Monitoring of Treated Domestic Waste Water Quality

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Abstract
Cyprus is experiencing severe water supply deficiency. Particularly in summer months the situation is aggravated mainly due to low precipitation, high evaporation and increased demands for irrigation and tourisms. The use of treated wastewaters for environmental purposes such as recharging aquifers, agricultural irrigation and municipal landscape is highly contributing in the scarcity problem. In Cyprus there are 8 large urban plants and 25 small community plants for domestic waste treatment. Various chemical analysis including Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), suspended solids, anions, total phosphorus, total nitrogen, toxic metals, pesticides and polycyclic aromatic hydrocarbons (PAHs) are contacted to ensure the quality of the treated wastewater. Instrumental techniques like ion chromatography, ICP, GC-MS and HPLC-fluorescence are used to determine ions, metals, pesticides and PAH,'s. In this study, the results of these analyses are presented for treated urban wastes. Heavy metals, boron, pesticides and PAHs are found in low concentrations ranging from low micrograms to milligrams per liter.
Keywords*:* treated wastewater quality, monitoring, organic pollutants, inorganic pollutants

1. Introduction

Treated wastewater reuse is an alternative source of water supply for different use purposes. Organic and inorganic pollutants are present in waste water. The pollutants presented herein are polycyclic aromatic hydrocarbons (PAHs), pesticides and heavy metals including Pb, Cd, Hg and Ni which are characterized as high risk parameters and are listed in European Union priority substances (*[European Union Commission, 2013*1)]. Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), total suspended solids (TSS), total nitrogen, total phosphorous, anions and metals are also determined to ensure that the quality of treated wastewater satisfies the requirements of the treatment plants permits (*[European Union Commission, 1991*2)] set to ensure protection of the environment from any adverse effects caused by their discharge.

2. Materials and Methods

The American Public Health Association methods were used for the determination of TSS [(*Baird. R. B., et al., 2017. 2540 D*3)], BOD_5 [(*Baird. R. B.,et al., 2017. 5210 B*)4], anions (*Baird. R. B., et al., 2017. 4110 B*) [5] and TP methods (*Baird. R. B., et al., 2017. 4500-P B*) [6]. Anions were determined using ion chromatography. The COD method used is according to International Organization for Standardization (ISO 15705) [(ISO 15705:2002E)7] and TN method is based on ISO 11905 [(ISO 11905:1)8].

A solid phase extraction method was applied for the isolation of the pesticides chlorpyrifos, trifluralin, simazine, atrazine, alachlor, chlorfenvinphos and dicofol, using Strata Solid Phase Extraction Cartridges C18. The eluents were concentrated to 1 ml hexane. Alachlor D13 and Dicofol D8 at 0.10 μg/ L^{-1} were used for internal standard calibration and quantification. Gas chromatography mass spectrometry (GC-MS) in Selective Ion Monitoring (SIM) mode was used for the analysis. Calibration curves were of 1st order with correlation coefficients better than 0.99.

The pesticides Aldrin, Dieldrin and Endrin were extracted using liquid-liquid extraction method with dichloromethane as a solvent and concentrated in 5 ml of hexane. GC with Electron Capture Detection (ECD) was used for the analysis and GC-MS in SIM Mode for confirmation.

PAHs were extracted using liquid-liquid extraction method with dichloromethane as a solvent, concentrated in 2 ml of acetonitrile and analysed using HPLC-fluorescence. Benzo(b)chrysene was used as internal standard.

Various metals (Na, K, Ca, Mg, Zn, B, Cd, Cu, Ni, Pb, Cr, As, Al, Co, Fe, Mn, Se and V) were determined using Inductively Coupled Plasma ([EPA 3015A) 10] after microwave digestion according to the Environmental Protection Agency method [(U.S. EPA, 20079).]

3. Results and Discussion

Chlorpyrifos is the pesticide determined the most. PAH's were not determined at concentrations greater than 0.02 μg L^{-1} for the last 4 years. The concentrations of chlorides and nitrates in treated urban waste samples sampled in January and September 2017 are shown in Table 1. The concentration levels of anions do not vary over the period of time. Uncertainty values are significant in cases where the quality parameters exceed the operating permit limits of the treatment plants.

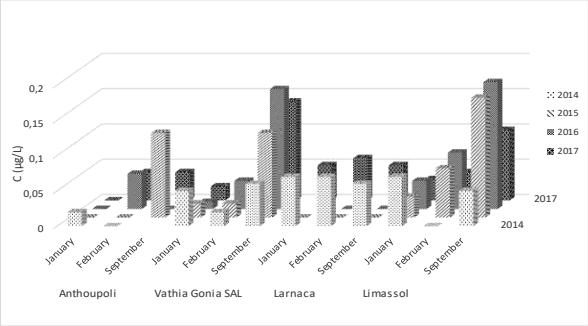

Figure 1. Concentrations of chlorpyrifos determined in four treated urban waste plants from 2014 to 2017.

Table 1. Determination of anions in treatment plants in January and September 2017

Treatment plants	Period 2017	Chlorides (mg/L)	Nitrates (mg/L)
Anthoupoli	January	181	21
	September	206	12
Vathia Gonia SAL	January	238	11
	September	226	19
Larnaca	January	646	2.2
	September	777	0.9
Limassol	January	255	27
	September	385	14

BOD, COD and TSS are analyzed twice a month for treated urban wastes. BOD and COD of WWTPs are usually less than the respective permit limits of 10 and 70 mg L^{-1} whereas TSS are sometimes found in concentrations greater than the permit limit of 10 mg L^{-1} in Larnaca treatment plant. The concentration of TP and TN is less than the respective permit limits of 10mg L^{-1} and 15 mg L^{-1}. In general, the quality of the treated wastes of the treatment plants comply with the requirements of the operating permit limits

Heavy metals were not determined at concentrations greater than the LOQ

4. Closing Thoughts

In Cyprus, the quality of the treated urban wastes fulfills the requirements of the treatment plants operational permit limits. COD, BOD, TSS, nitrates, TP and TN concentrations are less than the limits of the permit. Only in Larnaca the concentration of chlorides are occasionally found to be greater than 300 mg/L. Pesticides and PAH's were found to be below LOQ except from chlorpyrifos which was determined at concentrations as high as 0.1 μg L^{-1}. Cd, Ni, Pb, Cr, As, Co, Se, V and Zn were found to be below LOQ.

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