Occurrence of PAHs in Wastewater Treatment Plant Effluent

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ABSTRACT

Polycyclic aromatic hydrocarbons (PAHs) are a group of both naturally occurring and man-made chemicals which exist in over 100 different forms. They are most commonly considered a group of 16 which have been chosen as priority pollutants according to the Water Framework Directive (WFD) 2000/60/EC. The main sources of PAHs in the environment are anthropogenic as they are by-products of incomplete combustion, coal gasification and liquification processes, waste incineration, petroleum cracking, and in the production of coke, coal tar pitch, carbon black, and asphalt. PAHs may also be released into marine environments via sewage, industrial wastewater, road runoff, street dust, and through oil spills and ship traffic due to their presence in un-combusted petroleum.

While an efficient wastewater treatment process is said to remove 90 – 95 % of pollutants, it is important to ensure that waste water treatment plant (WWTP) outflow is not contaminating receiving water bodies, making the monitoring of WWTP effluent very important. Effluent samples have been collected from both a secondary and a tertiary waste water treatment plant over a period of 3 months, and 6 months, respectively, including several weeks of high intensive sampling. Solid phase extraction, (SPE), is used in the sample preparation process with subsequent analysis by gas chromatography (GC) with mass spectrometric detection (MS).

RESULTS

Introduction

Two different WWTPs were surveyed as part of this sampling plan, (Table 1)

The monitoring of wastewater is important for many reasons, including the facts that wastewater is:

- a major point-source input to surface waters
- responsible for localised EQS exceedances
- often upstream of drinking water abstraction
- can be controlled
- will complement storm water studies, and inform targeted monitoring programs

Table 1 – Comparison of main characteristics of the two WWTPs

	Tertiary Plant	Secondary Plant
Population Equivalent	1,900,000	50,000
Contributions	Industrial and domestic	Domestic and agriculture
Treatment	Tertiary - Screening - Grit/Grease Removal - Primary Settlement - Sequencing Batch Reactors (SBRs) - UV (Bathing Season)	Secondary - Screening - Grit/Grease Removal - Primary Settlement - Activated Sludge Tanks - Final Settlement
Sample	Grab	Composite

Summary

Presented below (Figures 1-4) are the results of our sampling plan.

Highlighted in red are the periods of intensive sampling, where samples were collected every second day rather than monthly.

The level of temporal variation data collected during these periods indicates that this level of sampling would be necessary for routine monitoring purposes.

Tertiary WWTP

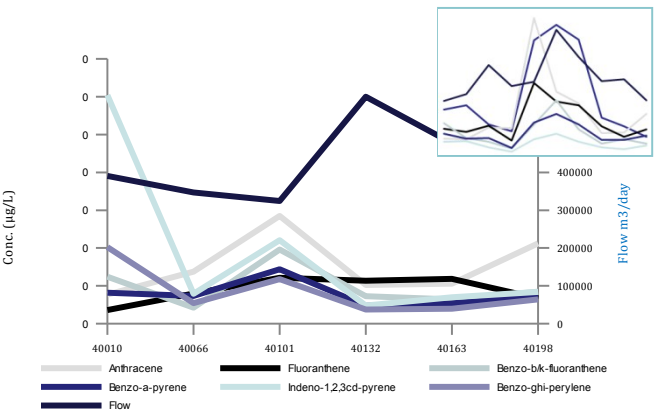

Figure 1 – PAH levels detected (µg L-1) and flow at the tertiary WWTP (m3/day)

Figure 1 shows that the levels of priority PAHs are directly affected by the flow through the plant, with levels increasing as flow increases. The exception to this rule was naphthalene, which decreased with increasing flow. Figure 3 shows that rainfall correlates to the flow through the tertiary WWTP, and thus to the PAH levels detected.

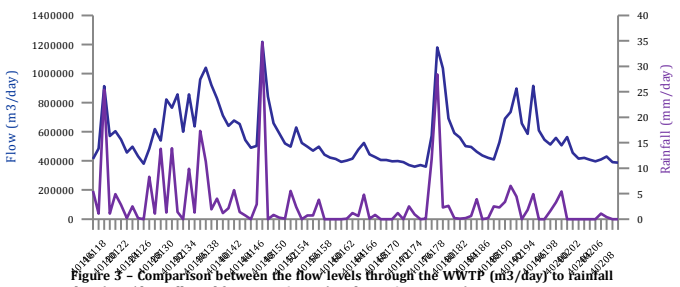

Figure 3 – Comparison between the flow levels through the WWTP (m3/day) to rainfall data (mm/day, collected from Met Eireann) at the tertiary WWTP)

Secondary WWTP

Figure 2 – PAH levels detected (µg L-1) and flow at the secondary WWTP (m3/day)

Figure 2 shows the PAH levels appearing to decrease as flow increases, again with the exception of naphthalene which increased as the other PAHs decreased. Figure 4 shows that there appears to be no obvious relationship between rainfall and flow at the secondary plant.

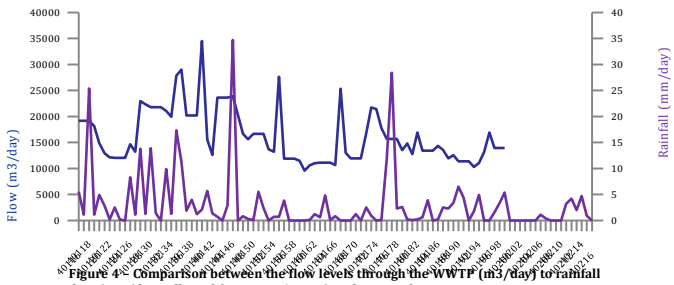

Figure 4 – Comparison between the flow levels through the WWTP (m3/day) to rainfall data (mm/day, collected from Met Eireann) at the secondary WWTP

CONCLUSIONS

All samples analysed contained all priority PAHs, however levels detected never exceeded environmental quality standards (EQSs). Naphthalene has the lowest Log Kow and is therefore the most water soluble of the priority PAHs making it probable that this was the most strongly affected by dilution forces. In comparison the secondary plant manages much lower flow levels, up to 30,000 m3/day compared to the peaks of 1,000,000 m3/day at the tertiary plant, also a different type of population is served at this plant with inputs mainly from domestic and agricultural sources. We would, therefore, expect to see lower levels of PAHs being emitted from the general surroundings.
The next step in this analysis will involve the testing of samples for pesticide levels and relating results obtained to more emission factors.

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