Technology solutions: Accelerators for treating water

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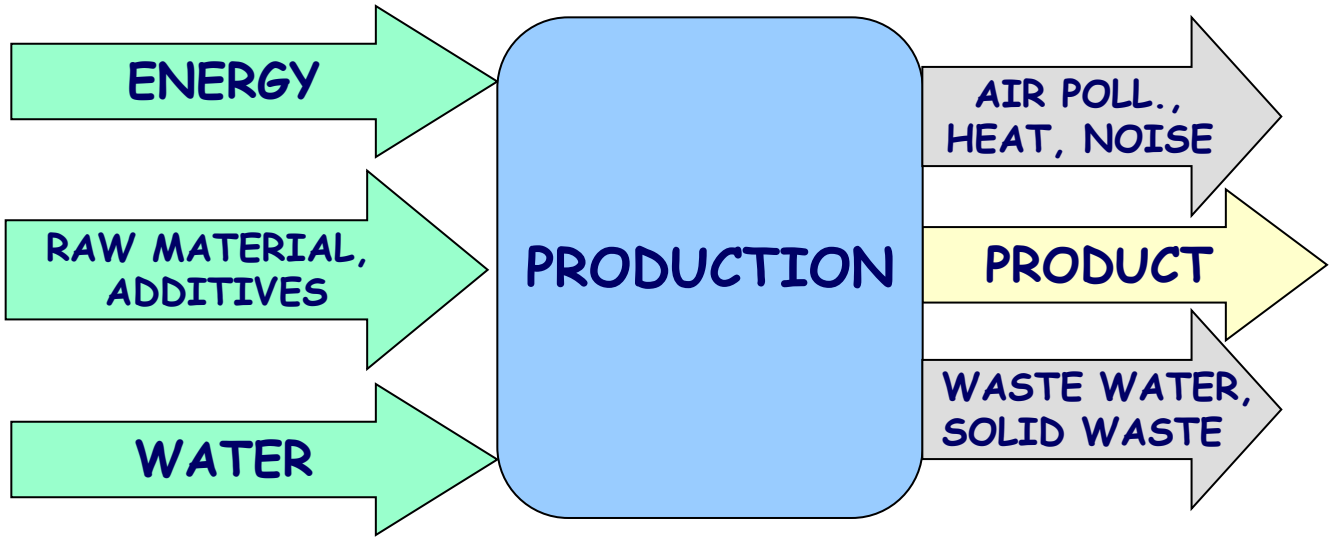
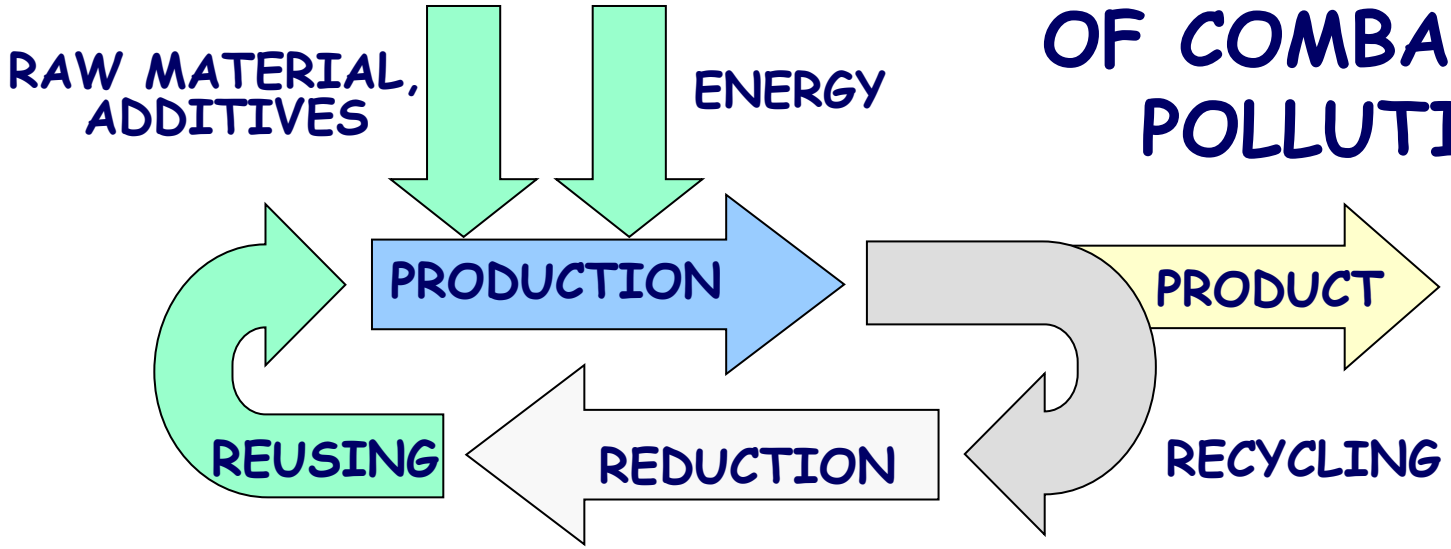


THE SIMPLEST WAY OF COMBATING POLLUTION



There is no argument that E-Beam technology is capable of providing a sustainable solution to solve global environmental problem but …

Active radicals are formed in water by EB:

- hydrated electron e-aq ; H atom (reducers);
- hydroxyl radical OH; H_2O_2 (oxidizers).

Radiation processing is one of Advanced Oxidation Technology (AOT)

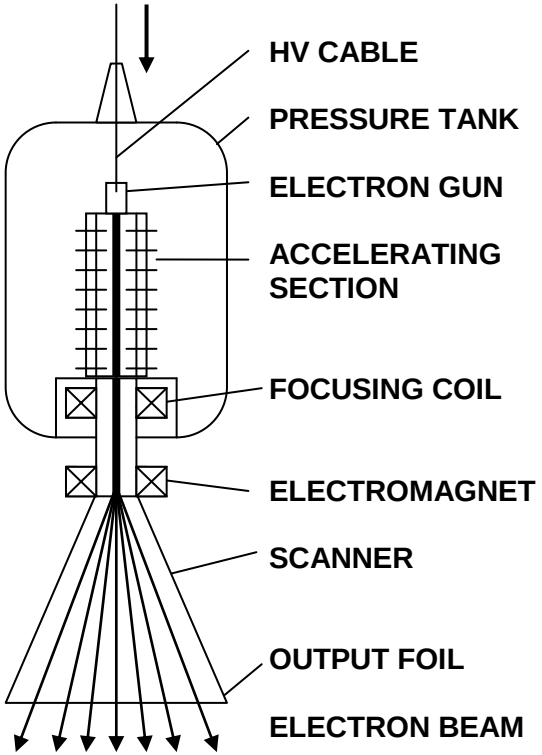
- Technical advantages (no catalysts, min. temperature rise, easy for automatic control, short processing time, simplicity of installation),
- Friendly to environment (no secondary waste),
- Experience in laboratory investigation as well as pilot and industrial scale of implementations,
- Economical advantages (less space, lower unit cost),
- Usable by product (flue gas and sludge treatment).

Economy of the radiation process

Electron beam process can be accepted if it has clear economical advantages over existing processes.

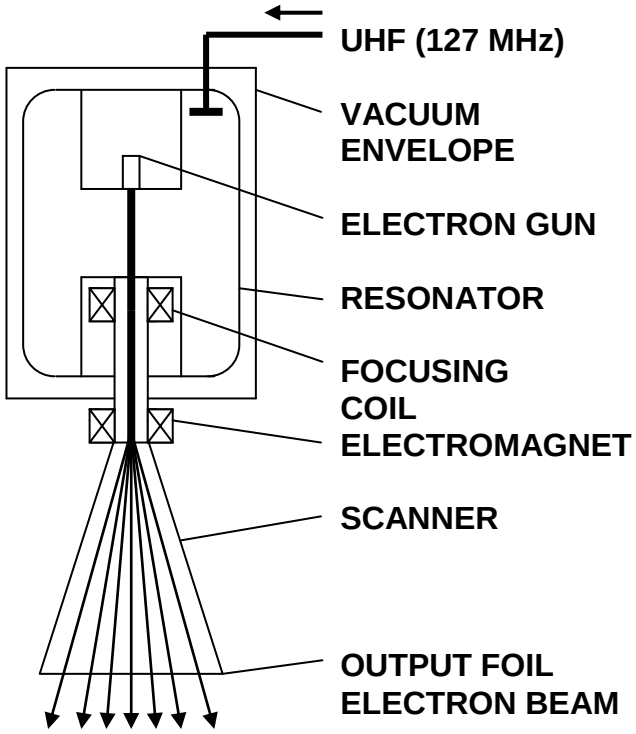
- Dose reduction by:
  - useful additives (like ozone, catalyst, …),
  - combined process with other methods (biological and physico-chemical systems).
- Efficiency of the equipment:
  - accelerator electrical efficiency,
  - electron beam utilisation coefficient,
  - efficiency of wastewater delivery system.
- Cost reduction of e-beam facility:
  - application of more powerful accelerators,
  - less expensive accelerator technology.

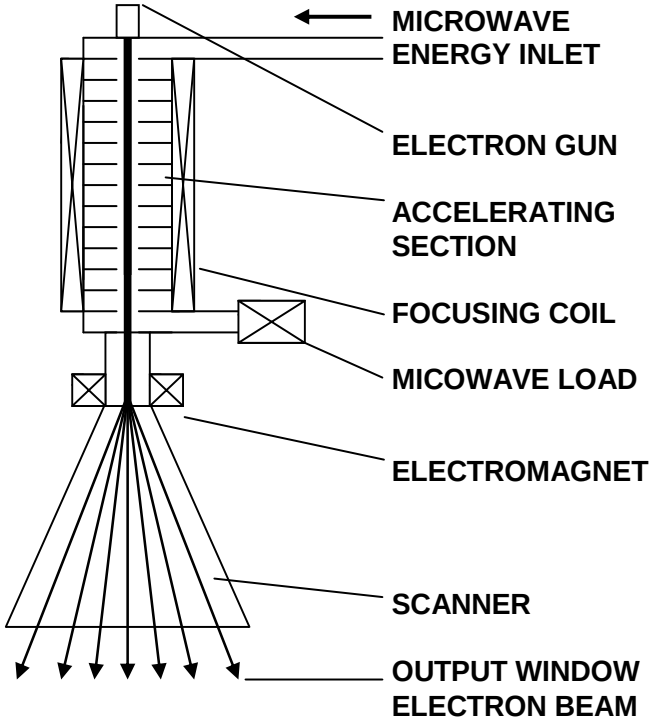
Electron accelerators for radiation processing



DIRECT (TRANSFORMER) ACCELERATORS
HV cable from DC power supply

SINGLE CAVITY (RESONANCE) ACCELERATORS
UHF generator 100-200 MHz





LINEAR (MICROWAVE) ACCELERATORS
Waveguide from microwave source 1.5-3 GHz

Accelerators for radiation processing

Accelerator type / Parameter	Direct DC	UHF 100 - 200 MHz	Linear microwaves 1.3–9.3 GHz
Beam current	<1.5 A	<100 mA	<100 mA
Energy range	0.05–5 MeV	0.3–10 MeV	2–10 MeV
Beam power	~500 kW	700 kW	100 kW
Electrical efficiency	60–80 %	20–50 %	10–20 %

RADIATION TECHNOLOGY APPLIED IN ENVIRONMENT PROTECTION

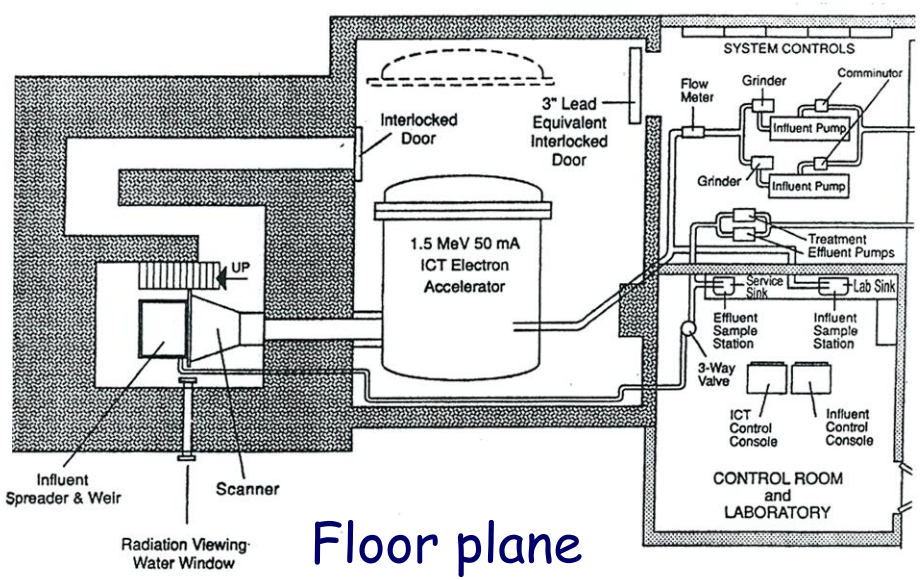
Phase	Object	Additives	Process
Gas	Flue gas	SO_2; NO_x	Removal
	VOC	Organic compounds	Degradation, removal
Liquid	Drinking water	Chemical pollutants	Degradation, removal
	Wastewater	Bacteria; viruses; parasites	Hygenizataion
	Industrial wastes	Organic and nonorganic compounds	Degradation, removal
Solid	Sewage sludge	Bacteria; viruses; parasites	Hygenizataion
	Solid materials	Agriculture wastes	Transformation

Why E-Beam for wastewater processing?

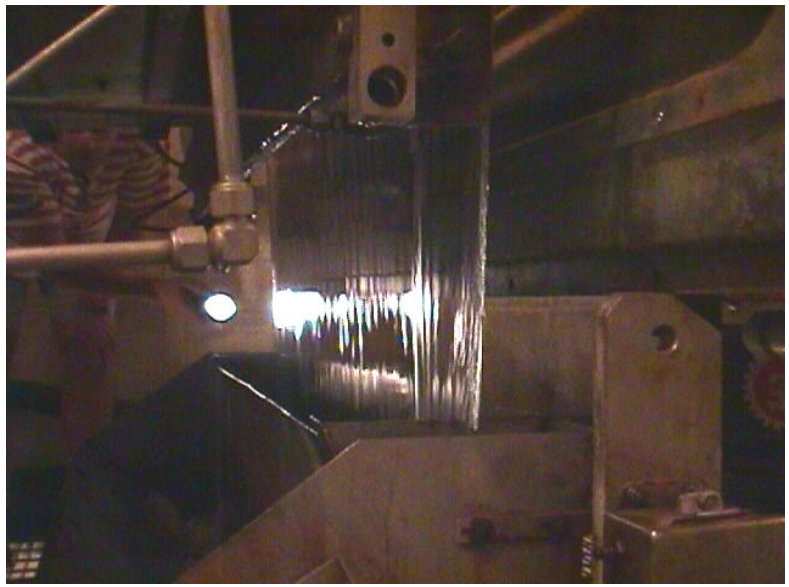
- Control the number of coli-forms in the effluent,
- Remove odor, color and reduce other residues for re-use in irrigation or industrial purposes,
- Bio-system is no good to control the number of e-coli,
- Ozone, UV and others are not good for large quantity.

Application of e-beam process in water/wastewater treatment:

- Wastewater from textile dyeing companies,
- Wastewater from papermill,
- Leachate from sanitary landfill,
- Wastewater containing heavy metals (Cd, Hg, Pb, Cr+6),
- Re-use of effluent from municipal wastewater plant,
- Remediation of contaminated water (PCB, explosives),
- Contaminated underground water, water from lakes, municipal plants effluent.

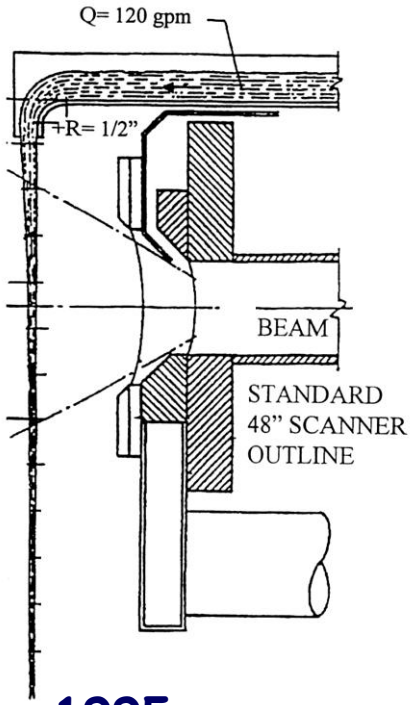


Floor plane



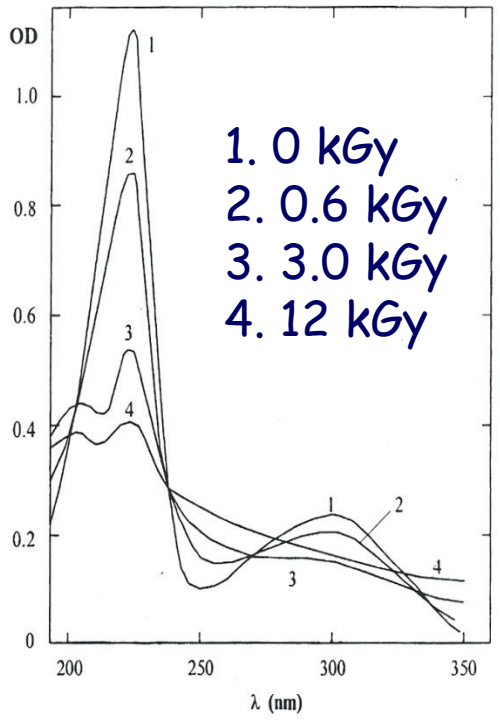
MIAMI E-Beam Facility for Wastewater Treatment

Electron energy	1.5 MeV
Beam power	75 kW
Flow rate	645 m^3/h
Liquid wastewater, sludge	
Dose	4 kGy

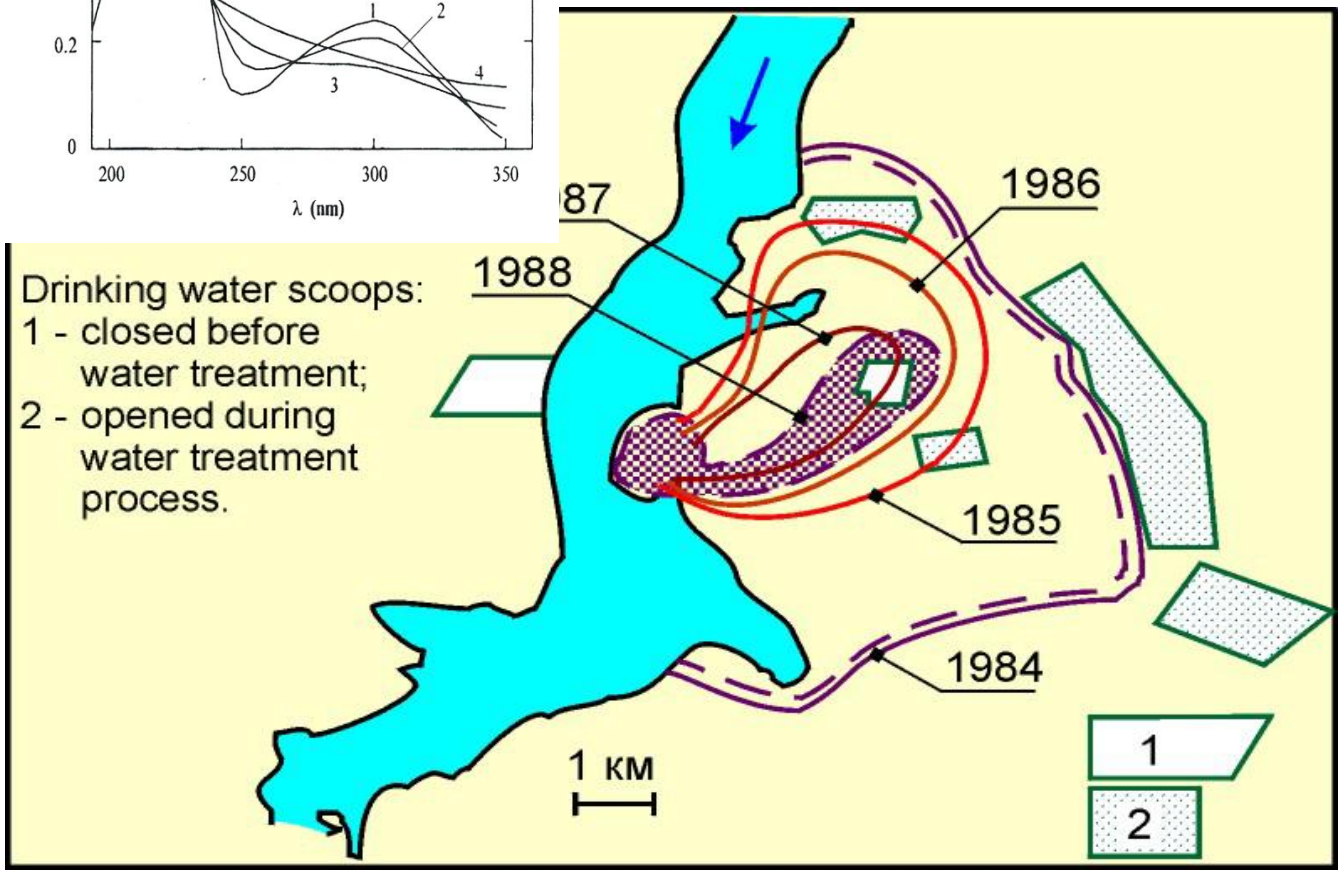


Kuruch et all., 1995

Contaminated Ground Water EB Treatment



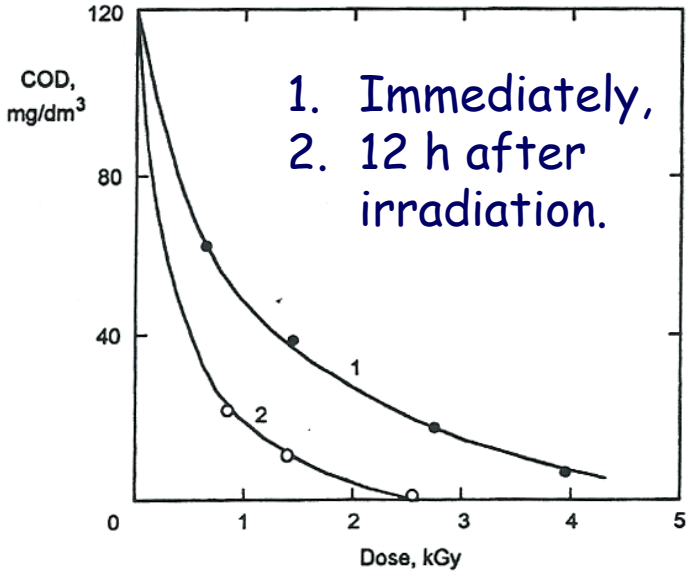
	Before	after
BOD	500-1000	7-15
COD	1600-5000	60-100



Nekal: isobutyl-naphtalene eb removal combinbed with biological treatment. Voronezh, Russia

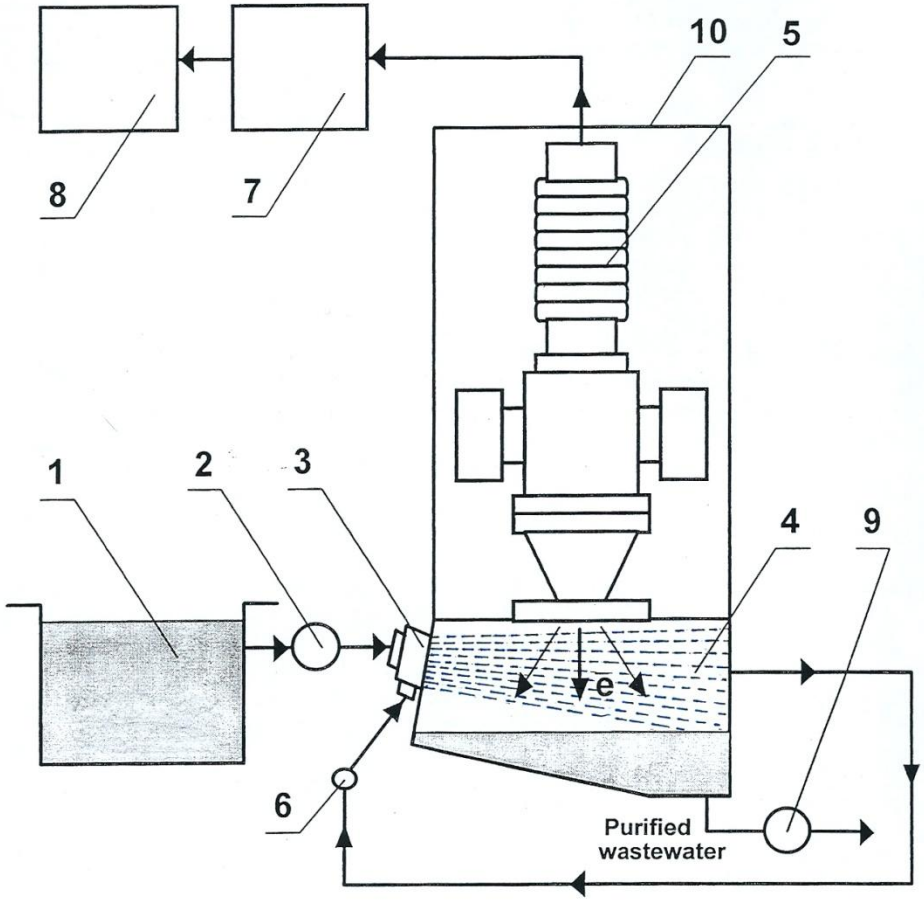
Combined E-Beam and ozone treatment of wastewater in the aerosol flow

1. Reservoir of wastewater,
2. Electric pump,
3. Sprayer unit,
4. Irradiation chamber,
5. Electron accelerator,
6. Turbo-blower,
7. Power supply,
8. Control desk,
9. Electric pump,
10. Shield.



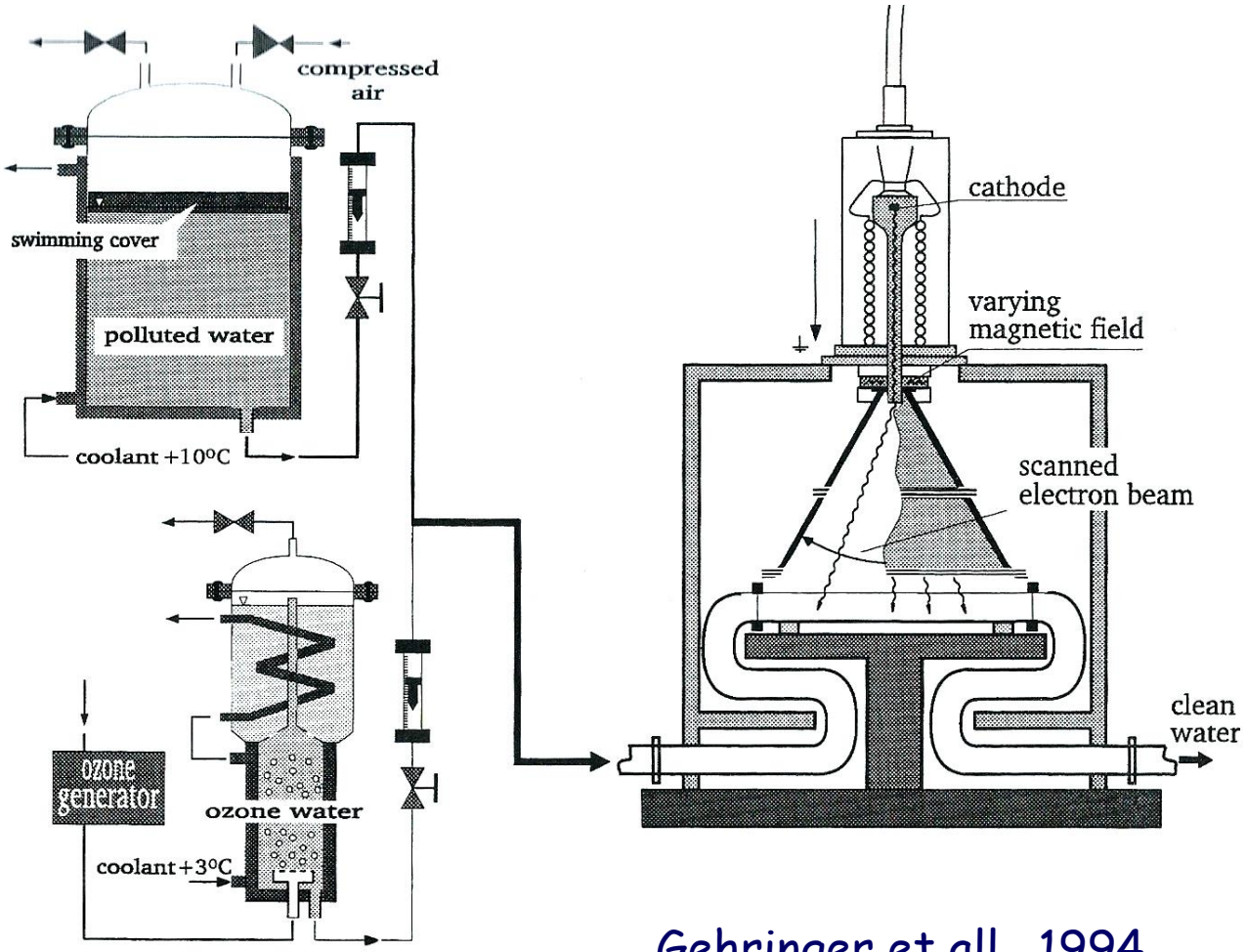
1. Immediately,
2. 12 h after irradiation.

- Accelerator 0.3 MeV, 15 kW,
- Flow 500 m^3/day,
- Dose 1.3 kGy,
- Occupied area 40 m^2.

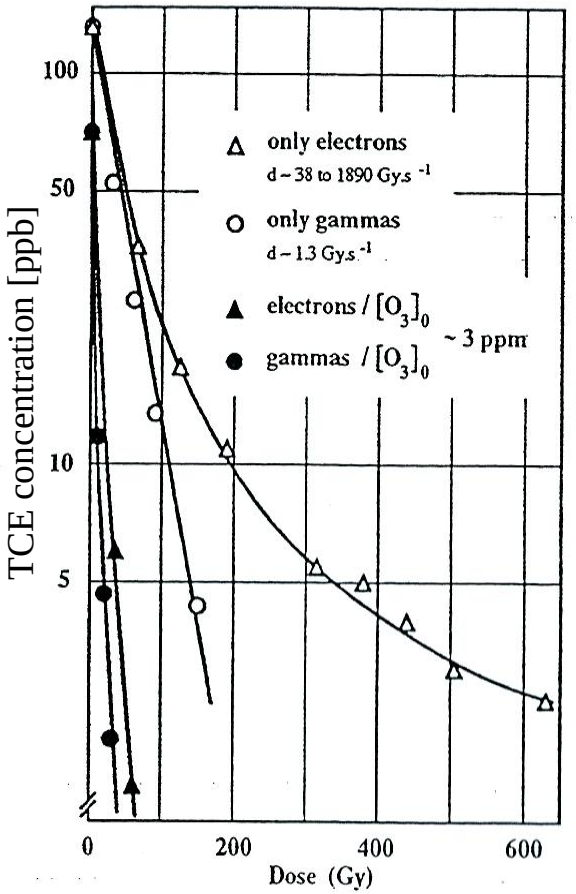


Pikajew et all., 1997

Ozone – 500 keV Electron Beam Treatment for Groundwater Remediation

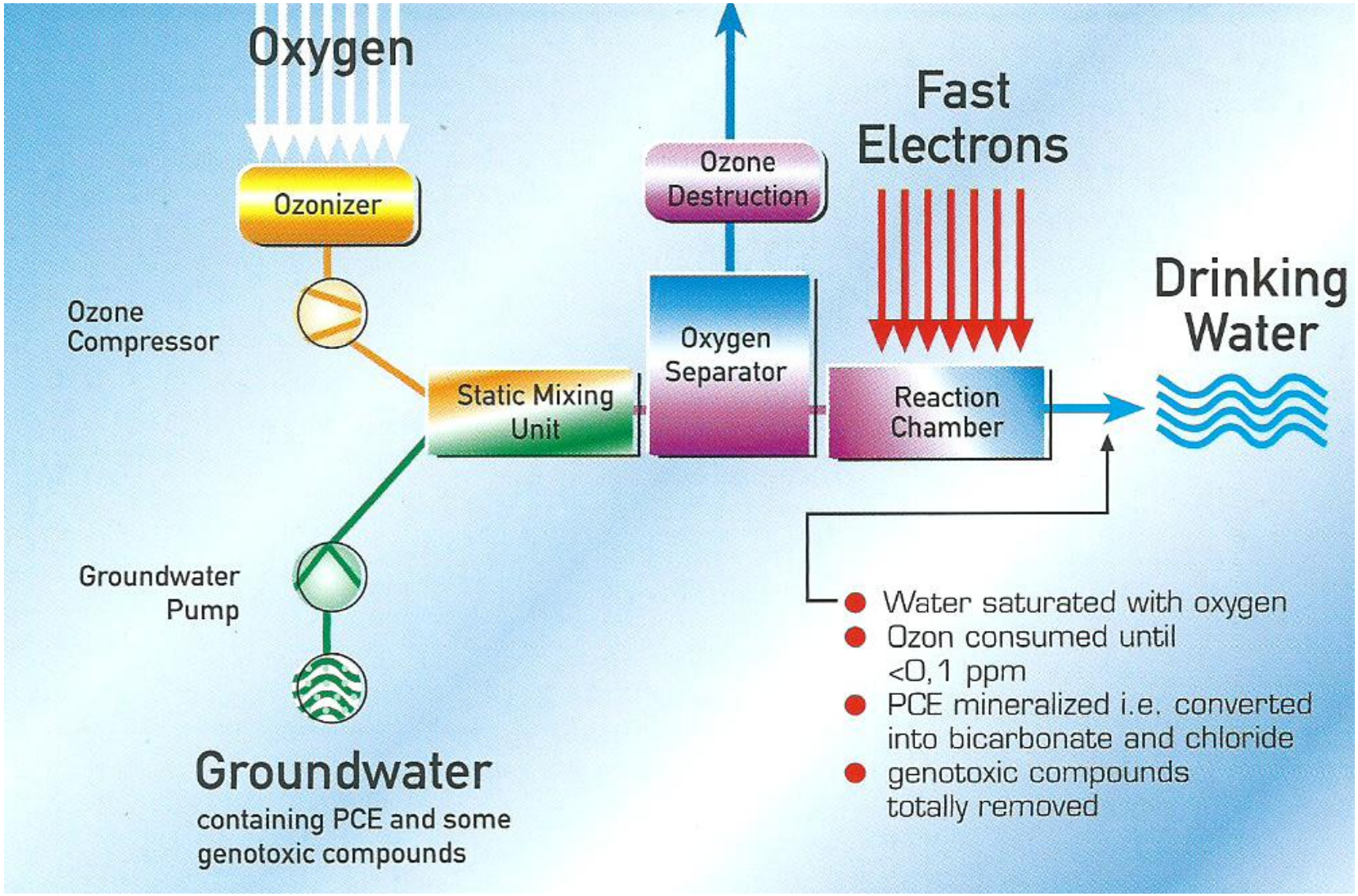


Gehringer et all., 1994

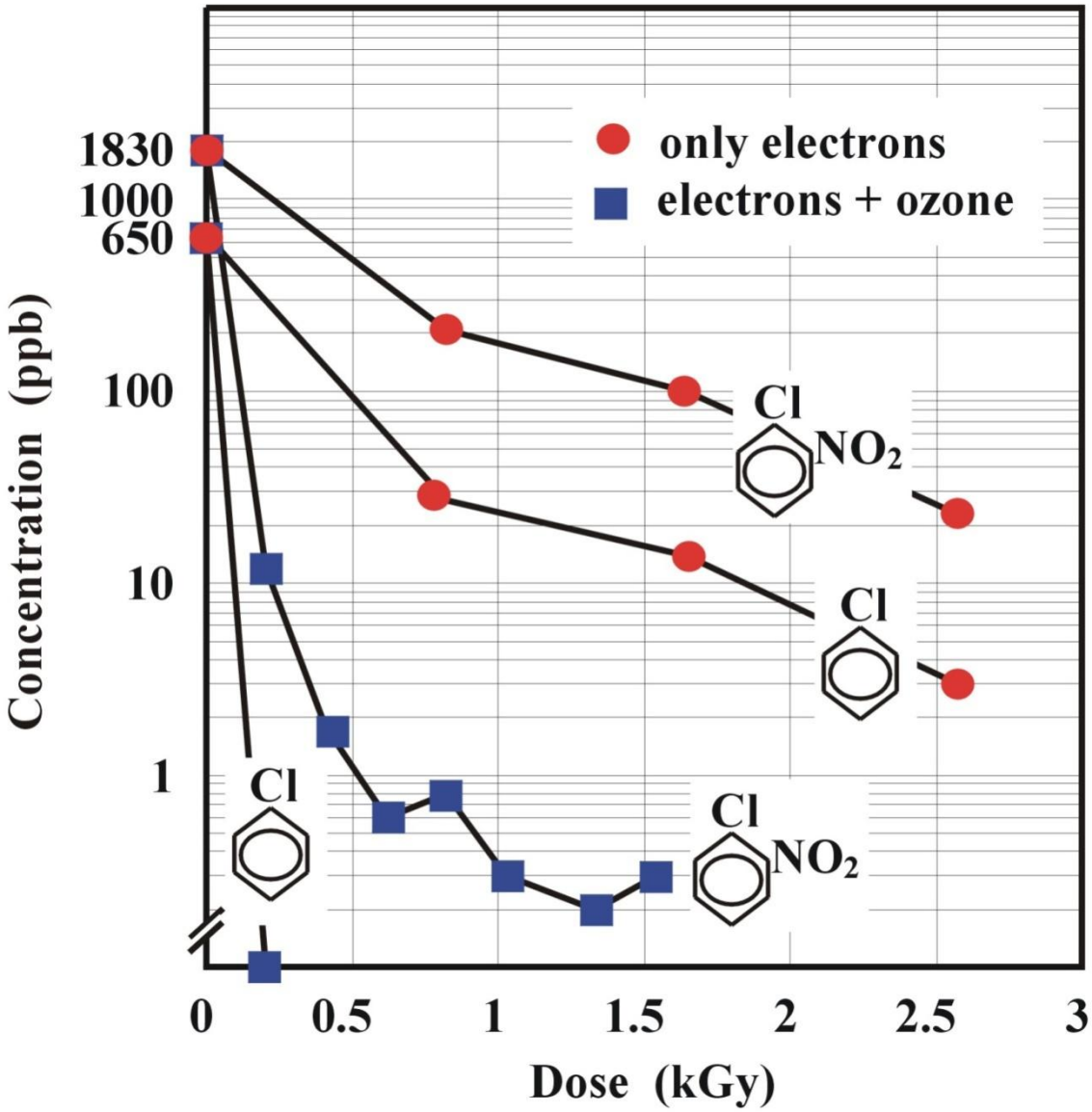


TCE decomposition

Combined Ozone Electron Beam Irradiation System for Water Treatment

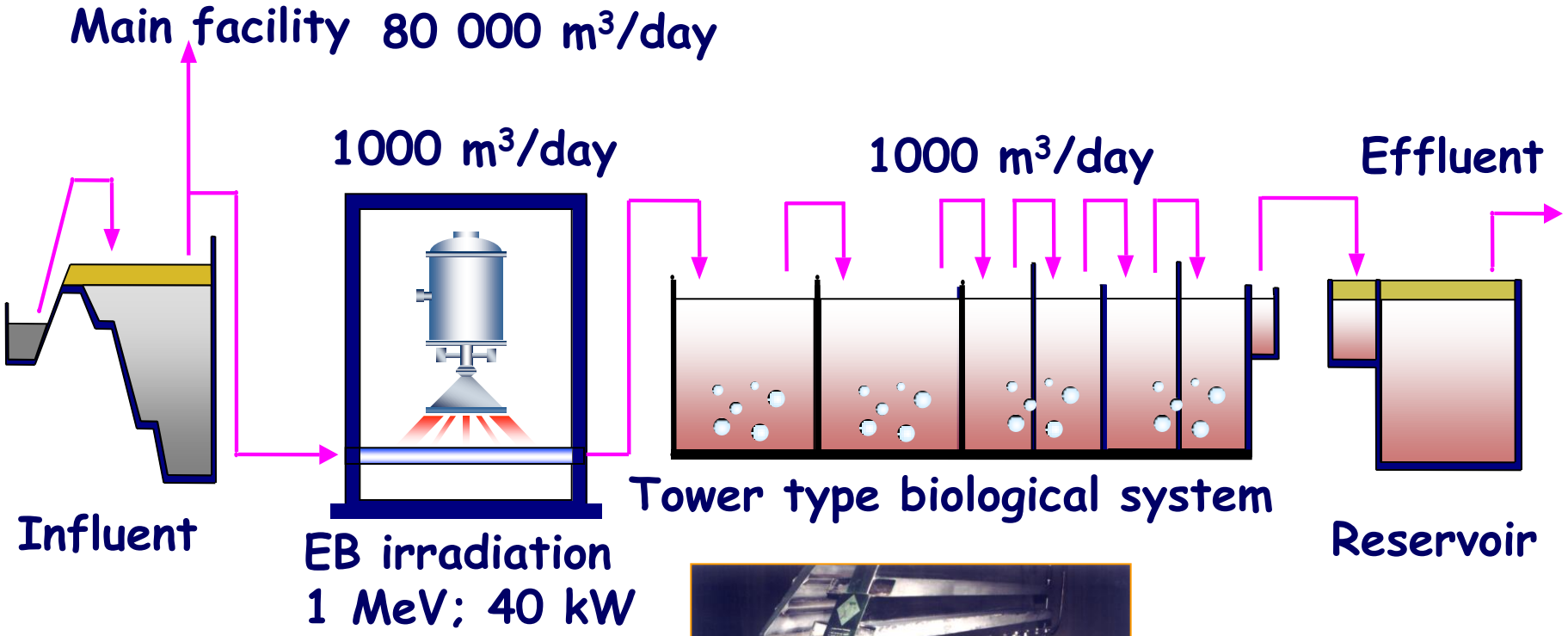


Medi-Scan GmbH



Elimination of the pollutants in water:
- high flow rate,
- low operation cost,
- high efficiency.

Electron Beam Treatment Pilot Plant for Textile Dyeing Wastewater (1998)



Dr. B. Han

ebTech, Korea

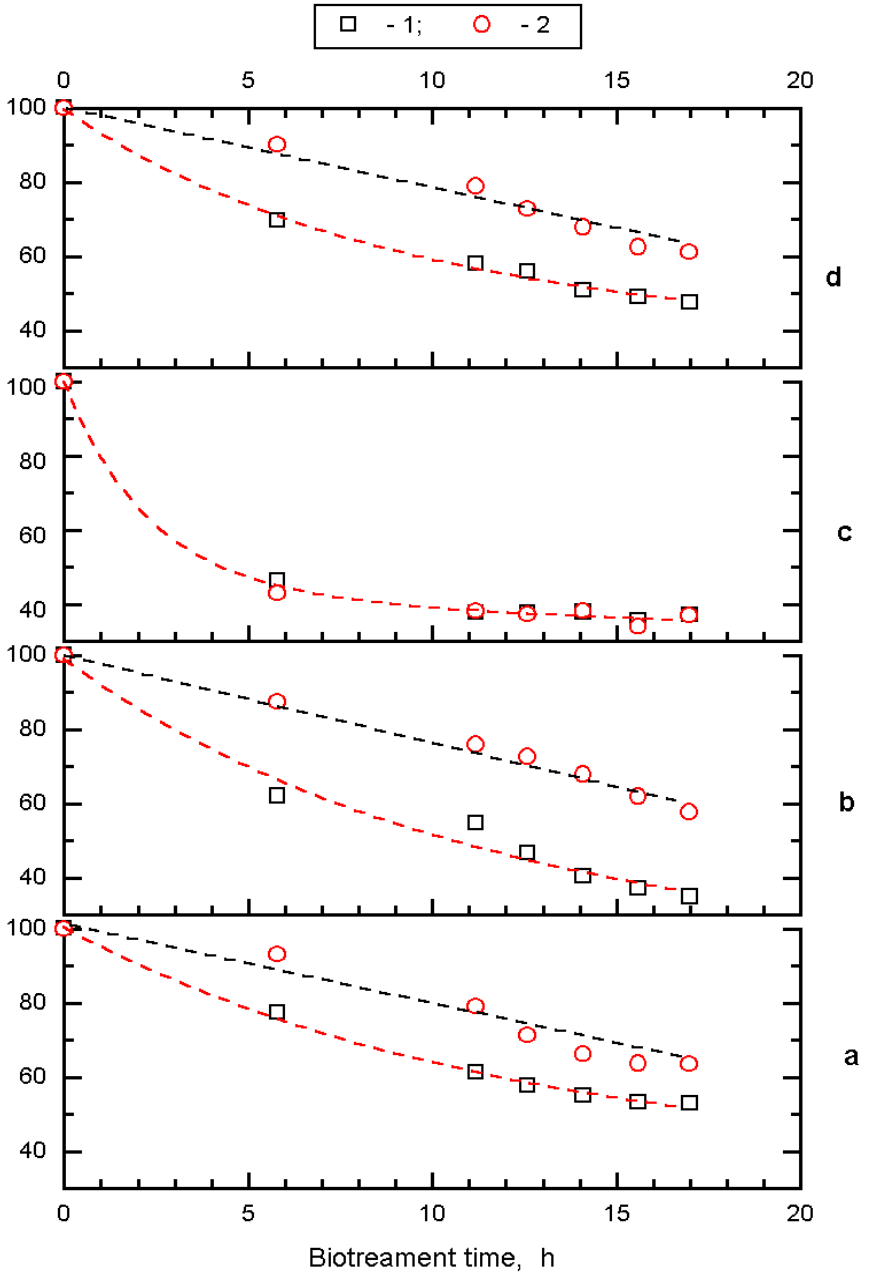
Effect of irradiation and biological treatment on wastewater parameters:

a-TOC; b-COD_{Cr};

c-COD_{Mn}; d-BOD.

1- after EB treatment

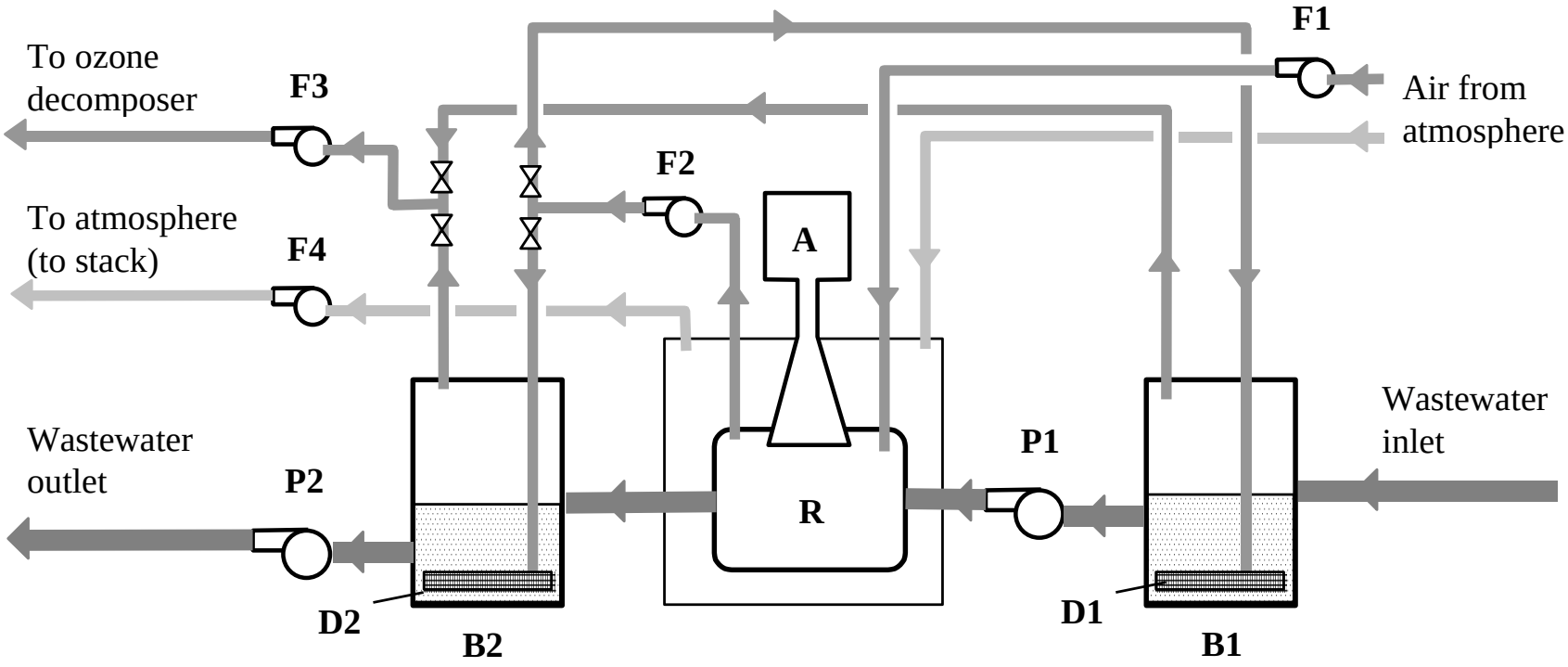
2- without EB treatment



Electron Beam Treatment Commercial Plant for Textile Dyeing Wastewater (2005)

10 000 m^3/day

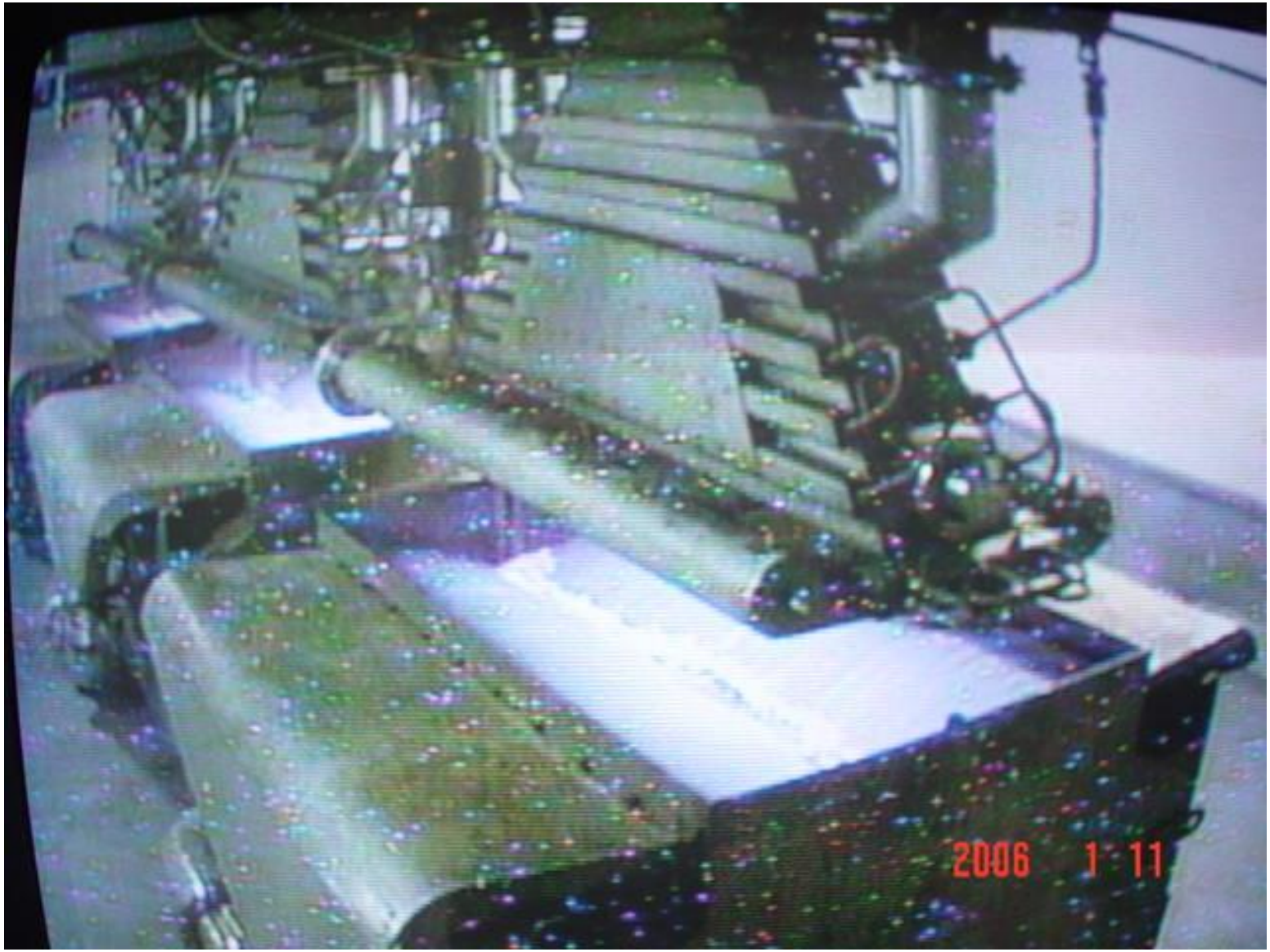
ebTech, Korea



Simplified technological scheme of the plant. F1-F4 – Air fans, P1-P2 – Water pumps, D1 and D2 – Diffusers, A – Accelerator, R – Reactor, B1 and B2 – Primary and secondary basins.

ELV 12 coreless transformer accelerator

Electron energy 1 MeV
Beam power 400 kW
Frequency 1000 Hz
One power supply
Three scanners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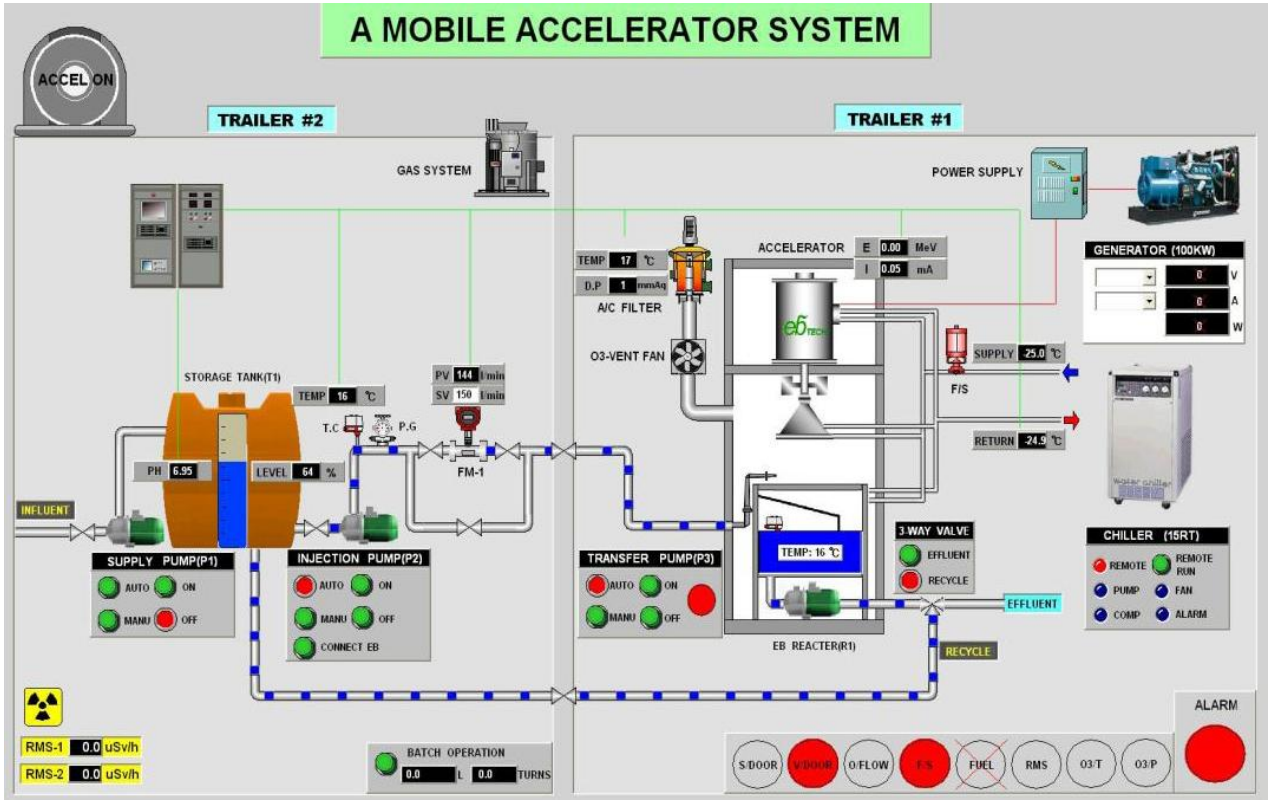
MOBILE ACCELERATOR SYSTEM

0.7 MeV, 20 kW

ebTECH



Thank you for your attention