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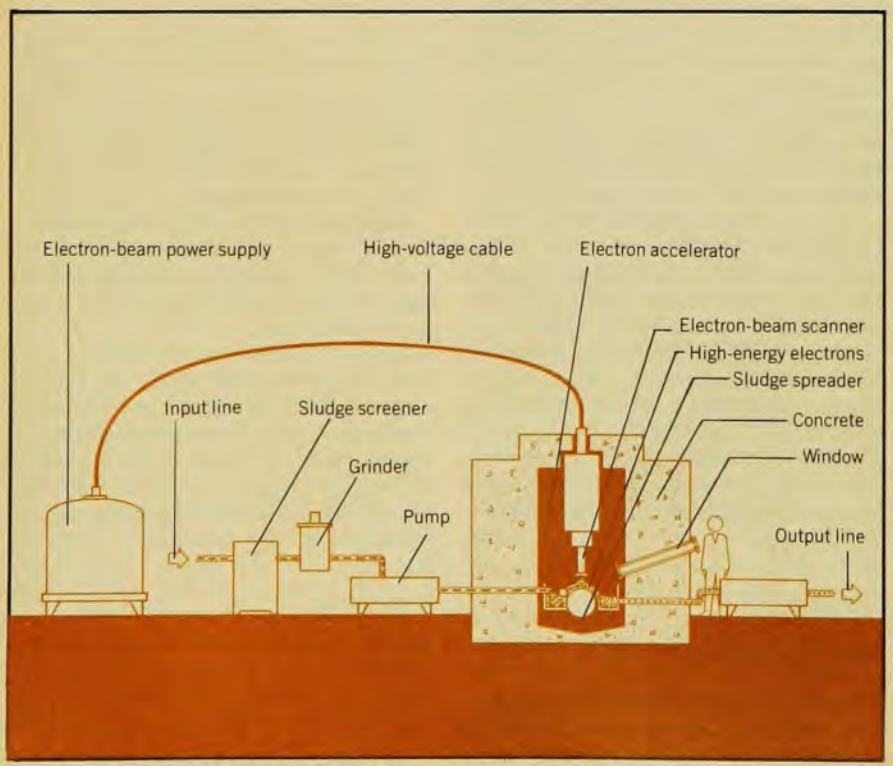
Treatment of sewage by electrons and gammas

The use of high-energy electrons in the treatment of sewage sludge for return to the land as fertilizer is undergoing technical and economic assessment under actual conditions in Boston. The project constitutes a joint effort by MIT's High-Voltage Research Laboratory, High-Voltage Engineering Corp (suppliers of the electron accelerator) and the State and municipal commissions in charge of the treatment plant. Another program, conducted at Sandia Laboratories in Albuquerque, N.M., is concerned with the scientific practicality of decontaminating sewage wastes by exposure to radioactive cesium.

MIT's method. Designed to treat 100 000 gallons of sludge extracted from municipal sewage daily, the new 50-kW facility at Boston's Deer Island Wastewater Treatment Plant employs a 750-MeV electron beam from a high-voltage accelerator. The sludge slurry (2–5% solid matter) flows through the intense beam at a rate of 2 m/s, in a stream about 2 mm thick and 1.2 m long, which disinfects and de-infests it of bacteria that pose the major health hazard in the re-use of such wastes for soil enrichment. Another benefit of the treatment is that the intense ionization process may help break up toxic chemical pollutants like PCB and pesticides.

Principal advantages of the electron-beam approach—which is also applicable to dry, composted wastes—are, according to HVRL director and project head John G. Trump, the availability and controllability (instant on-off switching) of this form of ionizing energy. At the electron energies used, no radioactivity is introduced into the treated matter, thus simplifying its disposal. Preliminary economic-feasibility studies indicate that costs may make the technique acceptable for nationwide use; for sludge with 5% solids, Trump estimates the price at $16 per dry ton of sludge processed. Capital costs total about $500 000, of which 60% is for the accelerator itself, while yearly operating costs are expected to be approximately $120 000.

Trump told us that the Deer Island facility, which commenced high-energy electron-beam treatment this May, is obtaining good disinfection results at its high flow rate. Initial results show that an exposure of 400 000 rads eliminates coliforms and salmonella and produces a reduction on the order of 10^4–10^5 in total bacteria count; it also adequately reduces the much lower viral count.



High-energy electron-beam treatment of sewage sludge is being done at Boston's Deer Island Wastewater Treatment Plant. Sludge slurry flows through the 750-MeV beam at rate of 2 m/s.

Gamma irradiation. Meanwhile, the Waste Management and Environmental Programs Department at Sandia, headed by H. D. Sivinski, is carrying on a sewage-treatment project that employs Cs^{137} as a source of 0.667-MeV gamma rays to destroy pathogens. The $750-thousand-per-year program, which originated in the investigation of sterilization problems associated with the Viking lander, combines heat with radiation to make liquid sewage sludges usable for conditioning and restoring depleted soil; the wastes may also be restored to the food chain by the treatment—Sandia researchers have found that sheep, cattle and other ruminants can readily digest the material, thus permitting possible diversion of animal feed supplements—such as soy beans—to help ease the world's food problem. For the last two years the project has been supported jointly by ERDA and the EPA, with the Department of Agriculture now joining in.

Sivinski told us Sandia's waste-irradiation approach could help in coping with nuclear-waste disposal, greatly increased sewage-sludge production expected to result from the secondary-treatment requirements of the Clean Water Act, and the world food shortage. At a cost of about ten cents per curie for the radiation source, using Cs^{137} capsules from the Hanford storage facility in Richland, Wash., the method could prove economically advantageous, he estimated. A principal advantage of the Sandia technique, according to Sivinski, is the high penetrating capability of gamma rays. Electrons lose their energy quickly in passing through a dense sludge, but gamma radiation is not thus limited; he feels that electrons may be best suited for treatment of waste-water effluents instead.

Sandia researchers are looking into the irradiation of composted sludge at the Agricultural Research Service's center in Beltsville, Md., and elsewhere. Their hope is to eliminate the curing portion of the composting process to permit treatment of larger volumes of waste and the agricultural use of this pathogen-free material as a soil amenity. Treatment costs of $3–5 per ton are projected.

From the mid-1960's until the project's termination in 1972, an Oak Ridge National Laboratory team under the direction of F. N. Case and A. F. Rupp studied the decontamination of liquid effluents. They used high-energy radiation from Cs^{137} and from Co^{60} (the energy released in Co^{60}'s gamma rays is about 1.5 MeV). The Oak Ridge study's largest source was 200 000 curies of radioactive cobalt, and the treatment capacity of the pilot unit was less than 10 000 gallons per day.

—FCB□