Technology solutions: Accelerators for sludge treatment

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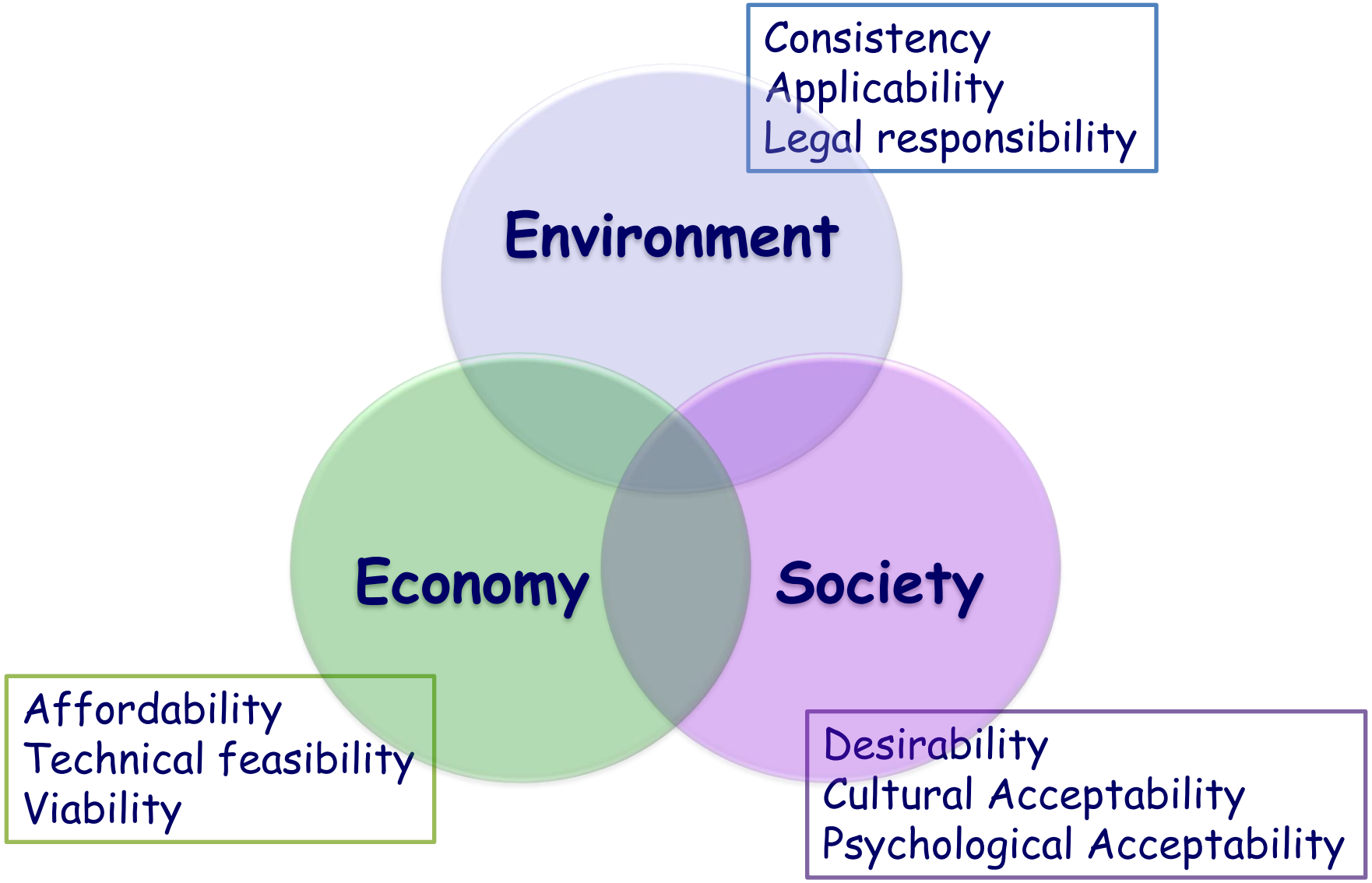
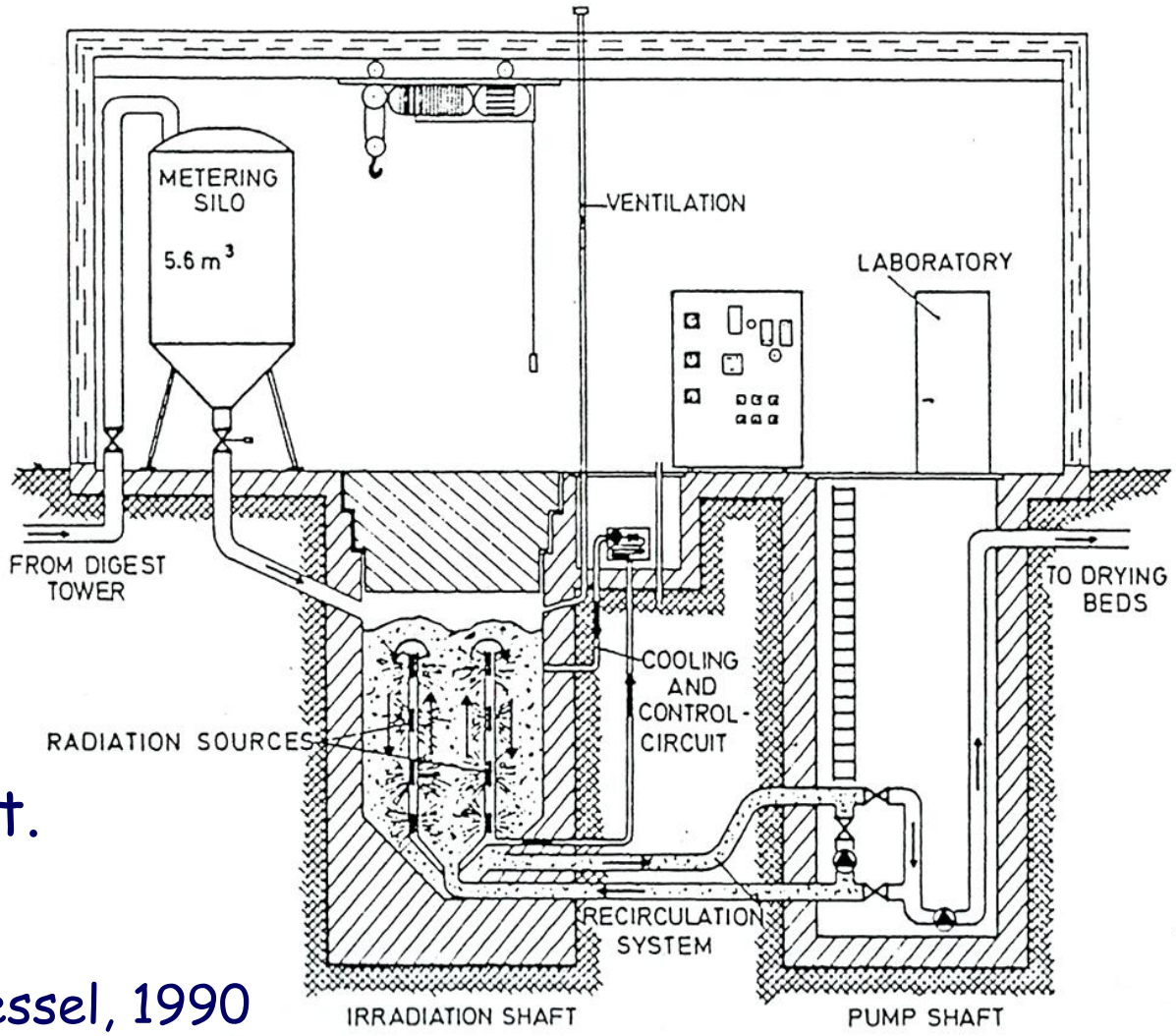
Biosolids Management



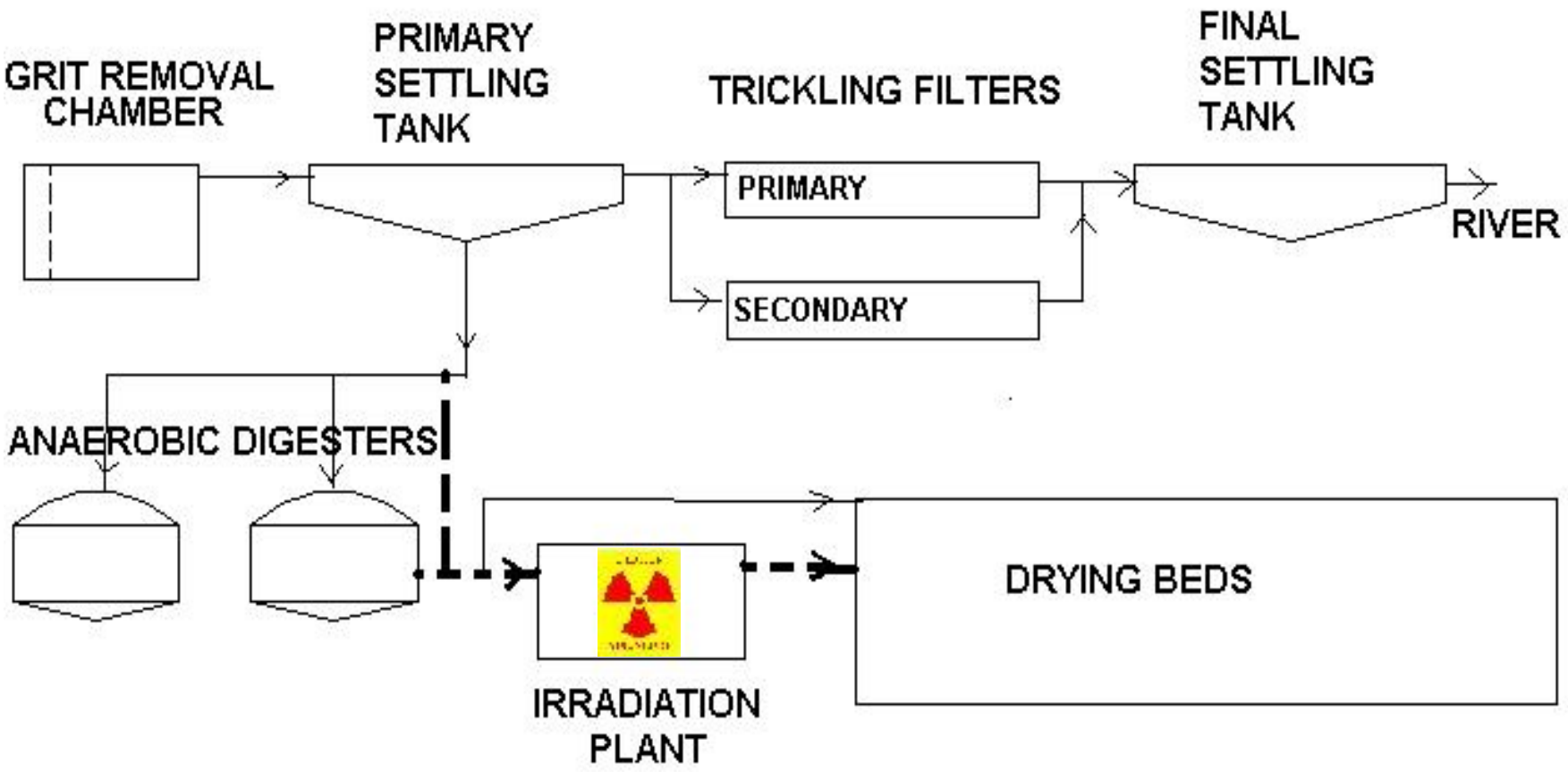
SEWAGE SLUDGE IRRADIATION PLANT IN GEISELBULLACH, GERMANY

- Gamma ray: Co-60, Cs-137;
- Liquid sewage: 145 m^3/day;
- Dose: 2-3 kGy;
- Batch mode;
- Demo plant: 1973-1980
- Commercial plant.



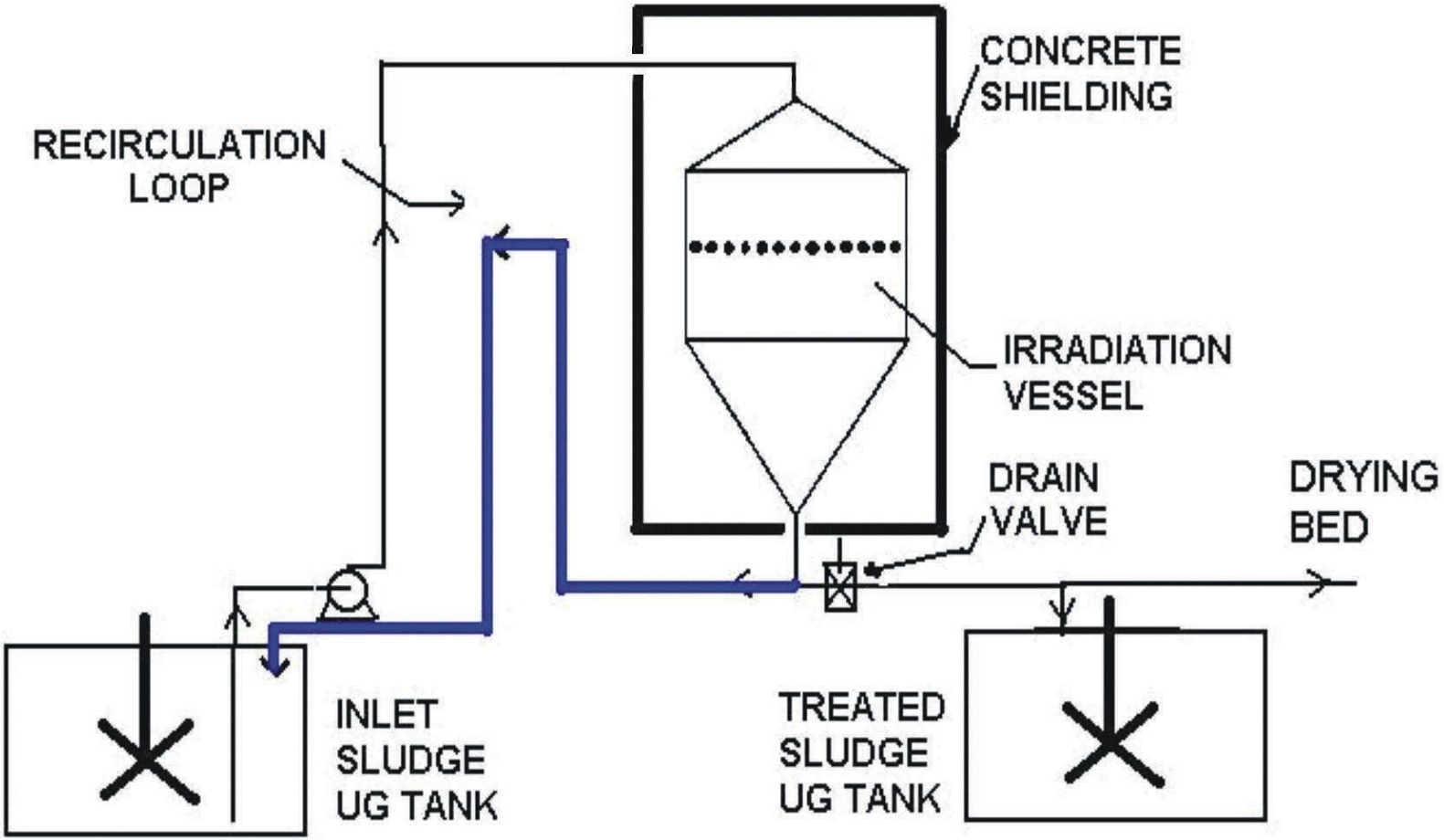
Lessel, 1990

Hygienisation of Sewage Sludge Using Radiation – Integrated with Conventional Plant



Kumar, 2013

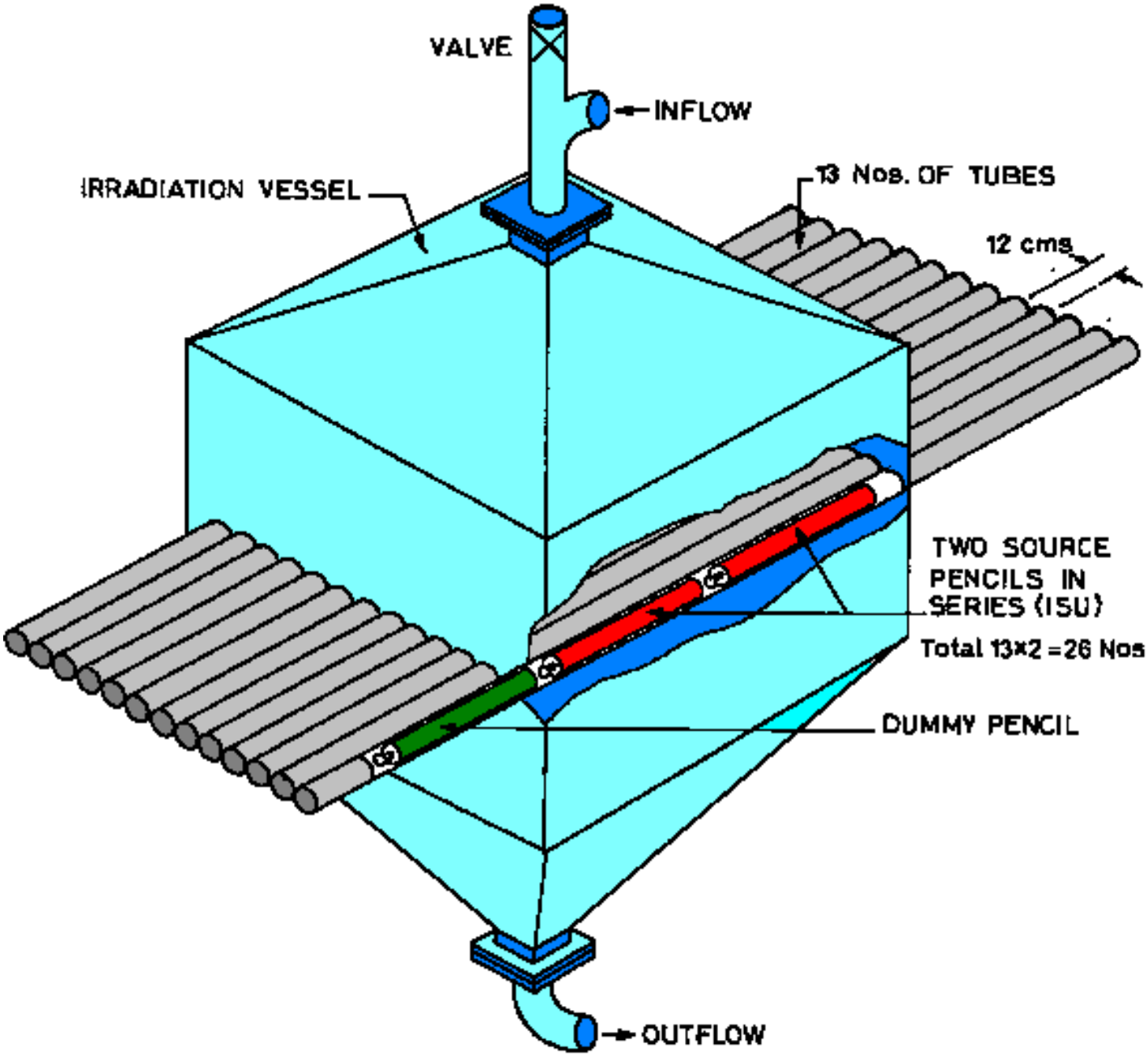
Radiation Treatment Process



Commercial plant, (1989)

Gamma ray
Co-60; 0.5 MCi

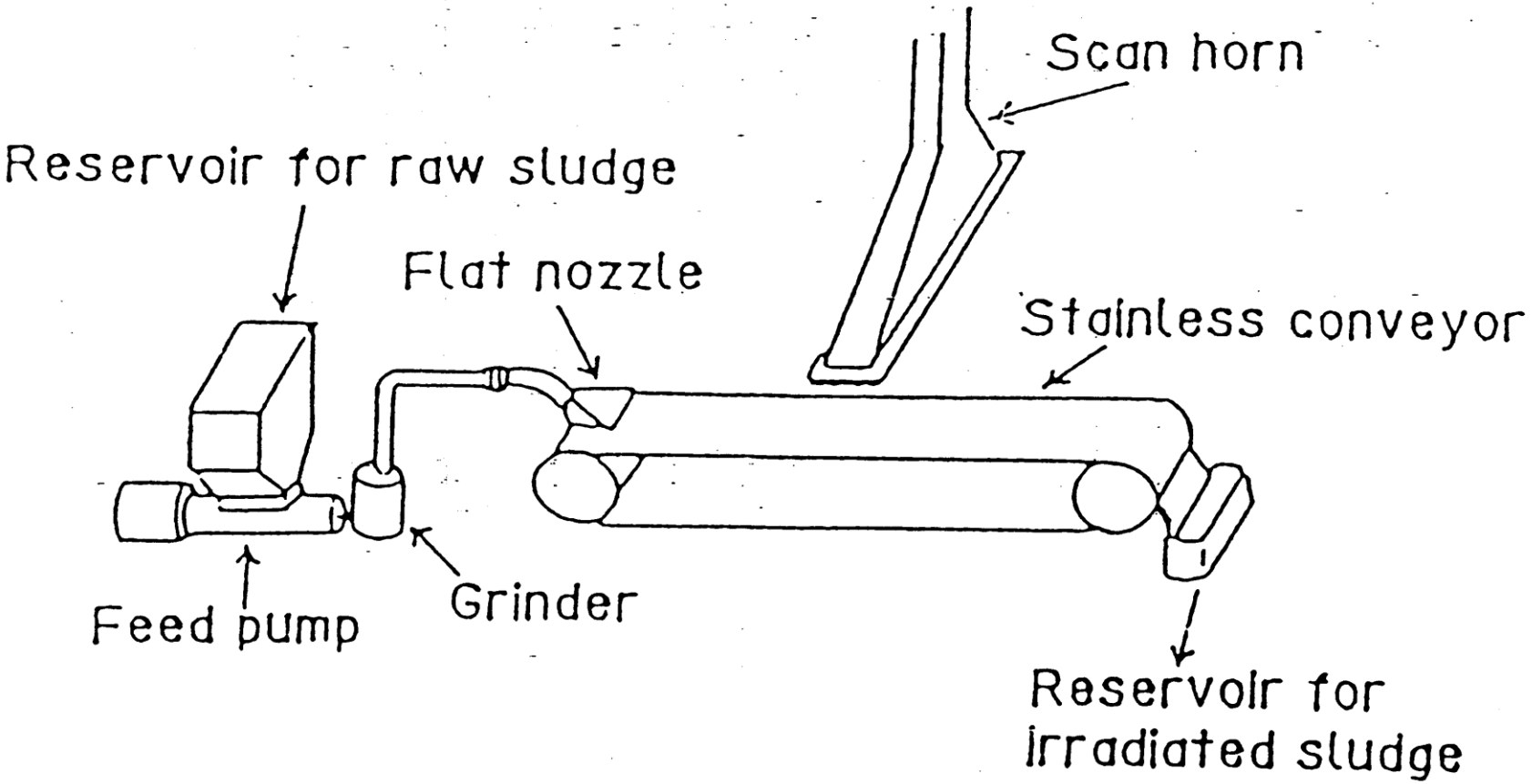
Liquid sewage sludge; 3 kGy
110 m^3/day; 4 % SS


VALVE
INFLOW
IRRADIATION VESSEL
13 Nos. OF TUBES
12 cms
TWO SOURCE PENCILS IN SERIES (ISU)
Total 13×2 =26 Nos
DUMMY PENCIL
OUTFLOW

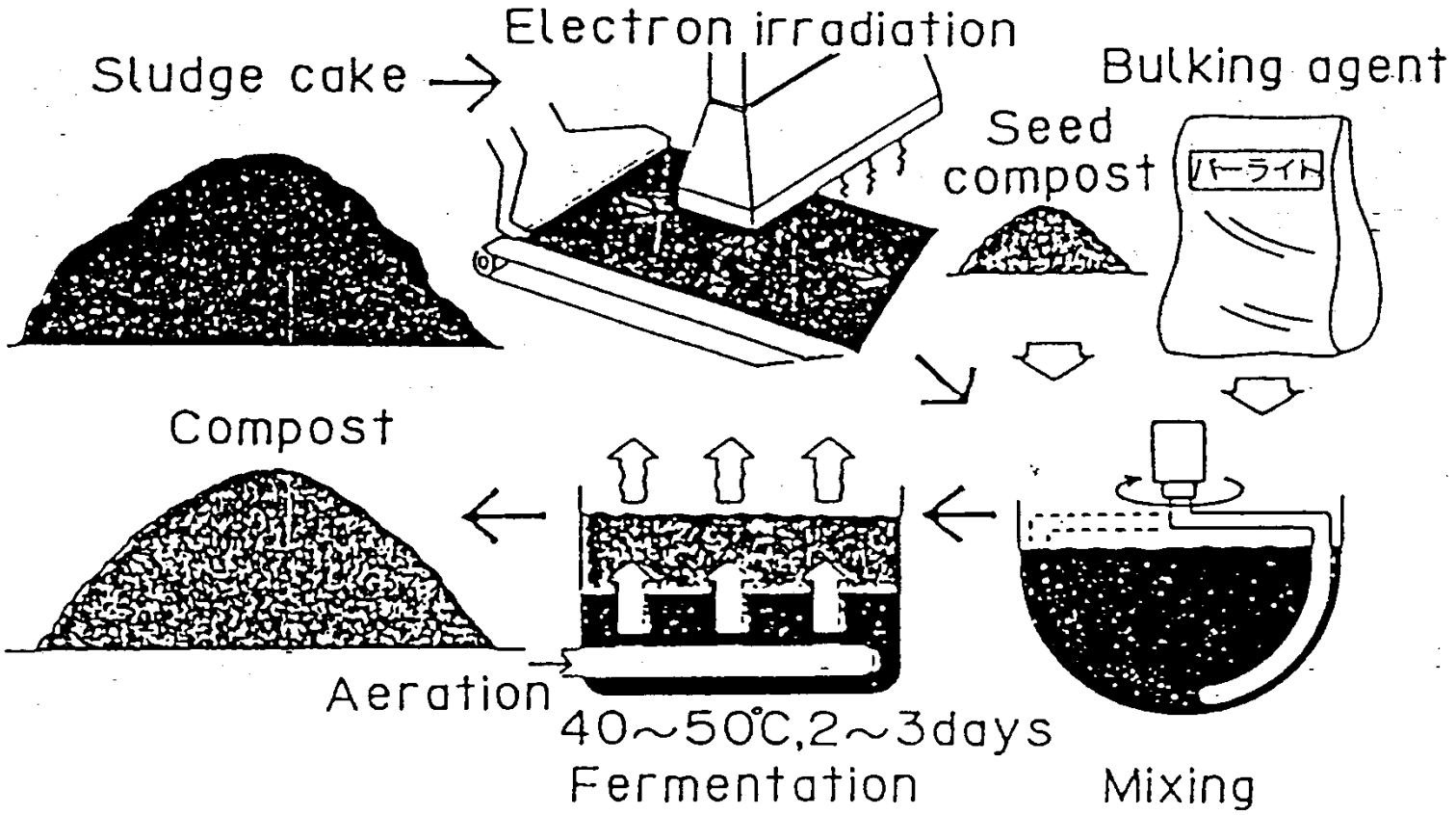
Sludge after drying ready for use In agriculture

Dried sludge being despatched for field trials

SLUDGE CAKE IRADIATION SYSTEM

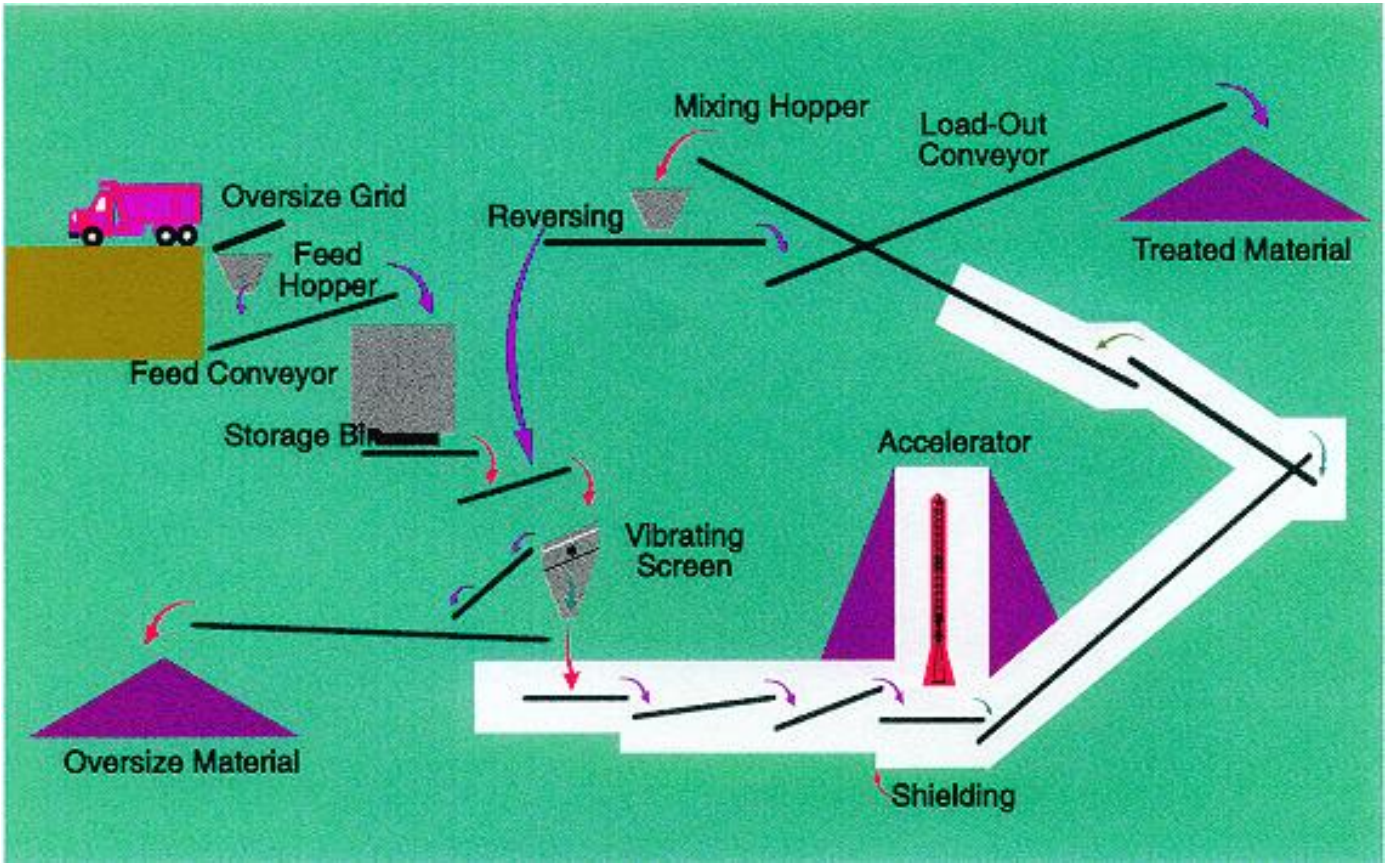


Hashimoto et all., 1991



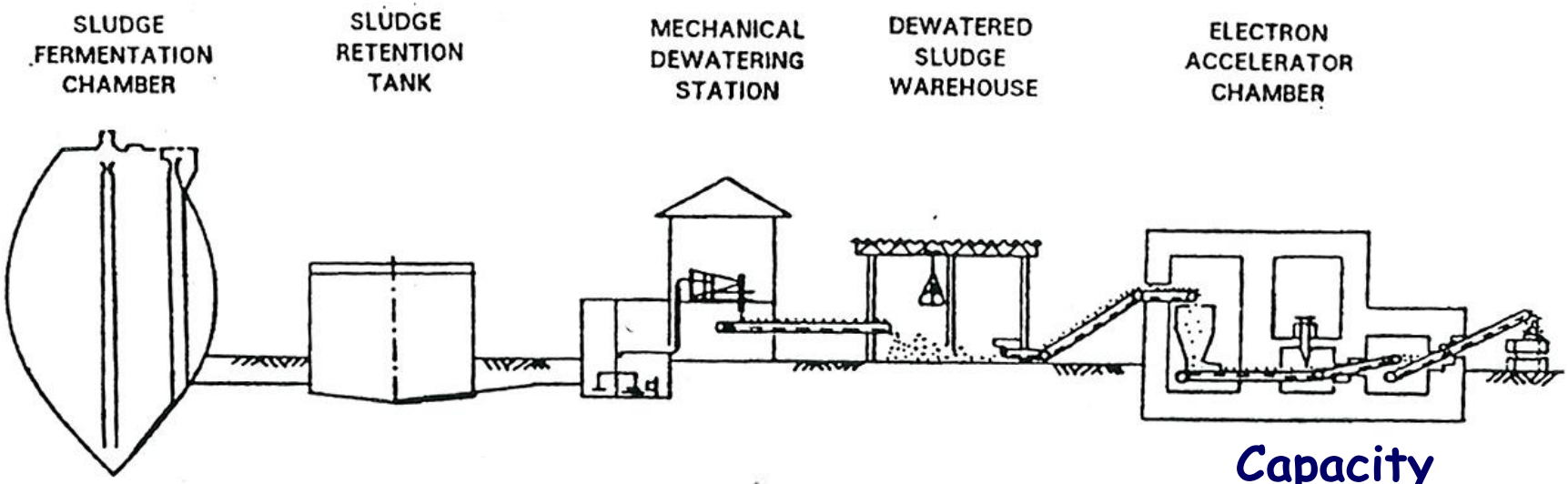
Irradiation-composting system of sewage sludge

Sewage treatment with electron beams
Proposals, City of Edmonton, Canada (1993)

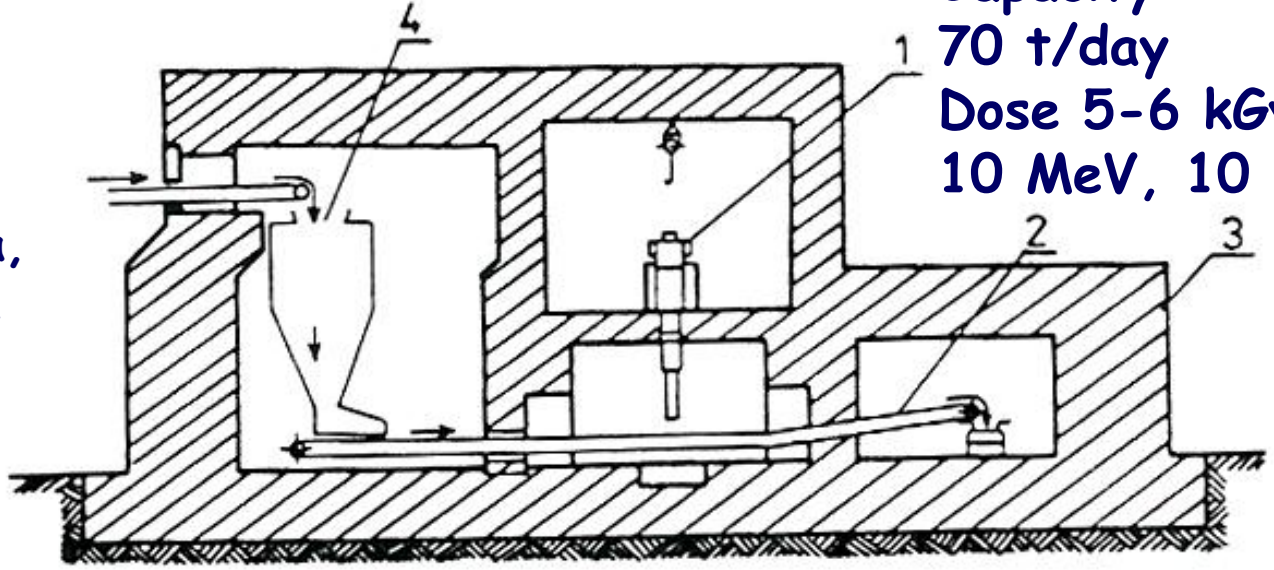


Electron energy 10 MeV; Beam power 50 kW;
Dewatered sludge 63 t/d; Dose 5-15 kGy

DISINFECTION OF MUNICIPAL SEWAGE SLUDGES IN INSTALLATION EQUIPED WITH ELECTRON ACCELERATOR



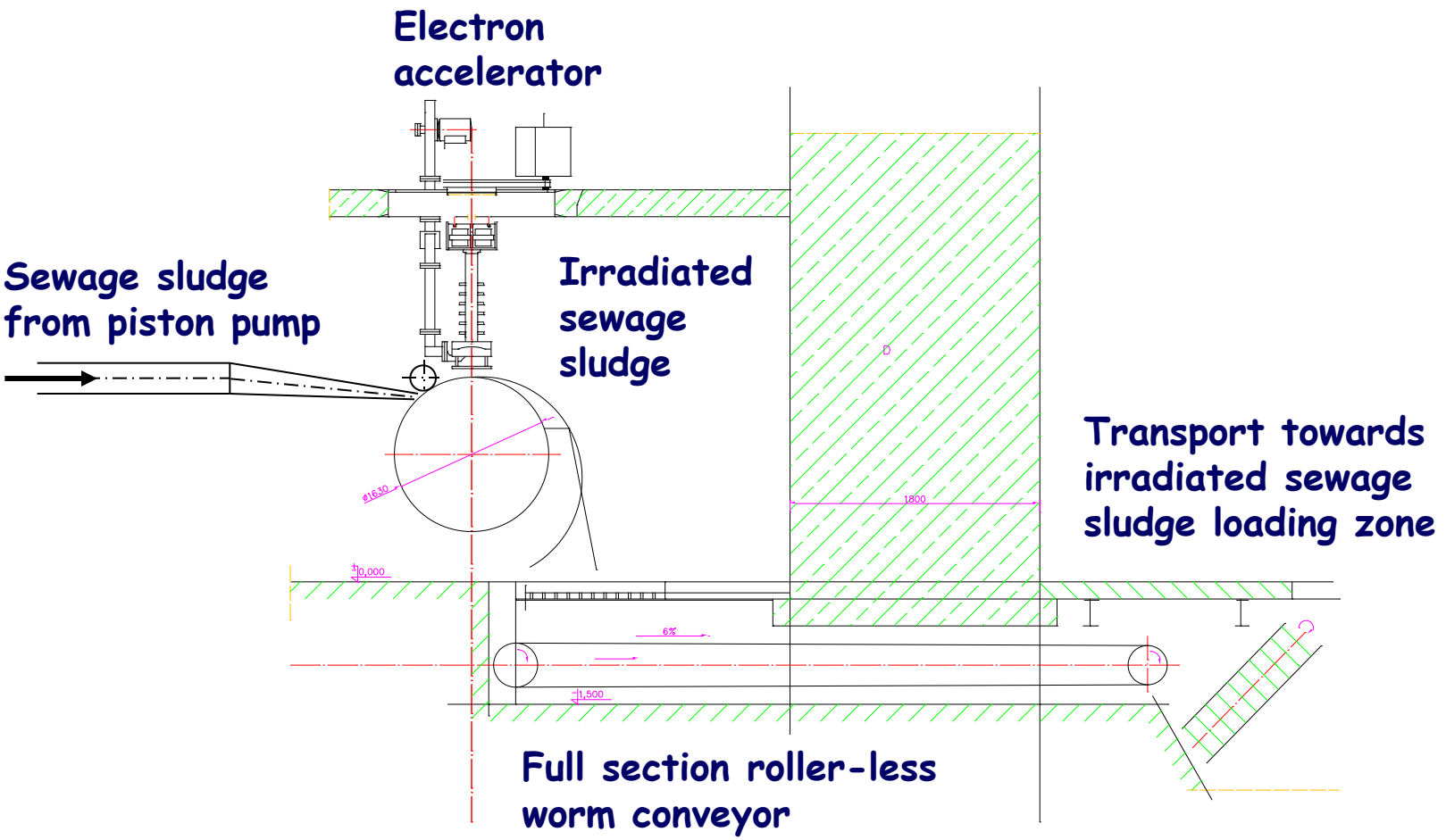
Capacity
70 t/day
Dose 5-6 kGy
10 MeV, 10 kW



A.G.Chmielewski
Z. Zimek,
T. Bryl-Sandalewska,
W. Kosmal, L.Kalisz,
M. Kaźmierczuk
Radiat. Phys. Chem.
V. 46, 4-6,1071-1074, 1995

1 – electron accelerator, 2 – conveyor, 3 – shielding, 4 -feeder

Transport equipment for sewage sludge irradiation

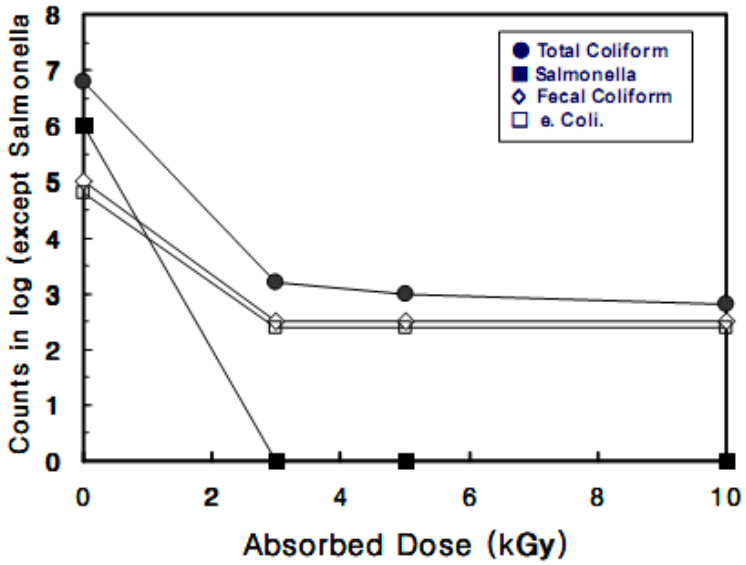


Economics of Current Technologies

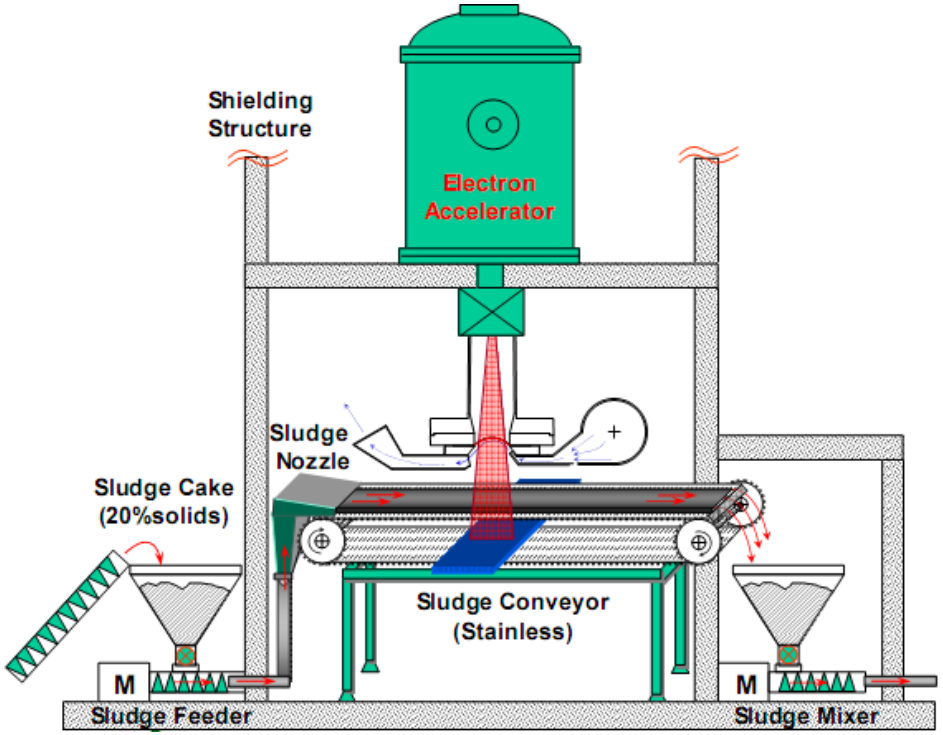
Process	Cost per Dry Ton (2005 US$)	Cost per Dry Ton as VA Product (2005 US$)
Incineration/Co-generation	600 to 1100	3 to 30 as Ash Reuse
Thermal Treatment	500 to 1200	30 to 150 Usage as a Fuel or Fertilizer
Biological Anaerobic Digestion	350 to 650	30 to 200 as Natural Gas /Residual Soil Amender
Biological Aerobic Digestion	350 to 700	30 to 70 as a Residual Soil Amender
Advanced Alkaline Stabilization	350 to 550	80 to 120 as a Ag Lime Agent
Acid Stabilization/Disinfection	350 to 550	30 to 70 as a Residual Soil Amender
E-Beam Disinfection/Stabilization	100 to 250	30 to 70 as a Residual Soil Amender

Reimers et al, 2013

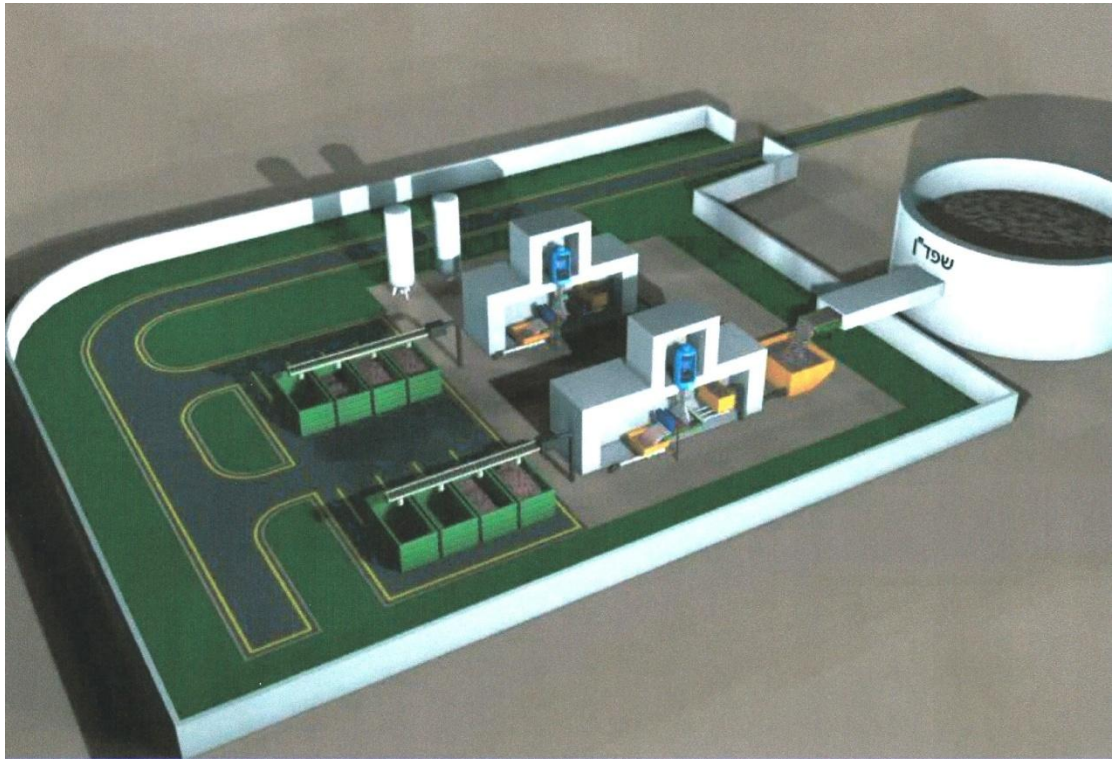
Electron Beam Sludge Hygienization Plant



Survival of micro-organism population vs dose (beam energy: 1MeV, thickness of sludge: 3mm)



Kim et all., 2009



Electron Beam Sludge Hygienization Plant

Design assumptions

- Application: land application of disinfected digesting sludge;
- Flow rate of dewatered dludge: 7,000m^3/month (22 m^3/h)
- Absorbed dose: 2~10kGy (depend on removal efficiency of total coli-forms bacteria (dewatered sludge - 18%SS)
- Electron beam utilisation efficiency: 70% (min. 60% ~ max. 80%)
- Electron Energy: 2.5 MeV; Beam power: 100 kW
- Operating time: based on 16hrs/day (20days/month)
- Nozzle width: 1.8 m; Speed of conveyor: 30 m/min

Electron Beam Sludge Hygienization Plant

Economy of sewage sludge e-beam treatment

(results of calculations)

Electron accelerator (2.5 MeV, 100 kW)	960 k$
Investment	1020 k$
Total capital requirements	1980 k$
Fixed cost (6 %; 20 years)	218 k$
Variable costs (5 c$/kWh, 2 shifts)	150 k$
Total operation cost	368 k$
Unit cost for sludge cake	4.4 $/m^3

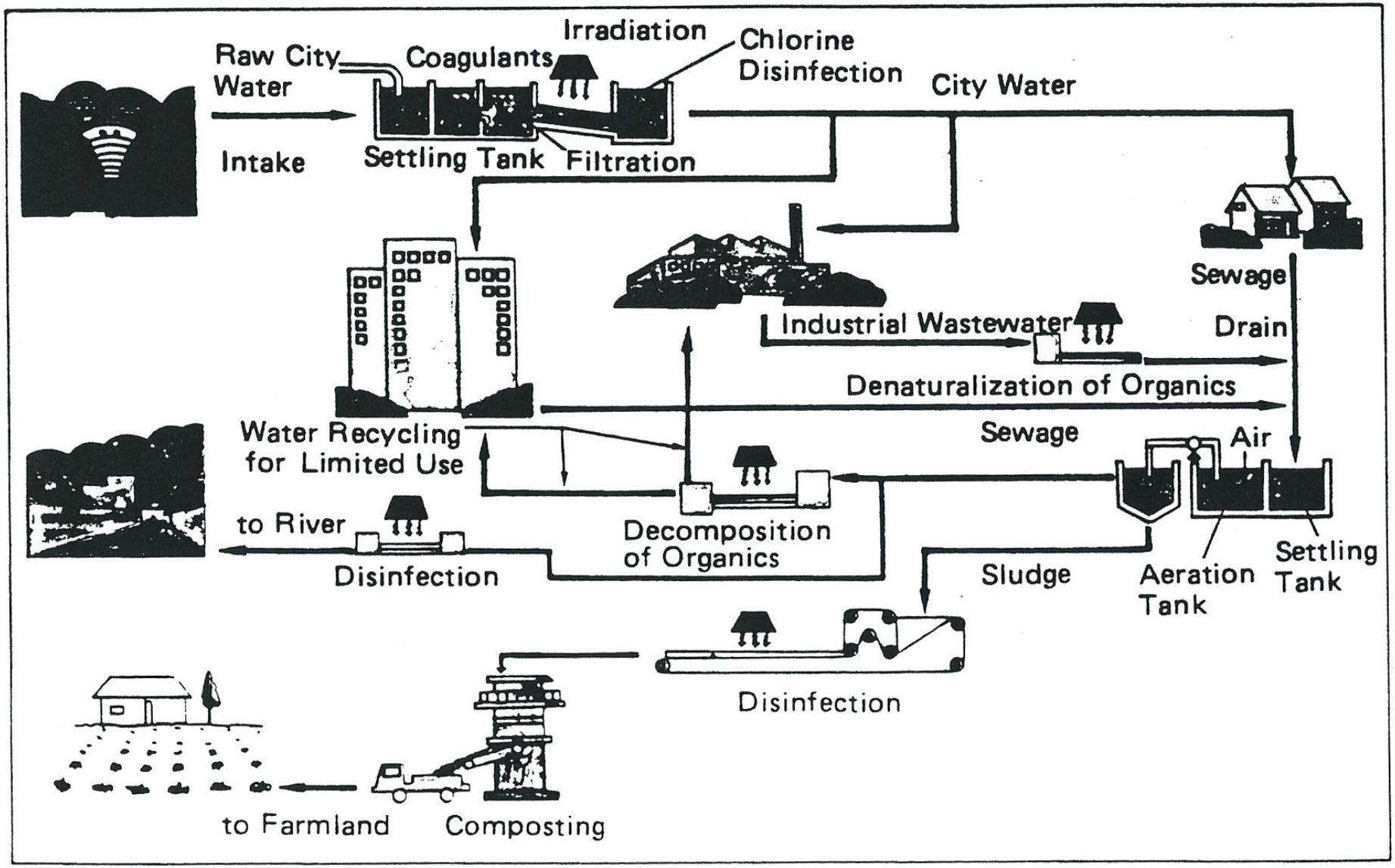
E-Beam is unable to achieve stabilization of treated solids

There is a need to couple E-Beam with one or more technologies to achieve sludge stabilization:

- composting of dewatered sludge pretreated by electron beam,
- lime application (amount 30-40 kg/t of dewatered sludge - 2.3-3.2 $/t).

E-beam sludge teatment process steps:

1. Sludge dewatering: (volume reduction);
2. EB Irradiation (disinfection);
3. Sludge stabilisation (lime or composting; smell reduction);
4. Agriculture Use (fertilizer).


Raw City Water
Coagulants
Irradiation
Chlorine Disinfection
City Water
Intake
Settling Tank
Filtration
Sewage
Industrial Wastewater
Drain
Denaturalization of Organics
Water Recycling for Limited Use
Sewage
Air
to River
Disinfection
Decomposition of Organics
Sludge
Aeration Tank
Settling Tank
Disinfection
to Farmland
Composting

Summary

- E-Beam Process is a quick and credible method of hygienization of municipal sewage sludge.
- Sludge hygienized with e-beam can be used as soil fertilizer immediately after treatment and no large land areas are needed to their disposal for long time.
- The operation cost of e-beam sludge plant can be reduced for larger facility.
- More convenient and competitive to compare with other technologies.