SAPP XV 15th Symposium on Applications of Plasma Processes
3rd EU-Japan Joint Symposium on Plasma Processing
January 15-20, 2005, Podbanské, Slovakia

Synergetic Effect of Non-Thermal Plasma Based Systems and Electrolysis for Waste-Water Cleaning

M. Morvová[1], I. Morva[1], B. Fógelová[1], M. Onderka[2], P. Lukáč[3]
[1]Department of Astronomy, Earth Physics and Meteology, Faculty of Mathematics, Physics and Informatics, Comenius University, Mlynská dolina F2, 84248 Bratislava, Slovakia
[2]Institute of Hydrology, Slovak Academy of Sciences, Račianska 75, 831 02 Bratislava 3, Slovakia
[3]Department of Experimental Physics, Faculty of Mathematics, Physics and Informatics Comenius University, Mlynská dolina F2, 84248 Bratislava, Slovakia
e-mail: imrich.morva@fmph.uniba.sk

Introduction

A huge quantity of wastewater is produced from industrial processes. It is mandatory to develop efficient and cheap processes for converting aqueous pollutants into harmless products. A number of alternate advanced oxidation processes (AOPs), such as direct ozonation, UV radiation, radiation by electron beam or γ -rays, electrical discharges or combination of these processes, are being studied for oxidation of aqueous organic pollutants.

Experiments

For our experimental work we have used the waste-water from manufacturing of veterinary, immuno-biological and pharmaceutical products which carry high environmental risks. The presence of antibiotics (Oxytetracyclin HCL, Flumequin, Norfloxacin, Gentamycin sulphate, Ampicilin, Procain penicilin G, Benzathin penicilin G, Strepthomycin, Tylosin tartrate, Enrofloxacin, Linkomycin, Chloramphenicol), oily substances (Polypropylenglycol, Sunflower oil, Maize oil, Miglyol 840, Miglyol 812, Cremophor EL), additives (Propylparaben, Methylparaben, Glycerol 85%, Polysorbate 80, Benzylalcohol) and the whole spectrum of vitamines disable a direct biological sewage disposal by conventional waste-water treatment technologies.

The experimental apparatus comprise high-voltage generator and water treatment reactor able to treat 5 m^3 of water per hour. The water treatment reactor was multi point-to-plane system, where stressed electrodes (240 pc) were on air and non-stressed electrodes (12 pc) were immersed in waste water, i.e. system was in reality the combination of electric discharge and electrolysis. We have used spontaneously pulsing transition discharge with 6mm distance between stressed electrode and water surface. In such system a very strong oxidation is caused due to production of O_3, O_2^{*-}, OH^*, $^1O_2$, $^1\Sigma g^+O_2$, $^1\Delta gO_2$ and H_2O_2.

Results

The oxidation species are forced to penetrate into the water witch flows under the discharge electrodes due to electric wind. The necessary residence time for full action of soluted oxidative species is 30 minutes. Then the non-spend oxidative matter as well as hydrocarbon fragments and dispersed particles is necessary to remove from water. For this purpose subsequent filtration with several type of adsorptive material (sand, activated carbon, Shungit). The problem associated with the oily substances, which clogged the filters were due to electrocoagulation formed in electrolysis part of the system eliminated. The fact that one electrode is immersed in water causes the change of fictive pH of waste-water, which strongly influence the electro-coagulation process due to esterification of oily substances. The decrease in content of antibiotics in the water is evident from the IR spectra on Fig.1. The spectra were measured using KBr pellet technique. According to these IR spectra, the content of antibiotics

in the water decreased after the treatment in about three order of magnitude. The evidence of chemical changes in the water composition has been depicted in the UV spectra measured from 190 nm to 400 nm (Fig. 2).

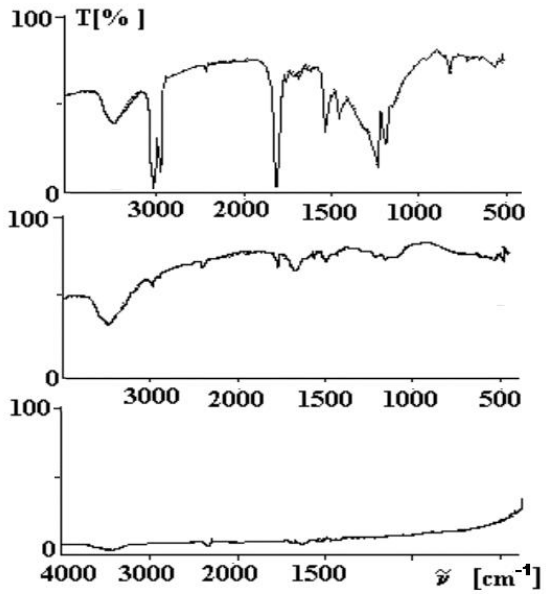

Figure 1. IR spectra of waste-water, from up to down without treatment, treated with transition discharge and treated with discharge followed by filtering with three types of filters (sand, activated carbon, shungit).

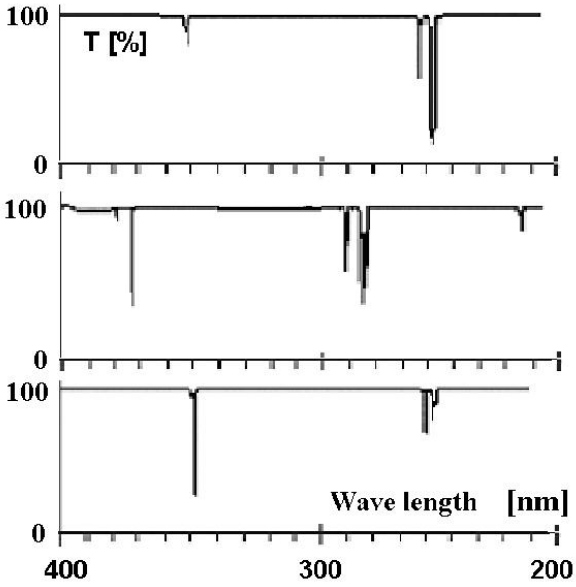

Figure 2. UV spectra of waste-water from up to down without treatment, treated with positive transition discharge and treated with negative transition discharge.

The results of the treatment by electric discharge with subsequent filtration on three types of filters (sand, activated carbon, shungit) are shown on the photographs on Fig.3.

Figure 3. Photographs of waste-water before and after treatment described above

Acknowledgement

The authors wish to thank to the APVT agency for financial support given to the project of bilateral Slovak-US cooperation No. 027/2001 and to the Slovak Grant Agency VEGA for support under the project 1/0256/03.