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Development and Construction of a Mobile Electron Beam Accelerator to Treat and Recycle Industrial Effluents

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In the world, there is a growing increase in the demand for water for human consumption, as well as the prioritization of the use of available water resources for public supply. Industries have been concentrating efforts on decontamination programs of industrial effluents. However, the existing wastewater treatment plants may have a low efficiency for removal of refractory pollutants, mainly organochloride compounds. The main gaps are associated with the following problems: a) removal of odorific substances, such as geosmine (GEO) and methylisoborneol (MIB), in drinking water to treat these chemical compounds responsible for taste and odor problems; b) removal and degradation of toxic and refractory pollutants (organic compounds) from sewage and industrial wastewater; c) sewage and sludge disinfection; d) wastewater from a municipal treatment plant for evaluation of the electron-beam technology in different steps of the plant; e) evaluation of the dewatering sludge; and f) toxicity removal by decomposition of surfactants and organic compounds in sewage and industrial wastewater treated by electron-beam process.

The treatment of wastewater and industrial effluents by electron beam irradiation is a promising technique, however, not very widespread in Brazilian territory.

The design and construction of a mobile unit by the Nuclear and Energy Research Institute (IPEN/CNEN), containing an electron beam accelerator is innovative to demonstrate the effects and positive results of this technology. The mobile unit has as one of its main advantages the possibility of treating effluents in the place where the source is located, eliminating costs and bureaucratic problems associated with the transportation of waste, besides publicizing the technology in several places in the country. To implement the project, IPEN/CNEN has been consolidating partnerships with national and international companies.

The resources for the development of the unit have been supplied by the Brazilian Innovation Agency (FINEP) and International Atomic Energy Agency, financing the “IAEA TC Project BRA1035 - Mobile electron beam accelerator to treat and recycle industrial effluents”. The Institute has associated with a specialized company (Truckvan Industry) in an innovation project for the unit design and development. Several meetings have been realized with the company and the International Atomic Energy Agency experts, aiming the compatibility of the design and the exchange of information necessary for the project development.

The project outputs are defined as: a) mobile irradiation unit with electron beam accelerator (EBA), operational and technologically established for treating industrial pollutants; b) capabilities on tests and demonstration of the mobile built; c) know-how in the design, manufacture and installation of the

radiological shielding for the EBA irradiation device; and d) treatment methodologies for different pollutants developed and demonstrated using radiation processing technology to end users.

The idealized project divides the cart in the following modules: a) control room and laboratory for technical and scientific dissemination of the technology; b) industrial electron beam accelerator, hydraulic units, ventilation system, cooler and bunker with irradiation device; and c) transformer and power source supply. A 3D model study of the control room and laboratory space was done to facilitate understanding the internal distribution of the laboratory analysis equipment (Gas Chromatography Mass Spectrometry, Total Organic Carbon and UV-Visible Spectroscopy).

The irradiation system with electron accelerators allows treating different types of effluents. Depending on the effluent, the amount of ionizing radiation energy required for treatment may vary, as well as the amount of treated effluent per day. For the construction of the mobile unit, the estimated cost is about US\$ 1.5 Million. The type of treated effluent, the treatment cost per m³/day and other information regarding the cost of maintenance and operation of the mobile unit are obtained from the Business Plan of the Mobile Unit.

As the installation of electron beam accelerator (700 keV, 28 mA, 20 kW and 640 mm window), irradiation device, radiological shielding, control panel and other associated systems, analytical instruments and components were completed, the mobile unit is now positioned at Technology Readiness Level (TRL) 7, in which the scale ranges from TRL 1 (lowest) and TRL 9 (highest). In other words, the working model or prototype was demonstrated in a space environment.

A new partnership agreement between IPEN/CNEN and Truckvan Industry is about to be established for the completion, demonstration and operation of the Mobile Irradiation Unit in several industries throughout Brazil. In this regard, technology will be fully positioned at TRL 9. In addition, IPEN/CNEN is also establishing a licensing agreement with Truckvan Industry to receive royalties from the upcoming exploration of this innovation in the market.