volume**
2. **Target dosage (ml/m³)**
3. **Pump delivery rate (ml/min)**

These parameters are linked by a straightforward sequence.

Room Dimensions
↓
Room Volume (m³)
↓
Target Dosage (ml/m³)
↓
Required Disinfectant Volume (ml)
↓
Pump Delivery Rate (ml/min)
↓
Calculated Operating Time (min)

Once these three parameters are known, the operating time is determined automatically.
The user does not select the operating time.
The engineering model calculates it.

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4 Engineering Calculations

Step 1 – Calculate the Room Volume
The treatment volume is determined from the room dimensions.

$$V = L \cdot W \cdot H$$

Where:

- **V** = Room Volume (m^3)
- **L** = Length (m)
- **W** = Width (m)
- **H** = Height (m)

Example:
10 m × 6 m × 3 m
= **180 m^3**

Step 2 – Calculate the Required Disinfectant Volume
The selected target dosage defines the amount of disinfectant required for each cubic metre.

$$M = V \cdot D$$

Where:

- **M** = Required Disinfectant Volume (ml)
- **V** = Room Volume (m^3)
- **D** = Target Dosage (ml/m^3)

Example:
180 m^3 × 8 ml/m^3
= **1'440 ml**

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Step 3 – Calculate the Operating Time
The CleanCube Pro Series III uses a calibrated pump delivering:
Q = 33.33 ml/min
(Certain CleanCube classic or CleanCube mini variants might also have a pump capacity of
Q = 16.666 ml/min)

The operating time is therefore:

$$t = \frac{M}{Q}$$

Where:
- **t** = Operating Time (min)
- **M** = Required Disinfectant Volume (ml)
- **Q** = Pump Delivery Rate (ml/min)

Example:
1'440 ml ÷ 33.33 ml/min
= **43.2 minutes**

Combined Formula
All three calculations can be combined into a single engineering equation:

$$\boxed{t = \frac{V \cdot D}{Q}}$$

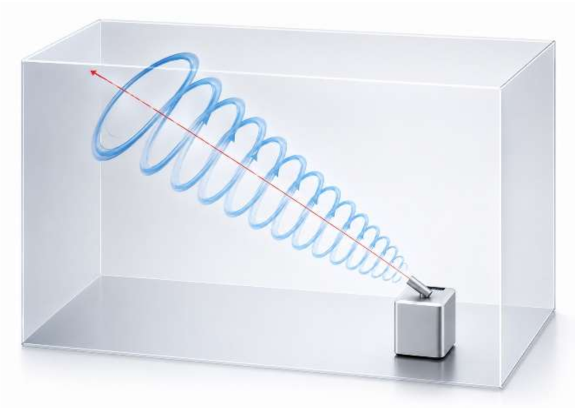
Where
- **t** = Operating Time (min)
- **V** = Room Volume (m³)
- **D** = Target Dosage (ml/m³) = e.g. 8 ml/m³
- **Q** = Pump Delivery Rate (ml/min)

For the CleanCube Pro Series III:
Q = 33.33 ml/min
(Certain CleanCube classic or CleanCube mini variants might also have a pump capacity of
Q = 16.666 ml/min)

5 Engineering Insight

The mathematics are intentionally simple.
The engineering behind them is not.

The calculation determines only **how much disinfectant must be introduced into the room**.
The effectiveness of the process depends equally on aerosol generation, airflow management, droplet behaviour and validated process conditions.



Volume-based dosing is only one element of a considerably more sophisticated airborne disinfection process.

Successful room decontamination is not achieved simply by dispersing a disinfectant into the air. It requires the controlled interaction of aerosol physics, fluid dynamics, volumetric dosing and microbiological validation.

During aerosolization, the disinfectant is transformed into an engineered aerosol consisting of millions of microscopic droplets. These droplets are transported throughout the room by naturally occurring and induced air movements before gradually depositing onto exposed surfaces.

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The physical behaviour of these droplets is influenced by several interacting factors, including droplet size, airflow patterns, gravitational settling, evaporation and room geometry. Together, these mechanisms determine how uniformly the disinfectant is distributed throughout the treatment volume.

From an engineering perspective, the objective is therefore not to generate the largest possible quantity of aerosol. The objective is to establish a homogeneous aerosol environment that provides reproducible exposure conditions throughout the entire room.

Achieving this level of consistency requires considerably more than a spray nozzle or a pump. It requires a carefully engineered process in which aerosol generation, airflow management, volumetric dosing and automated process control operate together as one integrated system.
Within this overall process, volume-based dosing provides the mathematical foundation. It defines how much disinfectant should be introduced into the room, while the aerosol generation and airflow characteristics determine how effectively that disinfectant is distributed throughout the treatment volume.

For this reason, the dosage expressed in ml/m^3 is not merely a calculation parameter. It represents the engineering target around which the entire aerosolization process is designed.
The following sections explain how this target dosage is translated into a precisely calculated operating time using a small number of simple engineering equations.

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6 Practical Examples

With Pump Delivery Rate of 33.33 ml/min

Room Volume	Target Dosage	Required Volume	Operating Time
50 m³	8 ml/m³	400 ml	12 min
100 m³	8 ml/m³	800 ml	24 min
180 m³	8 ml/m³	1'440 ml	43 min
250 m³	8 ml/m³	2'000 ml	60 min
500 m³	8 ml/m³	4'000 ml	120 min

For routine calculations, simplified factors can be used:

Target Dosage	Factor
8 ml/m³	0.24
10 ml/m³	0.30
12 ml/m³	0.36

Operating Time = Room Volume × Factor

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7 Common Misunderstandings

"A longer operating time means better disinfection."
No. A longer operating time usually indicates either a larger room volume or a higher validated target dosage.

"The operator selects the operating time."
No. The operator defines the engineering parameters. The operating time is calculated automatically.

"All rooms require the same amount of disinfectant."
No. Every room requires a different total volume of disinfectant, but each cubic metre receives the same target dosage.

"The pump controls the process."
No. The target dosage defines the process. The pump simply delivers the calculated volume required to achieve it.

8 Key Takeaways

The operating time of the CleanCube is never arbitrary.

It is the mathematical consequence of three engineering parameters:

- Room Volume
- Target Dosage
- Pump Delivery Rate

By using room volume as the reference parameter, the CleanCube ensures that every room is treated according to the same engineering principle, regardless of its size.
The result is a scalable, transparent and reproducible volumetric dosing methodology that forms the foundation of a validated airborne disinfection process.

The CleanCube does not calculate how long a room should be treated.
It calculates how much disinfectant every cubic metre of room volume should receive.
The operating time is simply the result of that engineering calculation.

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