Particle size distribution of viable airborne microbes and particulate matter during pretreatment of wastewater

E. Katsivela[1], E. Latos[2], L. Raisi[1], and M. Lazaridis[2]

[1]Department of Natural Resources and Environment, Technological Educational Institute of Crete, Romanou 3, 73133 Chania, Creece

[2]Department of Environmental Engineering, Technical University of Crete, Polytechneioupolis, 73100 Chania, Greece

Keywords: bioaerosols, bacteria, fungi, particle size distribution, indoor working place

Presenting author email: katsivela@chania.teicrete.gr

The aim of the present work was to determine the size distribution of the viable, cultivable, airborne bacteria and fungi, as well as of the inhalable particulate matter emitted from the coarse bubble aerated grit chambers (indoors) as well as from the primary settling tanks (outdoors, partially covered) of a Municipal Wastewater Treatment Plant. Measurements were conducted at a Mediterranean site (Chania) from March to July 2008.

Air samples were taken with an Andersen six stage viable particle impactor (Thermo Electron Corporation, USA). The heterotrophic bacteria were grown in Tryptone Soy Agar at 37°C for 48 h, whereas the mesophilic fungi were cultivated in Malt Extract Agar at 20°C for 72 h. The total coliforms were grown in Membrane Lauryl Sulphate Agar at 37°C for 48 h. Mass and number concentrations of particulate matter (PM) were determined using portable aerosol monitors (Dust-Trak and P-Trak instruments, TSI, Germany). Hydrogen sulfide measurements were performed using a Jerome 631-X sampler (Arizona Instruments, USA).

Table 1 summarizes the arithmetic mean concentrations of all measured parameters in the two stages of the wastewater treatment plant as well as of the control at a background site.

Table 1. Arithmetic mean values of parameters measured.

Parameter	Aerated Grit Chambers	Primary Settling Tank	Urban Background (control)
Sum Heterotrophic bacteria	3,145 cfu/m^3	36 cfu/m^3	89 cfu/m^3
Sum Mesophylic fungi	204 cfu/m^3	70 cfu/m^3	318 cfu/m^3
Sum Total coliforms	29 cfu/m^3	0 cfu/m^3	0 cfu/m^3-
PM_{10}	136 μg/m^3	38 μg/m^3	39 μg/m^3
$PM_{2.5}$	76 μg/m^3	28 μg/m^3	26 μg/m^3
PM_1	62 μg/m^3	23 μg/m^3	20 μg/m^3
PM_1	160,668 pt/cm^3	5,250 pt/cm^3	4,312 pt/cm^3
H_2S	8,121 ppb	195 ppb	4 ppb
T		23.6 °C	
RH		51 %	
υ		8.7 m/s	

A gradual decrease of bioaerosol concentrations was observed during the advanced wastewater treatment from the pretreatment to the primary treatment in agreement with a previous study (Karra and Katsivela, 2007). It is observed that the mean concentration of the airborne heterotrophic bacteria at the aerated grit chambers was 87 times higher than those at the primary settling tanks, and 35 times higher to the values measured at an urban background site. Similarly, the highest concentrations of the total coliforms as well as the mass and particle number concentrations of the inhalable particulate matter (PM_{10}, $PM_{2.5}$, PM_1) as well as the concentration of hydrogen sulfide were observed at the aerated grit chambers of the wastewater pretreatment. Only the mean concentration of mesophilic fungi at the aerated grit chambers had similar values to the background site.

Although, the size distribution profile of the mean concentrations of the airborne heterotrophic bacteria at the primary settling tanks and the urban background site was typical for this taxonomic group (Raisi *et al*, 2012), their profile at the aerated grit chambers was different and showed a maximum aerodynamic diameter concentration at the 3.3-4.7 μm size range (Figure 1).

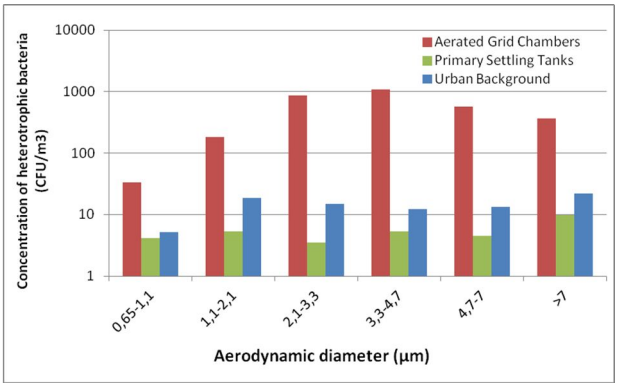

Figure 1. Mean concentration size distribution of viable, cultivable, airborne heterotrophic bacteria during the whole measurement period.

The current study concludes that the advanced wastewater treatment leads to the diminution of health risks associated emissions of potentially pathogenic microbes (heterochthonous heterotrophic bacteria and total coliforms), inhalable particles and hydrogen sulfide.

The research leading to these results has received funding from the European Union Seventh Framework Programme HEXACOMM *FP7/2007-2013* under *grant agreement* n° *315760*.

Karra, S. and Katsivela E. (2007) *Water Research* **41**, 1355-1365.

Raisi L., Aleksandropoulou, V., Lazaridis, M. and Katsivela E. (2012) *Aerobiologia* DOI 10.1007/s10453-012-9276-9.