Wastewater Treatment of Medical Establishments

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INTRODUCTION

Nowadays, the world production of pharmaceuticals is constantly increasing, and the pharmaceutical industry becomes one of the most highly developed. By the latest forecasts, the global consumption of medicines will be more than 100 thousand tons per year. This process is accompanied by environmental pharmaceuticals and their derivatives pollution. Moreover, a large part of them, in the form of original drugs or metabolites, is discarded to waste disposal site or flushed down via toilet into municipal sewer in excrement (removing with urine, feces and sweat). Hereby, these substances were found in sewage sludge, rivers and ocean sediments and in the municipal landfills filtrates in such countries as France, USA, UK, Germany, Denmark and Sweden. Some species have been found even in drinking water and ice, ground and ocean waters. Releasing pharmaceutical pollutants into environment leads to negative changes in its components, as well as violates the sustainability of ecosystems. For example, the contraceptives and steroids may adversely affect the birth and development of fish, reptiles and aquatic invertebrates. Many therapeutic groups, including antibiotics, analgesics, anti-cancer, contraceptives and antidepressants show pronounced toxic effect. In this case, the simultaneous presence of different types of micropollutants in water can lead to their interaction and demonstrate integrated toxicity effect on the organisms (McClellan, 2010; Bendz, 2005; Boxall, 2004). Wastewaters from hospitals, pharmaceutical companies, domestic sewage and wastewater veterinary clinics and livestock farms are considered the main sources of pharmaceuticals entering into the surface waters. Literature data indicate that the hospital wastewaters have 15 times higher potential ecotoxicity than general municipal ones (Falås, 2012).

METHODS

Pharmaceutical contaminants contained in sewage and purified on municipal wastewater treatment plants are not always undergo complete degradation. Efficiency of drugs removal can range depending on their physicochemical properties, as well as wastewater treatment technologies, the age of the activated sludge, the hydraulic retention time, environmental conditions and so forth. However, the most important in this case is improving of contaminated water purification methods by engineering methods that allow neutralizing even the difficult degradable pharmaceuticals. The current methods for drug removal (membrane cleaning, photo catalytic method Fenton, supercritical technology, and so on) have certain drawbacks that limit their using. The analysis of publications shows that the current direction of the research is focused on the study of removing such hard biodegradable compounds as diclofenac, ibuprofen, naproxen, atenolol, a beta-estradiol, and others (Feng, 2013). However, their joint removal in mixture with other medicines that appropriate for wastewaters of medical establishments are not considered by others scientists.

RESEARCH AND RESULTS

The authors of presented research work have performed a study of determination the feasibility of removing different pharmaceutical groups of pollutants in hospitals wastewaters. Such pretreatment of wastewaters before their dumping into the general municipal sewers would allow making removal of pollutants more effective and less costly. This is caused by over small volume of contaminated water (compared to municipal wastewater treatment plant (MWTP) and prevention of negative impact of pharmaceuticals on the activated sludge of MWTP. The purification process was performed by electrochemical degradation. The experiment was performed in the model solutions containing five pharmaceuticals such as diclofenac, beta-estradiol, furosemide, atenolol, cefuroxime. These substances belong to the different pharmaceuticals groups and relate to the hard degradation ones at MWTP. Ruthenium oxides were taken as base electrodes. As comparable electrode platinum was used. In Table 1 is shown a summary of data about the modes of pharmaceuticals degradation by using anodic oxidation method.

Table 1. Summarized data of the characteristics of the degradation process of pharmaceuticals by anodic oxidation method

Name of drug	Electrolyte NaCl, g/L	Current (RuO_2/Pt), A	Voltage (RuO_2/Pt), V	Process time (RuO_2), min	Process time (Pt), min
Diclofenac	0.5	0.54/0.39	29.0-31.5	6	≤ 60
β-estradiol	0.5	0.59/0.35	29.0-31.5	1	≤ 6
Furosemide	0.5	0.37/0.28	29.0-31.5	1	1
Atenolol	0.5	0.59/0.28	29.0-31.5	1	1
Cefuroxime	0.5	0.48/0.15	29.0-31.5	1	≤ 5
Mixture	0.5	0.55 (RuO_2)	29.0-31.5	10	–

CONCLUSION

Analytical studies for determination the residual quantities of pollutants was performed using Shimadzu HPLC model LC-UV and LC-MS Waters QTOF Xevo G2, Waters Acquity UPLC. The obtained results of this research show a complete destruction of the mixture components of pharmaceutical substances as well as separately for each substance. A side effect benefit of this method implementation is the disinfection treatment from pathogenic flora typical for hospital sewage.

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