DISTRIBUTION OF ORGANIC CONTAMINANTS BETWEEN THE AQUEOUS PHASE AND THE SUSPENDED PARTICULATE MATTER COMPOSING WASTEWATER

N. Barco Bonilla[1], R. Romero González[1], P. Plaza Bolaños[1,2], A. Garrido Frenich[1], J.L. Martínez Vidal[1], J.J. Salas[3] and I. Martín[3]

[1] Department of Analytical Chemistry, University of Almeria, E-04071, Almeria, Spain, bbm809@ual.es, rromero@ual.es, ppb515@ual.es, agarrido@ual.es, jlmartin@ual.es. [2] Department of Analytical Chemistry, University of Granada, E-18071, Granada, Spain. [3]Foundation Center for New Water Technologies (CENTA). Avda. Américo Vespucio, 5-A, 2ª planta, Módulos 9-10. 41092, Seville, Spain, jjsalas@centa.es, imartin@centa.es.

Abstract

A distribution study of organic contaminants between the two phases composing wastewater (aqueous phase and suspended particulate matter (SPM)) has been performed to establish whether the compounds can be more prone to be in the aqueous or in the solid phase, depending on their hydrophobicity. A general procedure to evaluate this issue is proposed. This evaluation demonstrated that non-polar pesticides and polycyclic aromatic hydrocarbons (PAHs) are distributed between the aqueous phase and the SPM (e.g. pyretrhoids are only found in the SPM) whereas for polar pesticides and phenolic compounds, they are mainly present in the aqueous phase.

Keywords: Wastewater, distribution, organic contaminants, aqueous phase, suspended particulate matter.

Introduction

Nowadays, there is an increasing interest in reusing wastewater (WW) in water-deficient regions. The treated WWs can be utilized in agricultural irrigation (Petrović *et al*, 2003), for municipal and industrial purposes, for environmental aims, such as the recharging of aquiferous or they can be directly discharged into rivers or the sea. Certain groups of contaminants (e.g. pesticides, polycyclic aromatic hydrocarbons (PAHs) and phenolic compounds) are listed as priority pollutants by the European Union (EU, Decision No 2455/2001/EC) and the United States Environmental Protection Agency (US-EPA) (CFR 40 Chapter I Part 423) and have been identified in WW. Consequently, these compounds need to be determined and controlled in WW effluents to assure their quality. An important question which is not usually considered is that WW is a complex multiphase matrix characterized by

the presence of suspended particulate matter (SPM) in different amounts depending on the treatment received. In fact, most of the analytical methods found in literature for the analysis of organic contaminants in WW are only based on the analysis of the aqueous phase obtained after sample filtration, without regarding to the SPM that is retained in the filters (Pitarch *et al*, 2007). However, due to the fact that the organic contaminants can be associated with SPM depending on their hydrophobicity and the nature and concentration of the particles, it is necessary to evaluate the possible distribution of the contaminants between both phases in order to avoid underestimations in the total concentration in the samples.

In this work a study of the distribution of pesticides (including polar and non-polar compounds), PAHs and phenolic compounds between the aqueous phase and the SPM in different WW effluents (anaerobic pond, maturation pond, extended aeration and membrane bioreactor) has been performed, which is, up to our knowledge, the first approach described in this topic. Moreover, a general approach to evaluate this effect is proposed.

Methods

Distribution study for pesticides and phenolic compounds: non-filtered WW samples were spiked with 4 µg L^{-1} (pesticides) and 0.5 µg L^{-1} (phenolic compounds), respectively. Then, they were shaken overnight (100 oscillations per min) to allow a thoroughly interaction between the compounds and the SPM. After this, the samples were filtered to separate and analyze both phases. The aqueous phase was extracted by solid phase extraction (SPE), whereas for the SPM, a pressurized liquid extraction (PLE) process was carried out in the case of pesticides while for phenolic compounds a QuEChERS method was applied. The distribution of the compounds between the both phases was determined as the percentage of them present in each phase.

Distribution study for PAHs: non-filtered WW samples were spiked with the corresponding compounds at a concentration level of 1 µg L^{-1} and shaken overnight at a rate of 100 oscillations per minute. After 24 hours, the samples were filtered and the aqueous phase was extracted by SPE. On the other hand, aqueous phases of WW samples spiked after the filtration step (1 µg L^{-1}) were also analyzed following the same extraction process aforementioned. The distribution of the target compounds was determined assuming that the difference between both results corresponds to the adsorption into the SPM.

Results and discussion

Because of the different physico-chemical properties, pesticides can be found distributed in the two phases composing WW samples: aqueous phase and SPM ("solid phase"). Therefore, a study of

their distribution between these phases was carried out. Figure 1 shows the results obtained for the non-polar pesticides in the anaerobic pond effluents. It can be observed that depending on the hydrophobicity (established as the log $K_{o/w}$) the compounds are mainly distributed in the aqueous phase or SPM. The same trend was observed irrespective of the type of effluent (data not shown). Thus, for non-polar pesticides it was observed that most of the compounds were distributed in both the aqueous and the SPM, except for pyrethroids and organochlorine pesticides, which were more prone to remain in the SPM. This fact must be adduced as a result that demonstrates the need for analyzing both phases, the aqueous and the SPM, which is normally discarded.

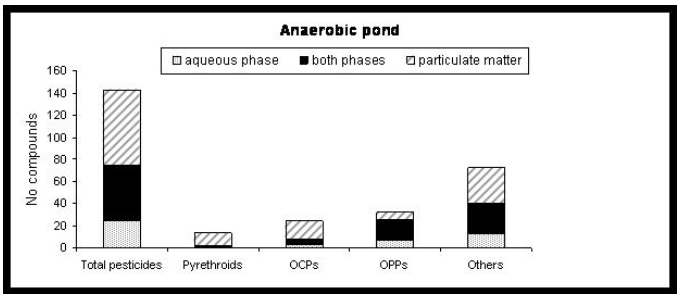

Figure 1. Distribution of the non-polar pesticides found in each phase with a rate higher than 75 %, as well as those distributed between both phases with rates between 25 and 75 %, in the anaerobi pond effluent. Abbreviations: OCPs: organochlorine pesticides; OCPs:organophosphorus pesticides.

On the contrary, for polar pesticides and phenolic compounds, the fraction of analytes bound to SPM was insubstantial, and they were mainly found in the aqueous phase (data not shown). Therefore, the analysis of SPM was not necessary when monitoring these compounds.

Finally for PAHs it was observed that most of the PAHs are mainly adsorbed into the SPM (data not shown). Consequently, it is necessary to analyze both phases when monitoring PAHs in order to obtain a reliable characterization of the WW effluents.

Conclusions

A distribution study of organic contaminants between the two phases composing WW samples: aqueous phase and SPM, has been carried out. Although the SPM is not usually analyzed, this study of the distribution between the aqueous phase and the SPM has revealed if it is necessary to analyze both phases to consider the total concentration in the sample. Thus, for the analysis of non-polar pesticides and PAHs, both phases should be submitted to analysis due to these compounds are more prone to remain in the SPM. However, for polar pesticides and phenolic compounds, this analysis does not provide significant information due to this type of compounds is mainly founded in the aqueous phase.

The same trend was observed for all the compounds despite of the type of treatment that wastewater had undergone.

References

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