



This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.

12.2 Design of advanced electron accelerator plant for biohazards treatment

04.05.2021

Open IFAST Steering Committee Meeting

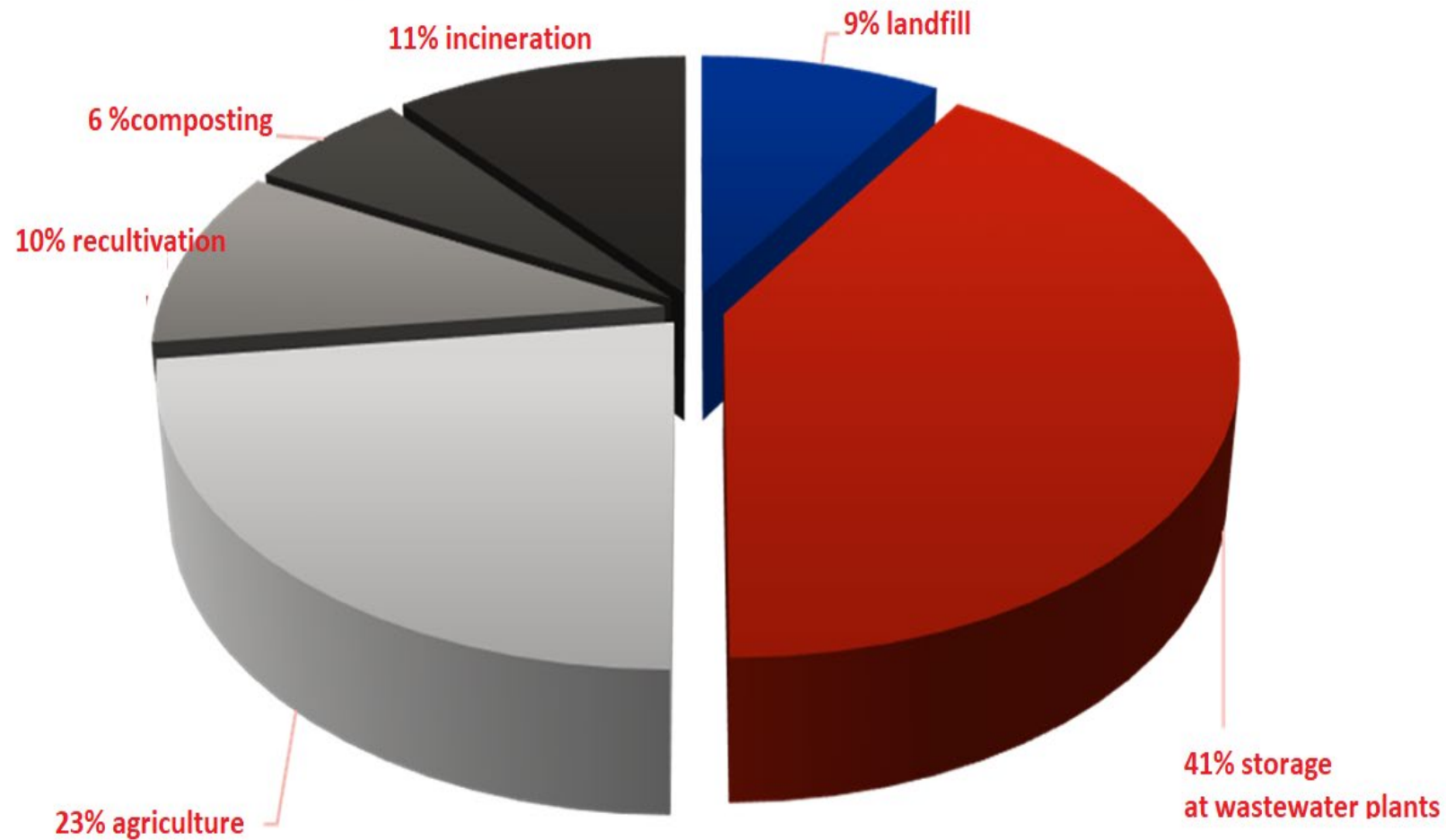
Andrzej G. Chmielewski

Institute of Nuclear Chemistry and Technology ,

Warsaw, Poland



Number of wastewater plants in Poland: 3143 (366 of 15,000 – 100,000 inhabitants equivalent). Wastewater treatment plants excess sludge utilization.



Directives

Poland

- Regulation of the Minister for environment 02/2015
- Act of 14th December 2012 (law on waste)



EU

- Council directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture
- Water Framework Directive 2000/60/EC on water protection
- Directive 91/271/EEC on urban waste water treatment
- Directive 96/61/EC concerning integrated pollution prevention and control
- Directive 99/31/EC on the Landfill of Waste
- Waste framework Directive 2008/98/EC



Can we use municipal sludge as fertilizer?

- Directive 91/271/EEC on urban waste water treatment
Sludge arising from waste water treatment shall be reused whenever appropriate. Disposal routes shall minimise the adverse effects on the environment.
- Art. 96.4 Act from 14 December 2012 (law on waste)
Usage of municipal waste is possible only if they're stabilised and prepared directly to it's purpose and way of use, especially by biological, chemical, thermal or any other treatment that decreases tendency to rotting or eliminates threat for human health and environment.



Some important legal requirements.



- Council directive 86/278/EEC

„treated sludge“ means: Sludge which has undergone biological, chemical or heat treatment, long term storage or any other appropriate process so as significantly to reduce its fermentability and health hazards resulting from its use.

- Waste framework Directive 2008/98/EC

The Directive lays down some basic waste management principles: it requires that waste be managed without endangering human health and harming the environment, and in particular without risk to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest.

Pathogens to be removed.

Pathogenic bacteria acceptable content

- In Poland one pathogenic bacteria species is considered: *Salmonella*
- None living cells of salmonella can be detected in 100g sample of municipal sludge



Species of parasites which have to be detected:

- *Ascaris sp.* - human parasitic roundworm
- *Trichuris sp.* - human whipworm
- *Toxocara sp.* - animal (mostly cats and dogs) parasitic worms
- Parasites and eggs acceptable content = 0



Objective

Basic engineering of e-beam municipal sludge processing line based on industrial electron accelerator.

Laboratory experiments

- excess sludge hygenization
- excess sludge fermentation (noirradiated/irradiated)
- postferment hygenization

Industrial partners

Biopolinex SA

(<https://biopolinex.pl/en>)

Gea Nova (<https://geanova.pl/>)

Regulatory obligations

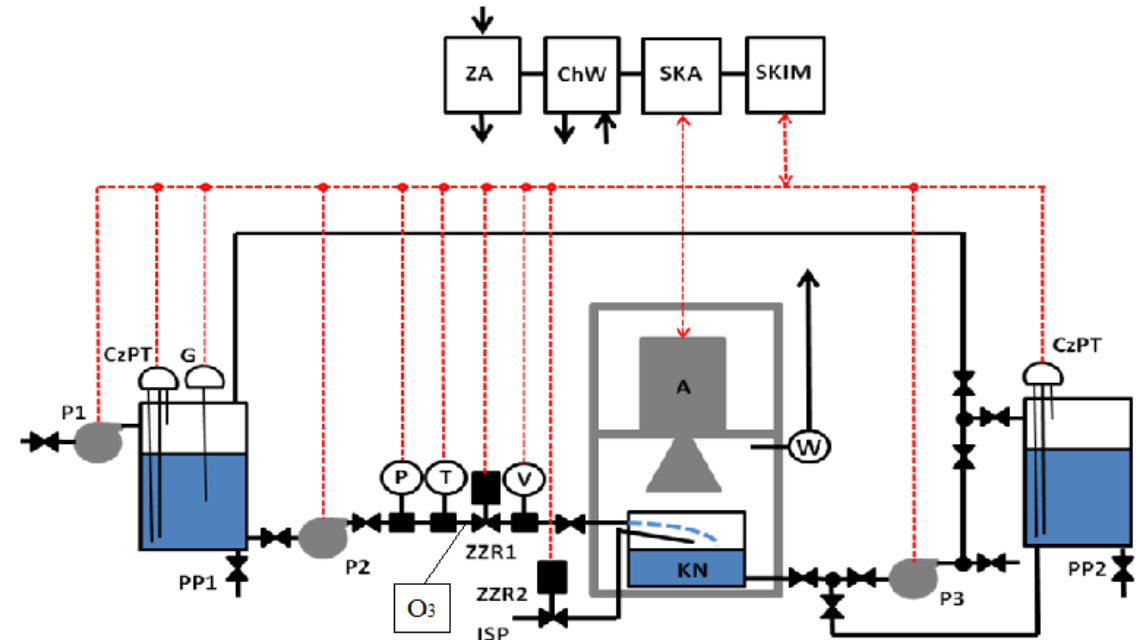
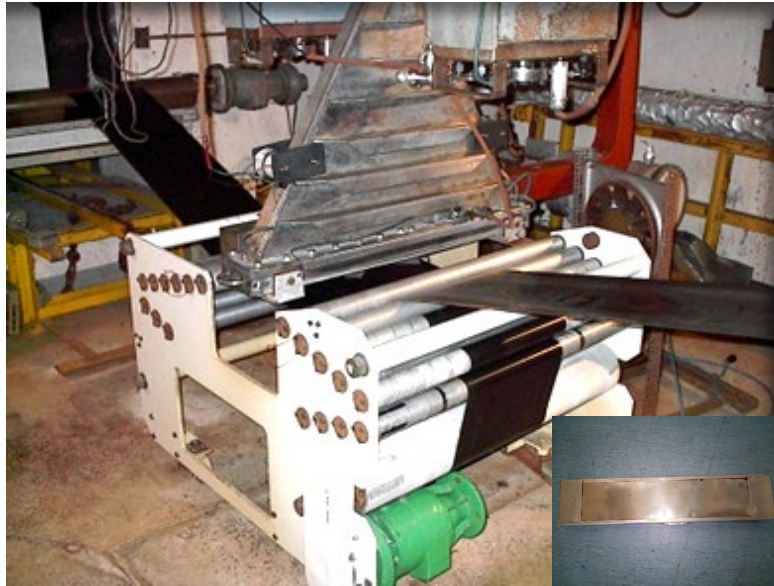
- environmental ompact
- radiation safety permit
- building permit

Basic engineering

preparation

- technology
- accelerator

Experiments



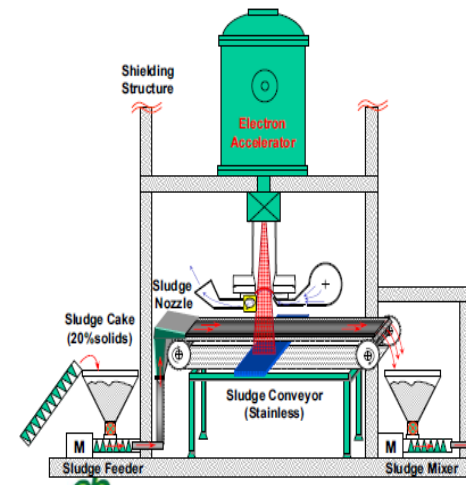
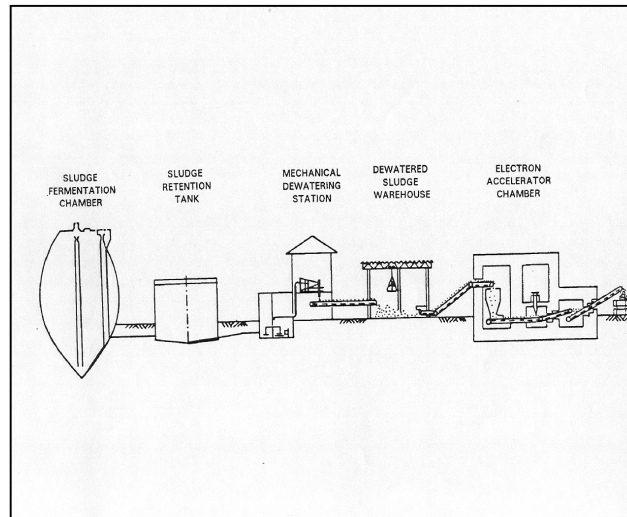
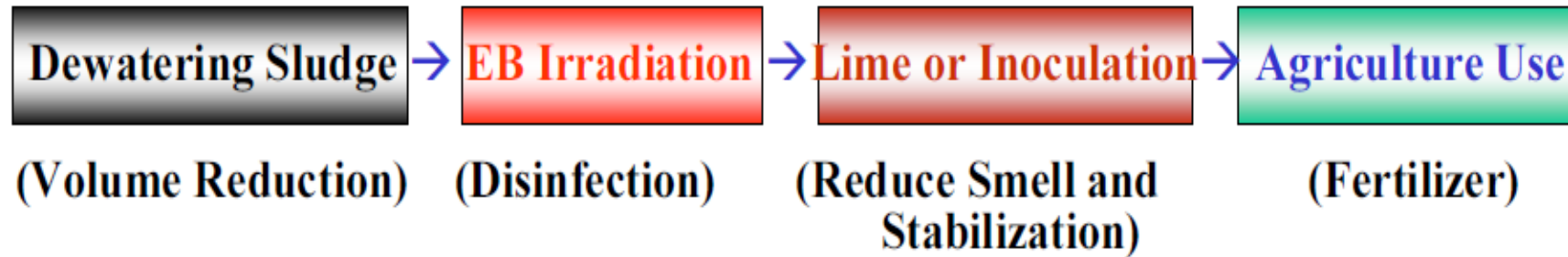
Presence of live parasite eggs in sludge from the sewage treatment plant - raw and irradiated).

	Sludge type	Dose [kGy]	Parasite	Eggs number
1.	Primary sludge	0	<i>Ascaris spp.</i>	19
			<i>Trichuris spp.</i>	6
			<i>Toxocara spp.</i>	2
2.		3	<i>Ascaris spp.</i>	4
			<i>Trichuris spp.</i>	1
			<i>Toxocara spp.</i>	n.d.
3.	5	<i>Ascaris spp.</i>	n.d.	
		<i>Trichuris spp.</i>	n.d.	
		<i>Toxocara spp.</i>	n.d.	
4.	Excess sludge	0	<i>Ascaris spp.</i>	11
			<i>Trichuris spp.</i>	3
			<i>Toxocara spp.</i>	2
5.		2	<i>Ascaris spp.</i>	3
			<i>Trichuris spp.</i>	n.d.
			<i>Toxocara spp.</i>	n.d.
6.		3	<i>Ascaris spp.</i>	n.d.
			<i>Trichuris spp.</i>	n.d.
			<i>Toxocara spp.</i>	n.d.
7.		5	<i>Ascaris spp.</i>	n.d.
			<i>Trichuris spp.</i>	n.d.
			<i>Toxocara spp.</i>	n.d.

Presence of live parasites in sludge from the sewage treatment plant - raw and irradiated).

No (Dose)	Parasite name	Number of parasites
1 "0"	<i>Ascaris spp.</i>	27
	<i>Trichuris spp.</i>	9
	<i>Toxocara spp.</i>	4
2 2 kGy	<i>Ascaris spp.</i>	16
	<i>Trichuris spp.</i>	6
	<i>Toxocara spp.</i>	1
3 4 kGy	<i>Ascaris spp.</i>	7
	<i>Trichuris spp.</i>	2
	<i>Toxocara spp.</i>	nd
4 6 kGy	<i>Ascaris spp.</i>	nd
	<i>Trichuris spp.</i>	nd
	<i>Toxocara spp.</i>	nd

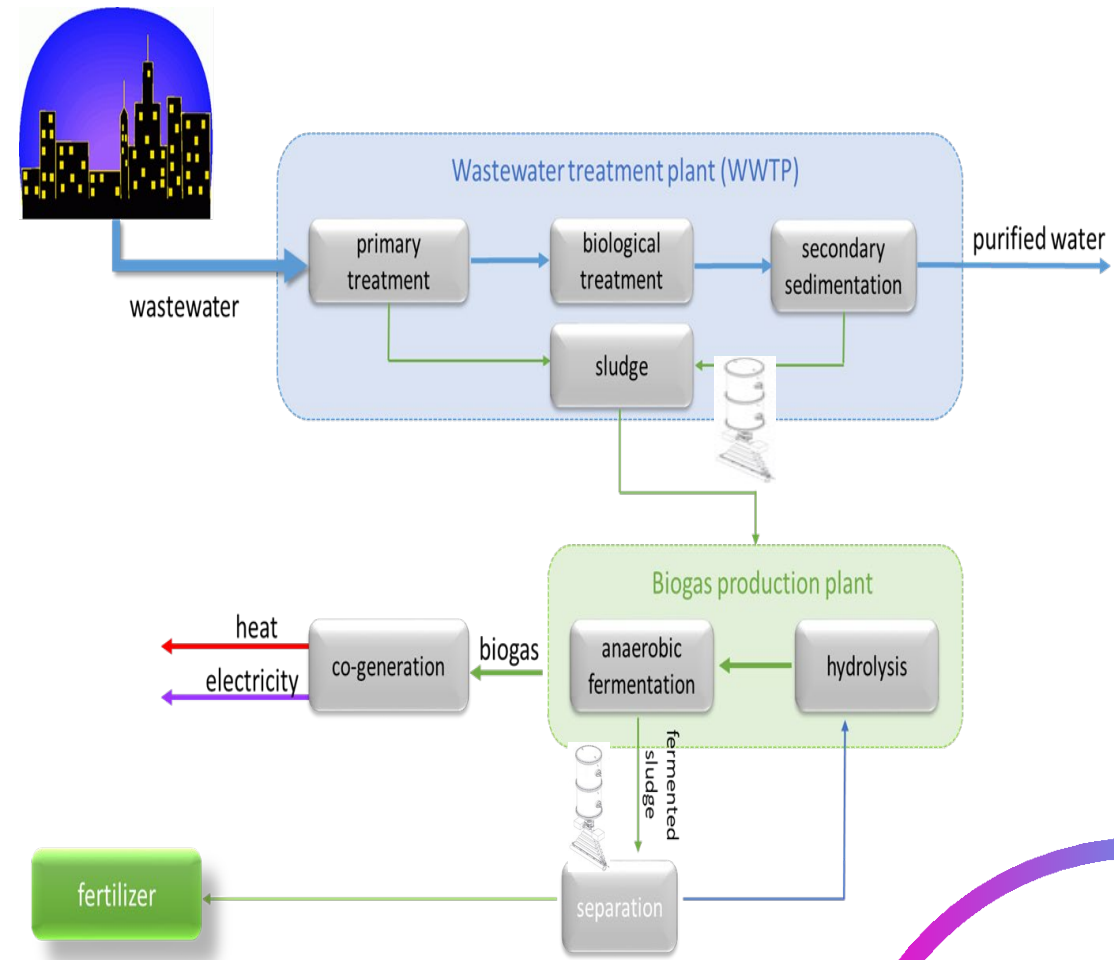
EB Sludge Treatment Systems .



HYBRYD BIOGAS – EB SYSTEM

Advantage of proposed solution:

- ❖ Environmental friendly technology (circular economy)
- ❖ Biogas production is a solution for disposal of problematic wastes
- ❖ Production of renewable power through combined heat and power cogeneration
- ❖ Production of microbiologically safe organic fertilizer due to electron beam hygenization
- ❖ Technology can be applied in any place with sufficient biomass resources while there is no need for external electric energy supply



Economical effects

- Sewage treatment plant with a capacity of 250,000 m³ of sewage (1,500 t d.m.) per year (10,500 inhabitants town),
- additional supply of biogas plant in 325 tons of biomass in the form of grass silage,
- the volume of produced biogas: 730 thousand m³,
- mass of organic fertilizer produced 2,281 t (912.5 tonnes of d.m.).
- **INCOME**
 - Revenue from the sale of fertilizer– 86,000 Euro,
 - savings on the cost of sewage sludge disposal – 168,000 Euro,
 - savings due to lower power consumption – 36,000 Euro.
 - Total benefits: 204,000 Euro/year.

Acknowledgements .

Sludge hygenization research is being developed under NCBiR POIR 04.04-0078/17-00 „BBNawOrg” POIR.04.01.04-00-0078/17 “Zero-energy technology for the manufacturing of biologically safe organic fertilizers based on sewage sludge” and International cooperation financed by European Union’s Horizon 2020 Research and Innovation programme under Grant Agreement No 101004730 - Innovation Fostering in Accelerator Science and Technology (I.FAST)and IAEA CRP RC-22642 and co-financed by ME&S.



Thank you for your attention !



This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.