E-beam Treatment of Toxic Wastes; The Experiences in Pilot and Industrial Scale Plant

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Over the last 70 years, we have been benefited from new drugs and other chemical products in our quest for “Better Living through Chemistry”. It is estimated that about 80,000 different chemicals were released into the environment over this period.
Typical routes to surface and ground water are treated domestic/industrial water, combined sewer overflows, septic tanks, animal feeding. 26 million organic and inorganic substances have been inventoried.
Pollutants in wastewater:

Pathogens
Oxygen depleting organics
Nutrients (N,P)
Heavy Metals
Chemicals – POPs
Endocrine disruptors
Pesticide
Pharmaceutical residues
Plasticizer etc.
Persistent Organic Pollutants (POPs): organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes. Because of this, they have been observed to persist in the environment, to be capable of long-range transport, bioaccumulation in human and animal tissue, biomagnify in food chains.
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Radiation technologies are effective means of remediation on ecological and economic damage to aquatic ecosystems and are well-proven to practical environmental problems, such as municipal and industrial wastewater remediation and treatment, sludge treatment and reuse. The ionization and excitation of water molecule by high energy radiation produces free radical to treat liquid streams for invasive organisms (in marine ballast water) and trace organics like persistent organic pollutants (POPs), and other trace constituents.
High energy irradiation of aqueous solutions generates highly reactive radicals that can interact with a wide range of pollutants. Laboratory research on industrial wastewaters and polluted groundwater was conducted in the 1970s and 1980s, and in the 1990s several pilot plants, including mobile EB facilities, were built. The first such full-scale application is combined radiation and biological treatment of textile dyeing wastewater of 10,000 m³/d using with 1 MeV, 400 kW accelerator.
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Lab. Scale Experiments (1~50m³/day)

Pilot scale (500~1,000m³/day)

or limited storages

Lab. Scale Experiments (1~10,000Nm³/h)

Industrial scale EBFGT Plant (~600,000Nm³/h)

Industrial scale Wastewater Plant (10,000m³/day)
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Pilot scale Experiments
(~500 m$^3$/day of water)
(~2,000 Nm$^3$/h of gas)
Beam Energy : 0.4~0.7MeV, Beam Power : 20kW
Self-sustaining system : Self-shielded accelerator
Built-in control and monitoring room
Diesel electricity generator (option)
Trailer and Shelter : Fit to U.S. and world standard
Total weight : 40 tons (trailer only 30ton)
Built-in Computerized Experimental & Monitoring System

Continuous Treatment of Wastewater/Flue gas on site

Treatment Capacity:
- Liquid waste: 500m³/day  (at max. 2kGy)
- Gaseous waste: 2,000Nm³/h  (at max. 15kGy)
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- Structural Analysis and Other calculations
- Structure stress simulation
- fluid calculation
- Heat & Cooling calculation
- Ozone simulation
- MCNP shielding calculation
- Vessel ASME
- ETC
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First Barrier
(Steel+Lead+Steel)

Second Barrier
Polyethylene(PE)10mm-assume for MCNP
(real 50mm: EpoxyGlass+Urethane+EpoxyGlass)
Radiation leakage calculation under ICRP with MCNP (Monte Carlo) Simulation
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Trailers

Vessels

Shields

Shelters
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Mobile e-beam in Flue gas Purification from the oil-refinery in Saudi Arabia

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Mobile e-beam in Flue gas Purification from the oil-refinery in Saudi Arabia
Summary

Water pollution, by the discharge of wastewater from commercial and industrial waste (intentionally or through spills) into surface waters, especially wastewater contaminated with chemical contaminants are getting more concerns in recent days. They are toxic and resistant to environmental degradation.

Radiation technology is quite effective for remediation of wastewater contaminated with POPs and other chemicals. When wastewater are irradiated with high energy electron practically all the energy absorbed is deposited in water molecules, and the ionization and excitation of water molecules entail which is known to result in formation of free radical and molecular species to destroy or to convert the harmful chemicals.

In order to avoid the contamination in environment with toxic chemicals, the radiation technologies will be an important role to remove them or to make them less harmful to the environment.