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Case / Report:
Determine the disinfection potential of the Air 160 air treatment system on micro organisms

A) Introduction:
In order of the producer we, TNO - quality of Life / Department microbiology - have investigated the disinfection potential of the Air-160 air treatment unit. To determine this various types of microorganisms have been used.

The Air 160 air treatment system is built up out of various components, knowing:
- A fan
- A filter (3M high air flow)
- A UV-C lamp (60 watt, 254 nm, make: Philips)
- An ioniser

B) The test equipment used to determine the disinfection ability:
- The Air 160 air treatment unit
- 4-jets Collison vaporiser
- Impinger 30 ml Physiological Salt (Fz) solution, 0,85 % NaCL
- Microbial Cascade Sampler
- Pepton Physiologic Salt (PPS) solution; 0,85 % NaCL / 1 % Pepton
- Physiological Salt (PS) solution; 0,85 % NaCL
- PTFE / Norprene antistatic hoses
- TSA-plates (Tryptone Soya Agar)

  Indicator organisms:
  - Staphylococcus aureus ATCC6538
  - Pseudomonas aeruginosa ATCC 15442

C) Working method:
The effect of the Air 160 air treatment system (without chlorine dioxide injection) on the microbial quality / content of the air has been investigated.

In the investigation 2 types of indicator organisms:
- Staphylococcus aureus, a gram positive bacteria and:
- Pseudomonas aeruginosa a gram negative bacteria have been used.

The indicator organisms Staphylococcus aureus ATCC6538 and the Pseudomonas aeruginosa ATCC 15442 have been cultivated on an oblique hose (slant TSA). After cultivation the cells on the slant have been washed down with a 9 ml PFZ solution, after this they have been diluted in a 100 ml FZ solution. This FZ suspension has been used to atomize.

The concentration of Staphylococcus aureus in the FZ suspension was $1{,}8 \times 10^7$ colony forming units (CFU) per ml. The concentration of Pseudomonas aeruginosa in the FZ suspension was $1{,}3 \times 10^8$ colony forming units (CFU) per ml.

By using the Collison vaporiser up-stream (via a connector part and PTFE hoses connected to the inlet of the Air 160 unit) a pre-defined quantity of the indicator micro-organisms has been atomized in the air stream. Upstream and downstream of the Air 160 unit, the concentration of the indicator organism has been determined with help of the Impinger and Microbial Cascade Sampler. The sampling time is 10 minutes for the Impinger and the Microbial Cascade Sampler.

After sampling the FZ-solution in the Impinger has been analysed on the presence of the indicator mechanism by means of spread plating on the TSA-plates. The TSA plates of the Impinger and the Microbial Cascade Sampler have been incubated at 37 Degrees Celsius for a period of 24-48 Hours. After this period the quantities have been determined.

The measurements have been executed with the UV-C lamp switched off (zero reference measurement) and with the UV lamp switched on (kill rate measurement) Each test has been carried out in 3-fold per indicator micro-organism. (3 reference measurements and 3 kill rate measurements)

By means of measuring the colony forming units (cfu) on the plates with the UV-C lamp switched off and the UV-C lamp switched on, the log reduction could be determined. This log reduction has been used as the variable to determine the kill rate of the indicator micro-organisms.

The air speed of the Air 160 was set at 25 m^3/hr (the low setting)

The results:
At an air speed of 25 m^3/hr we have registered a disinfection rate on the Staphylococcus aureus ATCC6538 and the Pseudomonas aeruginosa ATCC 15442. The results show that there is already a reduction due to the atomizing process used. This has not been taken into further consideration, as this is considered to have only a minor effect. After the UV-C lamp has been switched on we see an additional disinfection, that has taken place. The results of this disinfection level are shown in table 1.

Table 1: Amount of measured colony forming units (cfu) per test and in log reduction level

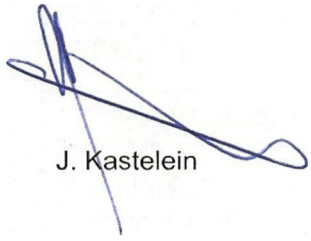
Sample number	CFU level used	CFU per test	Log reduction level
Staphylococcus aureus			
1. Kill rate measurement	$4{,}9 \times 10^6$	< 3 (*)	
1a Zero measurement	$4{,}9 \times 10^6$	$4{,}1 \times 10^4$	
2 Kill rate measurement	$4{,}9 \times 10^6$	< 3	
2a Zero measurement	$4{,}9 \times 10^6$	$4{,}6 \times 10^4$	
3 Kill rate measurement	$4{,}9 \times 10^6$	< 3	
3a Zero measurement	$4{,}9 \times 10^6$	$6{,}7 \times 10^4$	
Average	$4{,}9 \times 10^6$	< 3 and $5{,}1 \times 10^4$	> log 4
Pseudomonas aeruginosa			
4 Zero measurement	$3{,}5 \times 10^7$	< 3	
4a Kill rate measurement	$3{,}5 \times 10^7$	$2{,}2 \times 10^3$	
5 Zero measurement	$3{,}5 \times 10^7$	< 3	
5a Kill rate measurement	$3{,}5 \times 10^7$	$3{,}9 \times 10^3$	
6 Zero measurement	$3{,}5 \times 10^7$	< 3	
6a Kill rate measurement	$3{,}5 \times 10^7$	$5{,}2 \times 10^3$	
Average	$3{,}5 \times 10^7$	< 3 and $3{,}8 \times 10^3$	> log 3

(*) < 3 = Below the detection limit of 3 cfu per test for the Microbial Cascade Sampler. The detection limit of the Microbial Cascade Sampler is determined by the sample volume.

Conclusions:
From the results we can conclude that the micro-organisms: Staphylococcus aureus and the Pseudomonas aeruginosa are killed relatively easy by means of the amount of UV-C light, present in the disinfection chamber of the Air-160 unit.

The DNA of the micro-organism is damaged beyond repair, shortly afterwards the micro-organism dies. The disinfection level is of the height that the colony forming units (cfu) end up below the detection level of the measuring equipment.

The results of these measurements show that the Air-160 air treatment unit is able to achieve a reduction of at least a log 4 on Staphylococcus aureus and a reduction of at least a log 3 on Pseudomonas aeruginosa.



Made up by TNO in NL language and officially translated
Made up by: Mr J Kastelein / TNO Delft Netherlands