Calculation of the relative reduction of the particle concentration by an air cleaner

In report UN2-210311-T5599900-045A, we determined the CADR of the air cleaner OneLife X in different particle size ranges as follows

Test aerosol	Particle size (µm)	CADR (m³/h)
KCl	0.12	121
Paraffin	0.2 – 0.5	121
KCl	0.5 – 1.0	131

Assuming ideal air mixture, which is well justified for typical household room sizes, the concentration $C(t)$ in a room with the initial particle concentration C_0 evolves with time t according to

$$C(t) = C_0 e^{-kt}$$

Here, k denotes the decay rate caused by the air cleaner and is calculated according to

$$k = \frac{\mathrm{CADR}}{V}$$

with the volume V of the room and the CADR of the air cleaner. Thus, the time required for a relative reduction $C(t)/C_0$ of the initial particle concentration in the absence of particle sources calculates to

$$t = -\ln\left(\frac{C(t)}{C_0}\right) \cdot \frac{V}{\mathrm{CADR}}$$

Note that the actual time will be even lower because of the natural decay, which can however not be attributed to the air cleaner. Using the minimum CADR of 121 m³/h found in the previous study and a room volume of 30 m³ typically occurring in households, we get the following times for the reduction of the respective percentage of particles.

Relative reduction	90 %	99 %	99.9 %	99.99 %
Time (min)	34	68	103	137

This means that the initial concentration is reduced by one order of magnitude about every 34 min. The same levels of reduction can also be achieved in larger rooms over time periods that proportionally scale with the room volume. Consequently, it is justified to make claims based on the CADR measurement such as for example “The OneLife X cleans a contaminated 30 m³ sized room without particle sources by at least 99 % in 68 min”.