REPORT

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Test of the bactericidal effect of a UV light unit for the Aquatron biological toilet system

(1 appendix)

Commissioner

Amberes AB, Kungshamn

Commission

To test the bactericidal effect of a UV light unit for the Aquatron biological toilet system.

Test object

The test object consisted of a UV light unit to be used in the Aquatron biological toilet system. The system consists of an Aquatron separator, a bio-chamber and a UV light unit and can be connected to normal water closets. The liquid waste from the toilet system passes the UV-unit and goes to infiltration in the ground. Some leaching waste water from the bio chamber used for composting of the solid waste from the toilet also goes through the UV unit. The unit tested was new and made of a polyethylene box with a water seal and contained two UV light sources (Philips TUV 15 W) and an alarm system in case of light failure.

Arrival of test object at SP

The test object was delivered personally by the commissioner 2005-10-25.

Date of testing

2005-09-11

Methods

The UV light unit was positioned horizontally on a lab bench near a water sink. Incoming waste water sludge from Gässlösa waste water treatment plant in Borås, Sweden, was sampled in a plastic bottle on the day of testing. On arrival at the laboratory the sludge was kept on ice. We used sludge to mimic the normal bacterial flora of the intestine as close as possible without using test persons. The procedure for testing was the following:

The water seal was emptied before each test. The unit was flushed with de-ionized water directly from a tap and tubing for 3 minutes (approximately 7,8 l/min), the same flow was used between each test. The unit and the water seal was emptied again. This was made in order to get rid of the majority of bacteria from the previous test.

Two concentrations of bacteria were used in order to see if there was any difference in the results depending on the number of bacteria present. The concentrations were chosen to mimic some leaching from the bio chamber and some bacteria coming with the flush water. In the first set of tests, 10 ml of sludge was mixed with 2990 ml de-ionized water to give 3000 ml, which is the normal amount of flush fluid going through the system. In the second set of tests, 300 ml of sludge was mixed with 2700 ml de-ionized water. Each concentration was mixed separately for each test and also tested in triplicate.

Samples for culturing of bacteria were taken into sterile 250 ml plastic bottles from each dilution directly (zero samples) and the rest (2750 ml) was poured into the UV unit. The pouring took 30-35 seconds and it took 4 min 30 s for all the water to pass the unit. Samples for culturing (250 ml) were taken after the solution had passed the unit, 120 s after the water began to appear at the end of the unit in order to flush the water seal first. All samples were stored and delivered on ice to AK Lab in Borås, Sweden for culturing of bacteria the same day. See appendix 1 for details of standard methods for culturing. We chose to investigate the total numbers of culturable bacteria at 22°C counted after 3 days, anaerobic bacteria at 22°C after 2 days (common in the human intestine), and coliform bacteria cultured for 1 day (also present in the intestine and interesting from a health point of vue).

Results

The results are presented in appendix 1 and are summarized as CFU/ml in table 1 below. The numbers of the bacteria in the undiluted waste water sludge were approximately $1{,}5x10^6$/ml (total numbers at 22°C), $4x10^5$/ml (anaerobic) and $5\text{-}6x10^4$/ml (coliforms), calculated from the results of diluted samples below.

Table 1.

Sample no	Amount of sludge (ml per 3 l sample)	Sample taken before/after (B/A) UV unit	UV unit switched on/off	Total numbers of bacteria at 22°C, CFU per ml*	Anaerobic bacteria, CFU per ml*	Coliform bacteria, CFU per ml**
1	10	B	Off	4300	500	90
2	10	A	Off	4300	800	80
3	10	B	Off	5800	1500	210
4	10	A	Off	5400	900	170
5	10	B	Off	5400	1300	160
6	10	A	Off	5900	1500	135
7	10	B	On	6300	600	240
8	10	A	On	0	0	0
9	10	B	On	4100	800	180
10	10	A	On	0	0	0
11	10	B	On	5100	500	160
12	10	A	On	0	0	0

13	300	B	Off	240000	70000	7200
14	300	A	Off	270000	28000	7100
15	300	B	Off	260000	28000	6100
16	300	A	Off	250000	30000	4400
17	300	B	Off	190000	40000	5700
18	300	A	Off	260000	22000	4100
19	300	B	On	180000	30000	5200
20	300	A	On	0	0	0
21	300	B	On	130000	40000	5900
22	300	A	On	0	0	0
23	300	B	On	240000	30000	7400
24	300	A	On	0	0	0

*0 means that the result lies below 100 bacteria/ml.
**0 means that the result lies below 1 bacterium/ml.
CFU = colony forming units

The results show that there is a clear difference between the numbers of bacteria coming through the UV unit depending on if the UV light is used or not. The reduction of the numbers of bacteria was at least 2 orders of magnitude and very effective in both concentrations and regardless of the types of bacteria investigated when the UV unit was switched on. The numbers of bacteria after exposure to the UV light in the unit was below the limit for drinking water mentioned in the Swedish National Food Administration regulations SLV FS 2001:30 (* and ** in table 1).

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Appendix

1. Results from bacterial counting (24 pages)