Can WasteWater Treatment Plants (WWTP) clean the sewage for microplastics? (using a newly developed filtration instrument)

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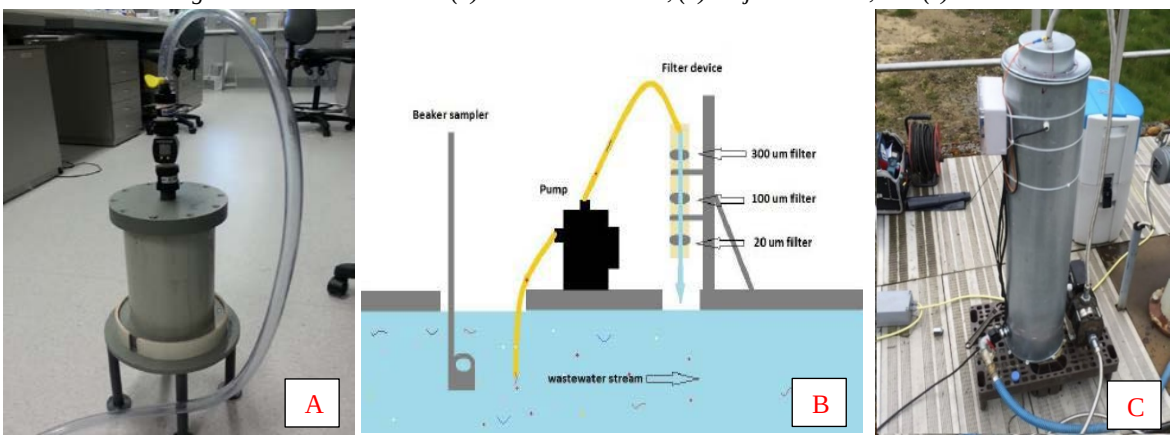
Introduction

There has been an increasing focus worldwide on the plastic contamination of the Earth, and in recent years MicroPlastics [MP] has also been added to this focus. However, since early 1970ties the environmental pollution of MP has been observed in natural compartments, initially in the marine environment in early 1970ties (Carpenter, Anderson et al. 1972, Kartar, Milne et al. 1973, Morris, Hamilton 1974, Kartar, Milne et al. 1973, Morris, Hamilton 1974). During later years also in the terrestrial (Horton, Walton et al. 2017, Duis, Coors 2016), and more recently in the atmospheric compartment (Cai, Wang et al. 2017, Dris, Gasperi et al. 2016). Estimates shows that between 4.8 and 12.1 million tonnes MP are entering the marine environment annually (Jambeck, Geyer et al. 2015), and the degenerative nature of most MP prohibits finding of the potential point sources. However, it is more and more accepted that MP can have serious concern for humans and other species. Focus on hubs for translocation of MP between compartments are increasing. Some research indicate that Waste Water Treatment Plants [WWTPs] acts as such a hub, both between terrestrial-marine (Dyachenko, Mitchell et al. 2016) and terrestrial-terrestrial compartments (Horton, Walton et al. 2017, Dyachenko, Mitchell et al. 2016). The focus for this paper is two folded: (1) Presentation of a new state-of-the-act sampling device, and (2) water filtering results from the Danish WWTP in Herning.

Sampling Device

The developed device for filtering high volume flow were inspired by the work by Ziajahromi et al. (2017) and Talvitie et al. (2017) see Figures 1a,b. Figure 1c shows the new developed filtration device.

Figure 1: Filtration devises: (a) Talvitie et al. 2017, (b) Ziajahromi et al, and (c) this work



The uniqueness of the new instrument is – that it consists of a casing with an internal steel filter bag (mesh size of 40 μm), and an in/output control unit for regulating the flow and volume of water filtered during the process. The device utilises a continuous flow when sampling, an upper limit of the sample sizes in this paper is 1000 liter.

Experiment/Results

The new sampling device has been tested at Herning WWTP (Denmark). The experiment was conducted during April and May 2017, where a series of test run of was conducted, The sample was taken just after the last sewage treatment at the WWTP and before in enter into the nature. During the experiment a process flow were measured between 6.96 and 18.3 L/min dependent on the elevation of the device to the drainage. A volume of approximately 1000L of sawage water were filtered in approx. 1.3 hours. In Table 1 is the total number for MP split into colours and appearance presented. The total number of particles is calculated from the assumption that the sample is homogeny in terms of distribution of the particles throughout the sample.

Discussion and Conclusion

Various studies of WWTPs ability to clean sewage have been carried out. A Finnish pilot study (HELCOM, 2017) concluded that even though retention rates of different types of MP to the marine environment are relative high (95.63-96.57 %) these particles still potentially enters the environment as they resides in the sludge sediment for later distribution to agricultural soils etc. Recently, a large Danish study funded by the Danish EPA EPA (2017) concluded that average emission of MP (size range 20-500 um) from a Danish WWTP to the marine environment

could be calculated to 0.3% (with 25th and 75th percentiles of 0.0% and 0.7%) of MP mass entering a plant. In quantifying

Table 1: appearance and color of found particles

Fragment	Colour	Numbers	Total sample	Colours	Numbers	Total
	white	53	5724	White	2	216
	Transparent	56	6048	Black	13	1404
	Blue	30	3240			
	Red	32				
Fiber	White	1	108			
	Transparent	4	432			
	Blue	2	216			
	Red	2	216			
	Black	5	540			
	Green	1	108			

numbers this is a median of 5800 particles /L or 0.02 mg/L (EPA 2017). Their study affirms that current practise is sufficient in preventing MP entering marine environment from WWTPs. A comparison of these studies together with this work shows diverse samplings sizes, methods and results. However, the main conclusion form HELCOM (2017) is in alignment with our results: WWTP has problems with cleaning sewage for the smallest particles such as MP. This is in contradiction with the large Danish study (EPA, 2017, and it can be argued that the samplings size used in the large Danish study is not representation enough as it seems like smaller sample sizes (4.1-81.5 L) has been processed in that study. The developed instrument has shown potential in delivering suitable output. In the future further test of the new device will be conducted, i.e. test of the efficiency of the instrument to deliver particles in size fractions of interest, etc.

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