

Argentina Chemotherapeutic Waste Project

OVERVIEW

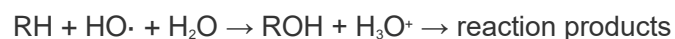
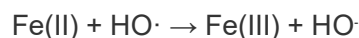
As cancer treatment and the use of chemotherapeutic agents increase worldwide, countries are faced with the problem of how to dispose of chemotherapeutic waste (including cytotoxic, cytostatic, antineoplastic, and genotoxic waste). Chemotherapeutic waste is very hazardous and often has mutagenic, teratogenic, or carcinogenic properties. The waste can be found in the form of bulk liquid waste and in trace amounts in vials, IV tubes, gauze, gloves, and syringes.

Incineration of CW has the potential of generating high levels of polychlorinated dioxins and furans, since many chemotherapeutic drugs are chlorinated and others contain heavy metals that are known to catalyze dioxin formation. Moreover, the costs of high-tech incinerators that meet the performance levels specified in the Stockholm Convention's guidelines on best available techniques are prohibitive for many developing countries. The project investigated a non-incineration method for the destruction of chemotherapeutic waste.

New Argentina Technology for the Treatment of Cytotoxic Waste

The Universidad Tecnológica Nacional – Resistencia, in collaboration with the Chief Technical Advisor and the UNDP GEF Project in Argentina, investigated the types of chemotherapy waste generated, conducted laboratory experiments to evaluate the effectiveness of the treatment process, evaluated the residues, and developed a hospital-scale prototype to demonstrate the technology.

A survey of chemical degradation methods by the Chief Technical Advisor found that the Fenton reaction was effective in destroying a range of chemotherapeutic agents. The Fenton reagent is a solution of hydrogen peroxide and a commonly available iron salt ferrous sulfate. The Fenton reaction involves mixing hydrogen peroxide and ferrous sulfate to produce free radicals:

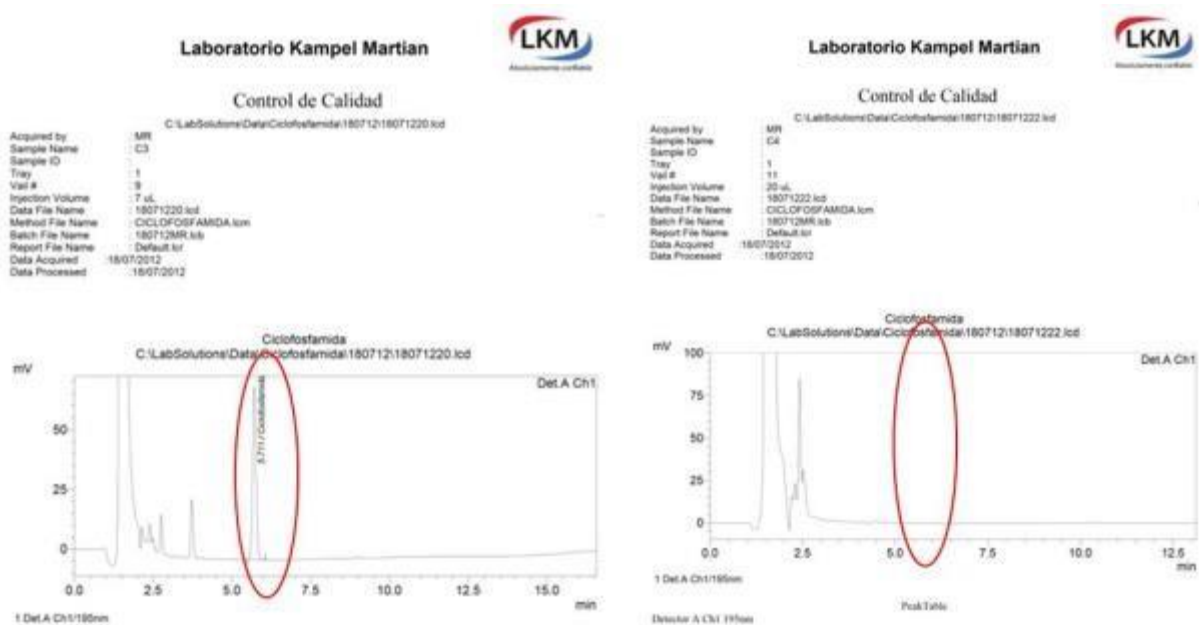


The iron salt acts as a catalyst to generate the extremely reactive hydroxyl radical (HO·), which is believed to be the predominant oxidizing intermediate. The Fenton reagent has been used to degrade many industrial pollutants including PCBs, formaldehyde, benzene, pesticides, herbicides, dyes, plastics additives, etc.



Experiments conducted in a Class II biosafety cabinet to determine the ideal reaction conditions.

The process was demonstrated on cyclophosphamide, methotrexate, 5-fluoracil and cisplatin. The destruction of these chemotherapy agents at pH of 3.5, temperature of 20-25°C and 40 minutes of continuous stirring was shown using high performance liquid chromatography-mass spectrometry.



Mass spectra before (left) and after (right) treatment showing the destruction of cyclophosphamide in the Fenton reactor [courtesy of KLM, Argentina]

The prototype technology is comprised of a locally made shredder, a stainless steel reactor vessel, PTFE-coated stirrer, 40 kHz ultrasonic transducer probe, ultrasonic generator, and metering pump.

The immersible ultrasonic probe proved to be essential to ensure mixing and penetration of the Fenton reagents into hollow items such as needles and tubes.



Testing of the reaction vessel (shown without cover), stirrer and ultrasonic probe

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Resources

Investigación y Demostración de tecnologías alternativas a la incineración para tratamiento de residuos Quimioterápicos en Argentina: presentation on the chemotherapeutic waste destruction technology by UTN-Resistencia QUIMOBÍ (in Spanish)

Argentina Technology Engineering Drawings (PDF files in Spanish)

- Reactor (5 drawings)
- Shredder (8 drawings)
- Frame assembly (8 drawings)
- Engineering drawing of the prototype

Photos of the Chemotherapeutic Waste Destruction Technology