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REMOTION OF ORGANIC COMPOUNDS OF ACTUAL INDUSTRIAL EFFLUENTS BY ELECTRON BEAM IRRADIATION

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ABSTRACT

Organic compounds has been a great problem of environmental pollution, the traditional methods are not efficient on removing these compounds and most of them are deposited to ambient and stay there for long time causing problems to the environment. Ionizing radiation has been used with success to destroy organic molecules. Actual industrial effluents were irradiated using IPEN's electron beam wastewater pilot plant to study organic compounds degradation. The samples were irradiated with and without air mixture by different doses. Irradiation treatment efficiency was evaluated by the Cromatography Gas Analyses of the samples before and after irradiation. The studied organic compounds were: phenol, chloroform, tetrachloroethylene (PCE), carbon tetrachloride, trichloroethylene (TCE), 1,1-dichloroethane, dichloromethane, benzene, toluene and xilene. A degradation superior to 80% was achieved for the majority of the compounds with air addition and 2kGy delivered dose condition. For the samples that were irradiated without air addition the degradation was higher.

KEYWORDS

Organic compounds degradation, electron beam accelerator, radiation processing, actual industrial wastewater

INTRODUCTION

Organic Compounds has been a great problem of environmental pollution, the traditional methods are not efficient on removing theses compounds and most of them are deposited to environment and stayed there for a long time causing problems to the human health, animals and plants. The variables involved in the environment's preservation are numerous, mainly those that are originated by the chemical compounds and raw material used by the industries. Organic compounds, specially synthetic ones from industrial effluents are difficult to be treated by conventional methods.

Sao Paulo State in Brazil presents the main industrial park of the Country and in the Metropolitan Region (SPMR) there are metallurgical (including mechanical and automobile), textile, food, chemical, electrical, cellulose and paper industries contributing with nearly 80% of organic and

inorganic load discharged, without any kind of treatment, delivering these effluents direct to the main river of Sao Paulo city ,Tietê. (Alonso, 1994).

Considering these aspects the Government of Sao Paulo State and Industries are concentrating a major effort in a decontamination program of the main rivers and water reservoirs located close to industrial areas, with news Wastewater Treatment Plants construction. As these plants can present a low efficiency for the removal of refractory pollutants, mainly organochloride compounds, there is a requirement for an alternative technology to be used in conjunction with the conventional treatment to improve the reduction of pollutants.

The IPEN - Instituto de Pesquisas Energéticas e Nucleares, is developing an alternative technology for wastewater, sludge and industrial effluent treatment, mainly for the degradation of pollutants, using the radiation from a high energy industrial electron beam, as demonstrated by the experiments performed at the Miami Dade Central District Waste Treatment Plant in Miami, Florida, USA. (Cooper, 1992; Waite, 1994)

Among the Industries that have a chance to use this technology, it was made an approach with one of the most important chemical an pharmaceutical Industry in Brazil. This Industry nowadays presents a high aware for environmental protection and is investing a large amount of resources for general waste treatment.

This paper presents the results obtained with the irradiation in the IPEN's pilot plant of actual industrial effluents in order to evaluate the efficiency and cost effectiveness of this technology to be transferred to de local industries.

EXPERIMENTAL

The IPEN's pilot plant was set up to treat wastewater and industrial effluents (Figure 1), it can process a stream at a flow rate $0.5m^3$ to $3.0m^3$ per hour with an average dose of 5kGy. Two tanks with 1,200 liters capacity are used for storage and collection of the stream and two centrifugal pumps are used, one to homogenize and the other pump to the liquid through the irradiation device specially built for this purpose. A system allows tp collect samples just before and after irradiation process. The Electron Beam Accelerator is a 1.5MeV from Radiation Dynamics Inc., the beam current range from 1mA to 25mA, and the electron beam is scanned on a 60cm length and 4cm width area, at a frequency of 100Hz (Sampa, 1995).

The absorbed dose is measured by calorimetric system using a temprature transducer type, WCOTT, Wire Current Output temperature transducer, - Intensil, GE-AD590, that allows to obtain in real time the average absorbed doses. Two WCOTT are used, one in the influent and the other in the effluent stream tubes close 35cm before and after the irradiation chamber. The WCOTTs are connected via an interface to a computer which continuously reads and records temperatures, the absorbed dose is calculated by the conversion of the temperature difference to the equivalent energy transferred to the stream.

A special truck with capacity of 1,000 liters was used to transport the liquid waste from Industry to the IPEN's Electron Beam Pilot Plant. The industrial liquid wastes were irradiated with air addition using the following doses: 2kGy, 5kGy, 10kGy, 15kGy and 20kGy an without air addition with the doses: 2kGy, 15kGy and 20kGy. The air flow rate was 4.0L/min during the irradiation process, the industrial effluent stream had a medium flow rate of 25L/min, and using a electron beam with 1.5MeV energy and fixing the current from 1.2mA to 10.6mA in order to obtain the desired doses. The effectiveness of the treatment was performed by gas chromatographic analyses of the samples before and after irradiation.

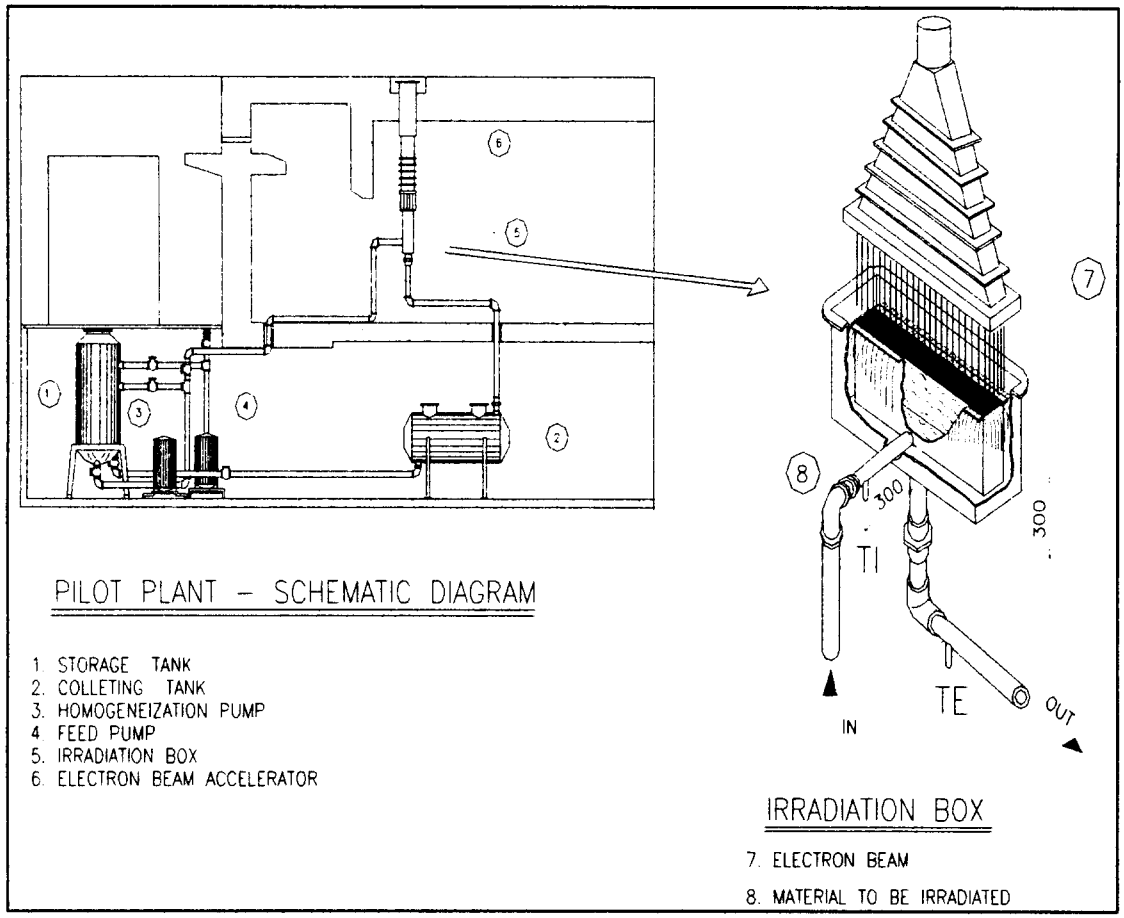

FIGURE 1. Pilot Plant - IPEN - Sao Paulo

RESULTS AND DISCUSSION

The studied organic compounds were: phenol, chloroform, tetrachloroethylene (PCE), carbon tetrachloride (CCl_4), trichloroethylene (TCE), 1,1-dichloroethane, dichloromethane, benzene, toluene and xylene. Figure 2 shows the chromatography analyzes of samples irradiated without air addition. A degradation above 90% was achieved for the all compounds with a 2kGy dose.

For the samples that were irradiated with 2kGy and air addition a degradation up to 80% was achieved for all the compounds. The phenol compounds did not suffer significant changes when irradiated with air addition, but underwent a degradation close to 50% when the samples were irradiated with the same doses but without air addition.

CONCLUSION

The results showed that this technology is efficient and promissory for treatment of real industrial effluent that is a mixture of different kinds of organic compounds. A good efficiency for organic compounds degradation with 2kGy dose and without air addition was observed, showing that this technology has a great potential to be transferred to the industries as a permanent cleanup alternative for hazardous wastes.

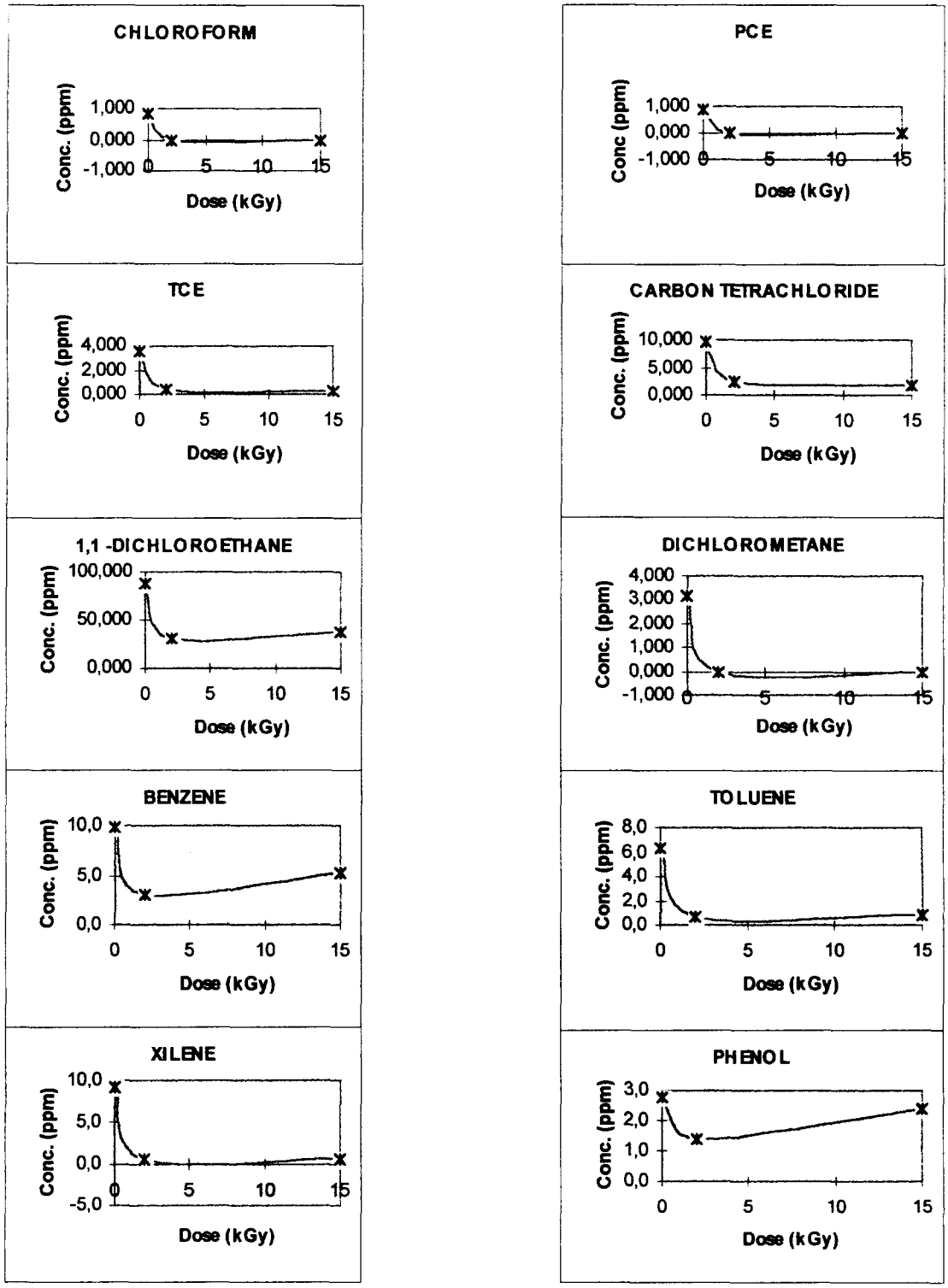

FIGURE 2. Degradation of organic compounds by irradiation.

The preliminary studies of irradiation costs using the IPEN's facility allow to estimate that they will range from US$1.00/m^3 to US$10.00/m^3 for doses of 2kGy up to 20kGy.

The coming tests with actual industrial effluents will be performed changing the doses rates, air and ozone addition in order to optimize the process and to get data for industrial economical feasibility studies.

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