

METROLOGICAL EVALUATION OF A SYSTEM OF COLLECTION OF BIOLOGICAL AEROSOLS IN A COOLING TOWER OF A FRENCH NUCLEAR POWER PLANT

M. LE BRUN¹, C. BOUTELEUX, M. BINET¹

¹EDF R&D, National Laboratory of Hydraulics and Environment, 6 quai Watier, Chatou, F 78401 Cedex 01 France.

The determination of *Legionella* rate transfer from water to air in a cooling tower represents the first step of risk assessment. The last recent years have seen the raise of new approaches allowing to biological samples in outdoor conditions. In order to assess the behaviour of bacterial aerosols in 160 meter high cooling tower, a biocollector SASS 2300 and its pre-concentrator (SASS 4000 - Research International - USA) were tested in industrial conditions.

MATERIAL & METHOD

Material : SASS 2300 (Figure 1) is a multi-stage wetted-wall cyclone with a air flow collection of 325 LPM. Particles are collected in 4 -6 cc of liquid (distilled water). SASS 4000 pre-concentrator (Figure 1) amplifies the ambient aerosol concentration (4to 15 fold), while retaining most of the particles that were present.

Bioaerosol sampling : The trials were led in a cross-flow cooling tower of a 1300 MW nuclear power plant unit. The air flow rate in the cooling tower was modeled to defined a location without turbulence (Figure 2) and was confirmed by direct measurements (between 2 and 4.5 m/s) . The biocollector and its pre-concentrator were installed 3 meters high from the ground and 20 m away from the droplets shelter inside the cooling tower. Air collections were made in autumn, spring and summer to obtain varying weather conditions. Collection time ranged from 30 minutes up to 15 hours long.

Measures : Total bacterial microflora count, cultivable *Legionella* spp, quantitative *Legionella* spp PCR, Total *Legionella* count by laser cytometry and ATPmetric measures were performed on each sample. Cultivable bacteria analysis (Total bacterial microflora, *Legionella* spp and *Legionella pneumophila*) were immediately realized after sampling. Dilutions of the collected liquide were plated on R2A medium for total bacterial microflora and incubated 72 hours at 30°C. Diluted and non-diluted liquid collected were plated on GVPC selective medium for *Legionella* according to the french standard protocol (AFNOR NF T 90-431). *Legionella* spp and *Legionella pneumophila* quantitative PCR were performed according to the french standard protocol (AFNOR XPT 90- 471). Total *Legionella* counts by laser cytometry were made according to Aurell et al (2004). ATP measures were performed according to provider s protocols using TCM™ Total control Kit (LuminUltra™) and Kikkoman C100 lightmeter.



Figure 1 :SASS 2300 and it pre-concentrator SASS 4000.

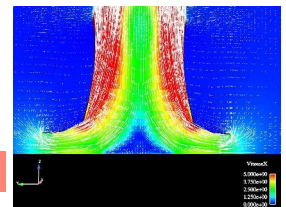


Figure 2: Longitudinal air flow pattern in cooling tower (Saturn_code@ EDF).

RESULTS

Measurements indicate an important contamination of the cooling circuit. The average concentration of total bacterial micro-flora was 1.29×10^8 UFC/L ($\pm 9.55 \times 10^7$, n=7) while concentration of cultivable *Legionella* spp was 1.18×10^5 UFC/L ($\pm 4.98 \times 10^4$, n=7) and 1.62×10^5 GU/L ($\pm 1.49 \times 10^5$, n=7) by quantitative PCR.

Each of the air collection samples made inside the cooling tower were all positive to total cultivable bacterial microflora indicating that some bacterias were transferred from water circuit to the air in the cooling tower. Figure 3 shows a correlation between total bacterial microflora and time collection (Figure 3). This correlation doesn't improve when SASS 2300 is coupled to its pre-concentrator SASS 4000. (Figure 3).

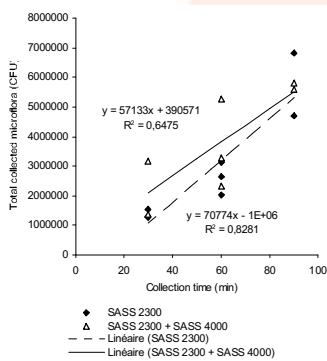


Figure 3 : Total cultivable bacterial micro flora versus time collection.

Figure 4 represents for each sample cultivable *Legionella* spp, *Legionella* spp. quantitative PCR counts and cytometrics counts of *Legionella* spp. Quantitative PCR appears to over-estimate *Legionella* spp when compared to the other count methodologies. Cytometry approach doesn't over-estimate systematically regarding cultivable counts and shows values closer to culture than Quantitative PCR. Threshold of cultivable of *Legionella* spp was estimated to 4 UFC for a 30 minutes time collection.

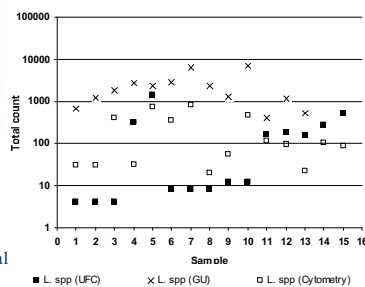


Figure 4: Sample s *Legionella* counts.

Figure 5 shows a linearity between ATP measurements and air collection volume indicating that this kind of approach could be used as an indicator of total biomass transfer. These results need to be confirmed.

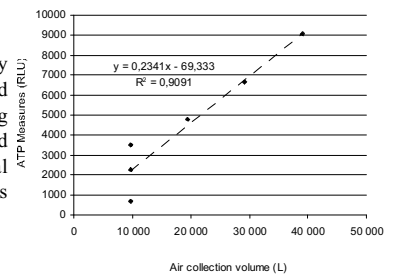


Figure 5: ATP measures versus collected air.

CONCLUSIONS

These first trials in cooling tower have shown the ability of SASS 2300 to collect live biological aerosols. These results need to be confirmed with further trials. Other campaigns will focus on testing SASS 2300 and SASS 4000 in different cooling tower configurations. To our knowledge, this is the first time that biological aerosols were collected with SASS 2300 in such high cooling tower.



REFERENCES : Rapid Detection and Enumeration of *Legionella pneumophila* in Hot Water Systems by Solid-Phase Cytometry . H. Aurell, P. Catala, P. Farge, F. Wallet, M. Le Brun, J. H. Helbig, S. Jarraud, and P. Lebaron, Applied and Environmental Microbiology, March 2004, p. 1651-1657, Vol. 70, No. 3

