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Biomethane potential of post-processing liquid from the hydrothermal carbonization of sewage sludge

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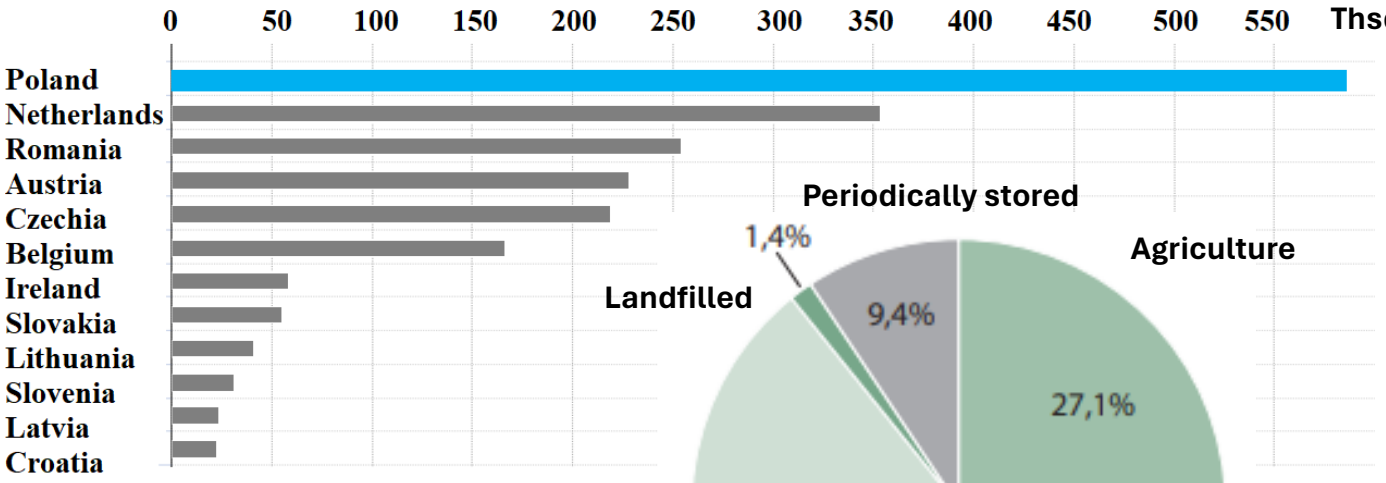
MOTIVATION

Sewage sludge production and disposal from urban wastewater (db)*,***



*EUROSTATE 2021

**STATISTICS POLAND, ENVIRONMENT 2023

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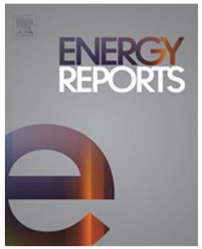
UNFAVOURABLE PROPERTIES SEWAGE SLUDGE

- High content of moisture
- Insufficient dewaterability
- Organic content - biodegradable elements
- Bacteria, viruses, pathogens
- Pharmaceuticals
- Microplastics
- Odorous
- High volume of waste
- Frequently disposed in landfill

PRETREATMENT
CONDITIONING
TREATMENT



Wilk M., Czerwińska K., Śliz M., Imbierowicz M. Hydrothermal carbonization of sewage sludge: Hydrochar properties and processing water treatment by distillation and wet oxidation. Energy Reports 9 (2023) 39–58

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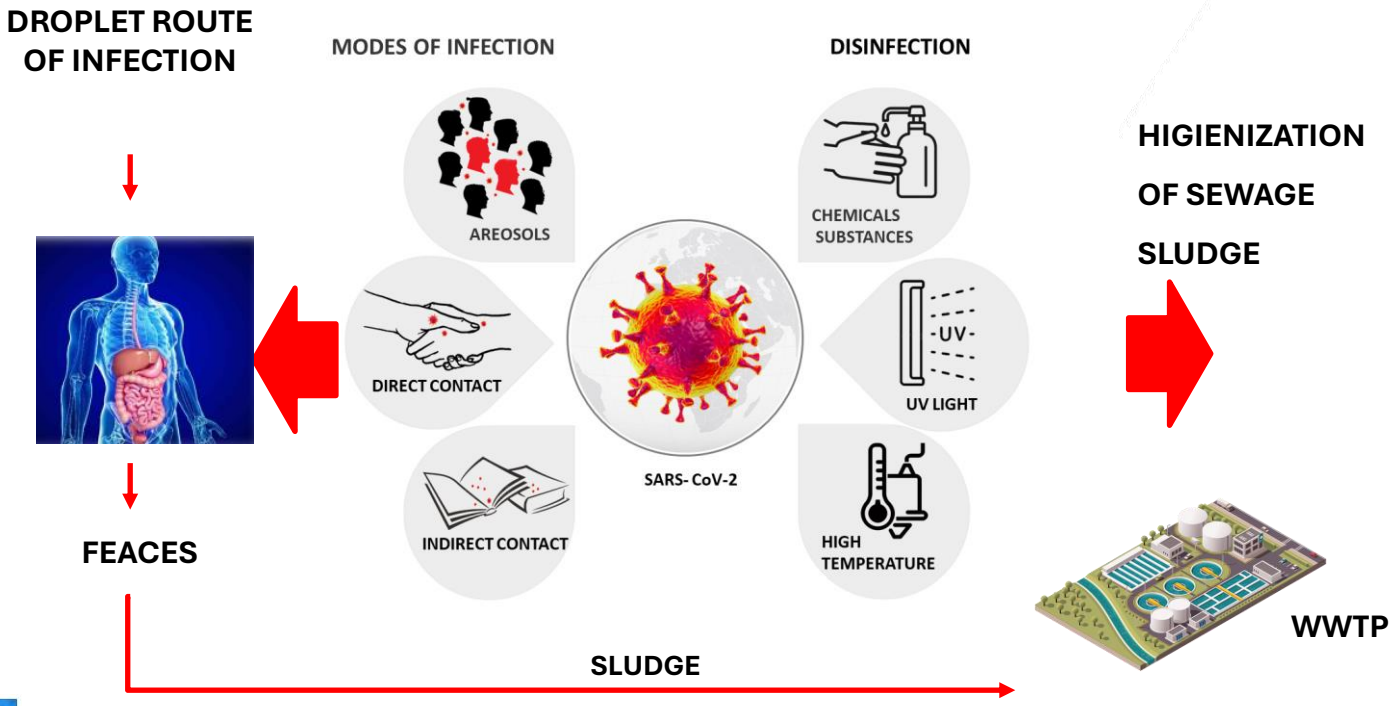
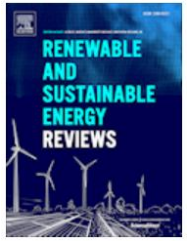
SEWAGE SLUGE as POTENTIAL RISK of SARS-COV-2





Czerwińska K., Śliz M., Wilk M. Hydrothermal carbonization process: Fundamentals. main parameter characteristics and possible applications including an effective method of SARS-CoV-2 mitigation in sewage sludge. A review. Renewable and Sustainable Energy Reviews 154 (2022) 111873

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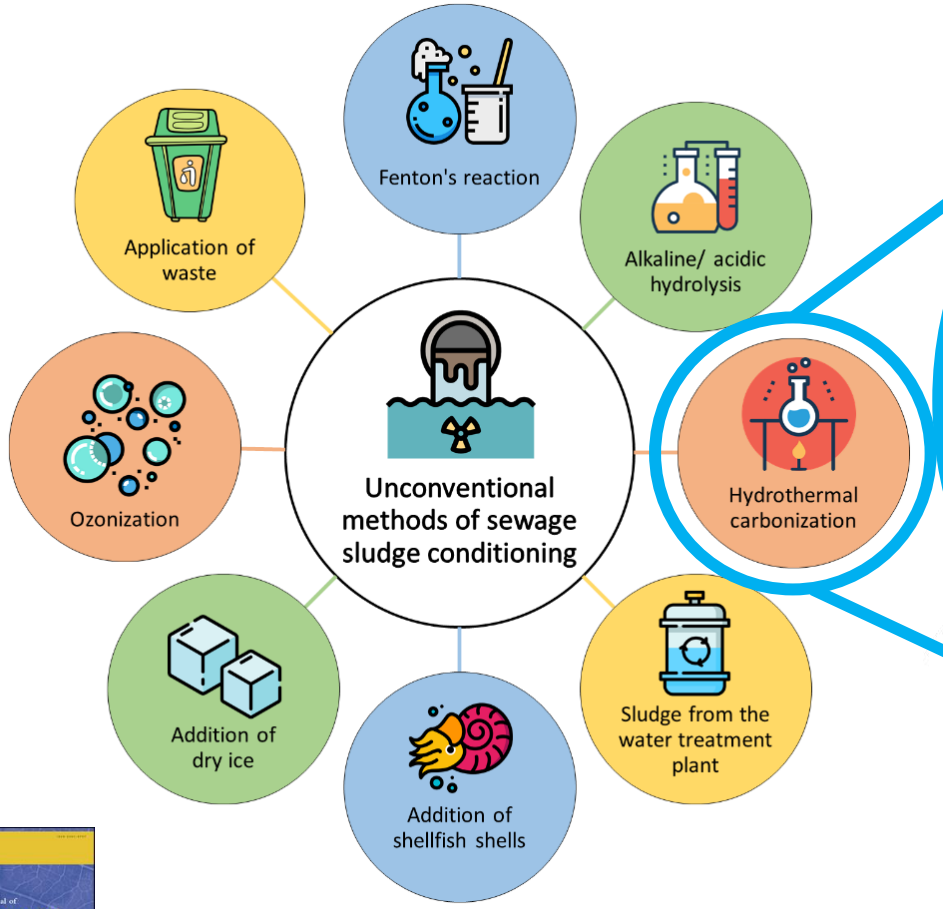
SEWAGE SLUDGE TREATMENTS



IMPROVED PROPERTIES:

- **Dewaterability !!!**
- Disinfection
- Reduction of waste volume
- Biodegradability
- Microplastic removal
- Pharmaceutical removal

Wilk M., Śliz M., Czerwińska K., Śledź M. The effect of an acid catalyst on the hydrothermal carbonization of sewage sludge. Journal of Environmental Management 345 (2023) 118820

HYDROTHERMAL CARBONIZATION PROCESS

SEWAGE SLUDGE

~ 80% moisture

HYDROTHERMAL CARBONIZATION

210 °C, 2 h

Water vapour pressure

Aqueous environment

SLURRY

suspended

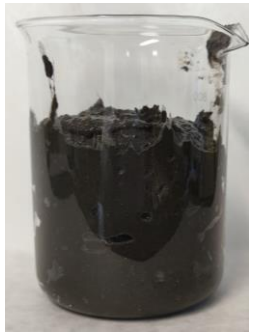
solid HYDROCHAR (3.3 %)

in

POST-PROCESSING LIQUID (92.5%)

+

GAS AND LOSSES (4.2%)



Dewatered sewage sludge pretreated in open digestion chamber from Wastewater Treatment Plant in Lubin, Poland

1 L of volume, Zipperclave Stirred Reactor equiped with MagneDrive, Parker Autoclave Engineers, USA

hydrothermal slurry

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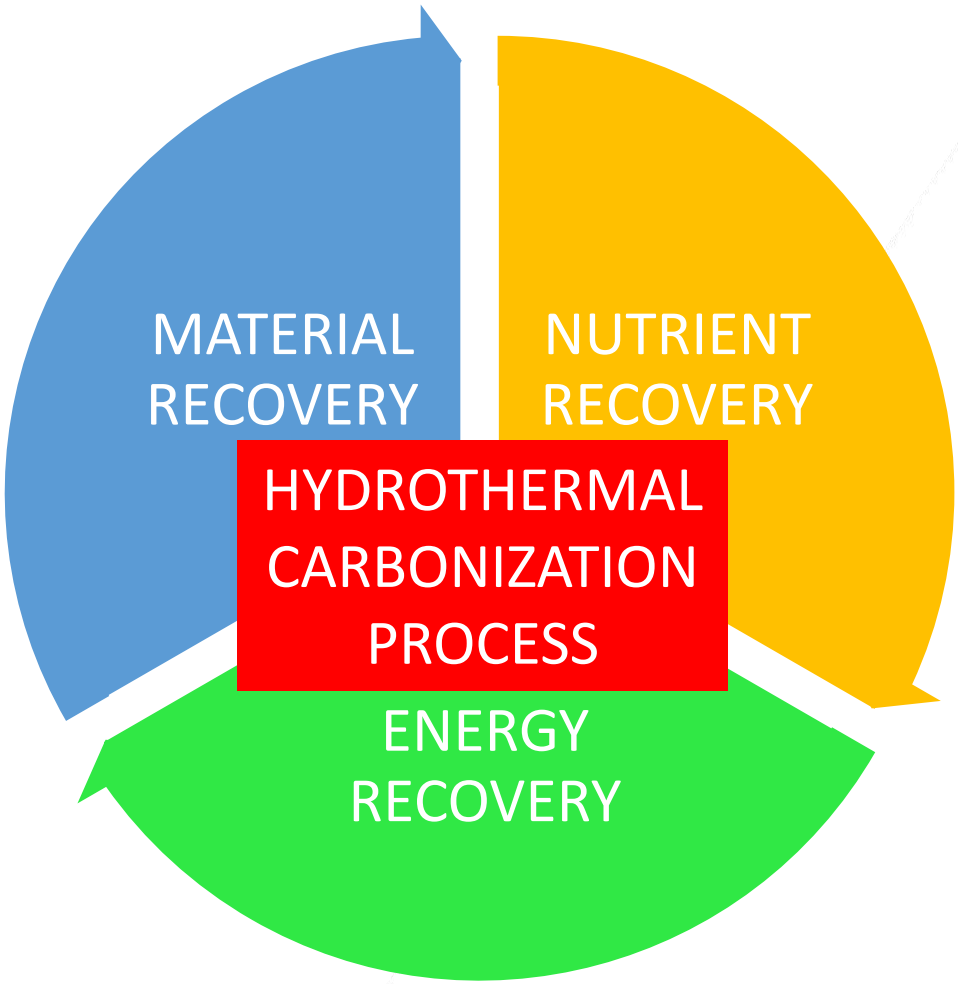
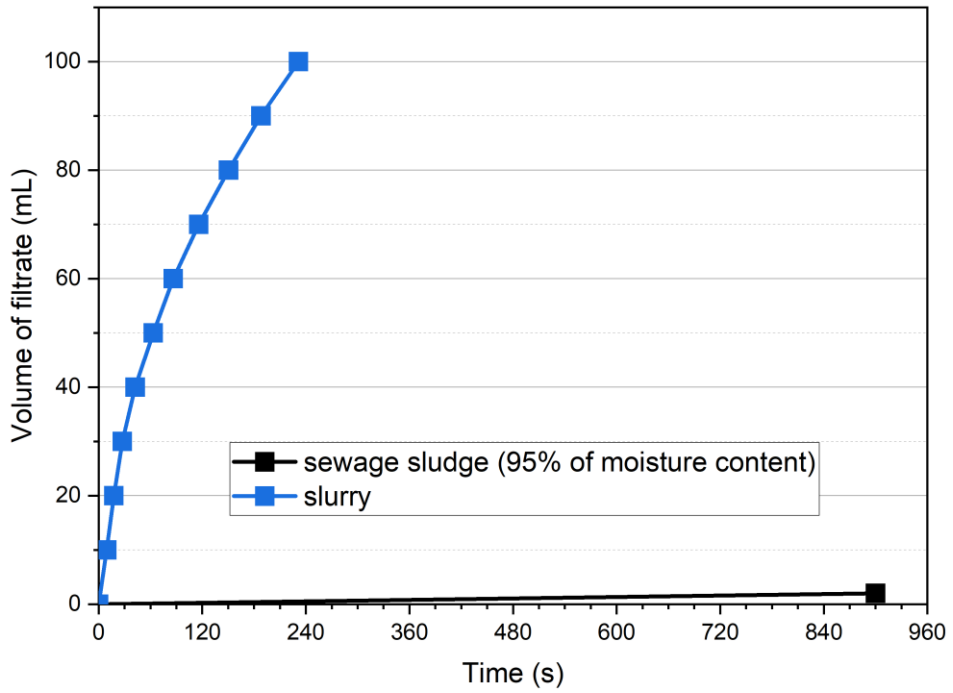
CIRCULAR ECONOMY CONCEPT



DEWATERING



Vaccum filtration process:

- Volume of slurry: 150 mL

I step:

- Fitration under pressure: 4 bar
- Registered time of collected filtrate: every 10 mL

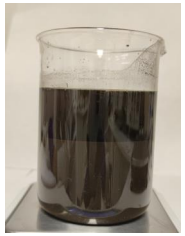
II step:

- Filtration under pressure: 16 bar at 100 mL of collected filtrate

Total volume of filtrate: 130 mL

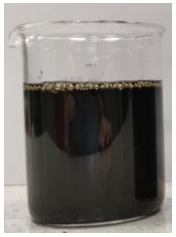
Total time: 6 min 25 s

Filtration cake: 35.4% d.m.



SEPARATION

FILTRATION



Sedimented slurry

Post-processing liquid

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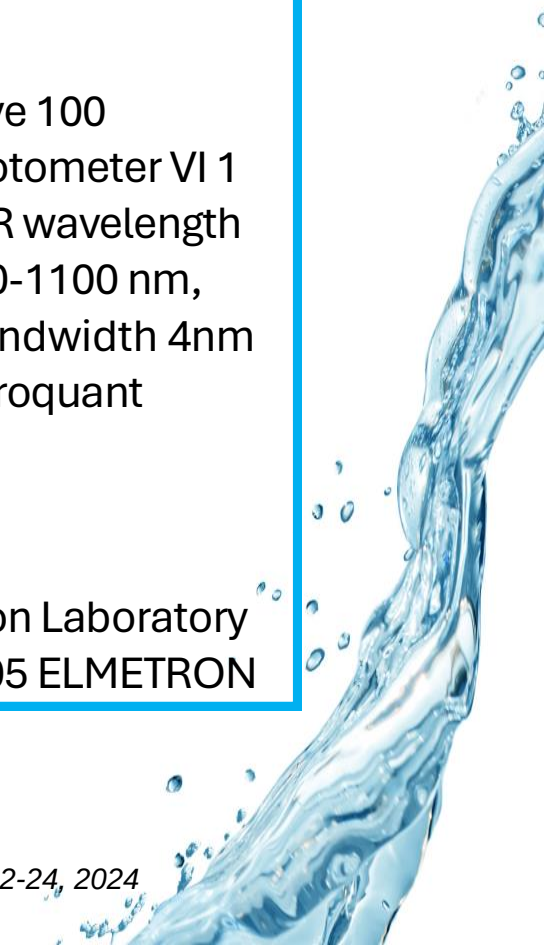
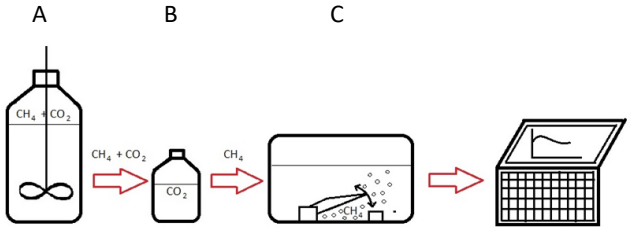
POST-PROCESSING LIQUID CHARACTERISTICS

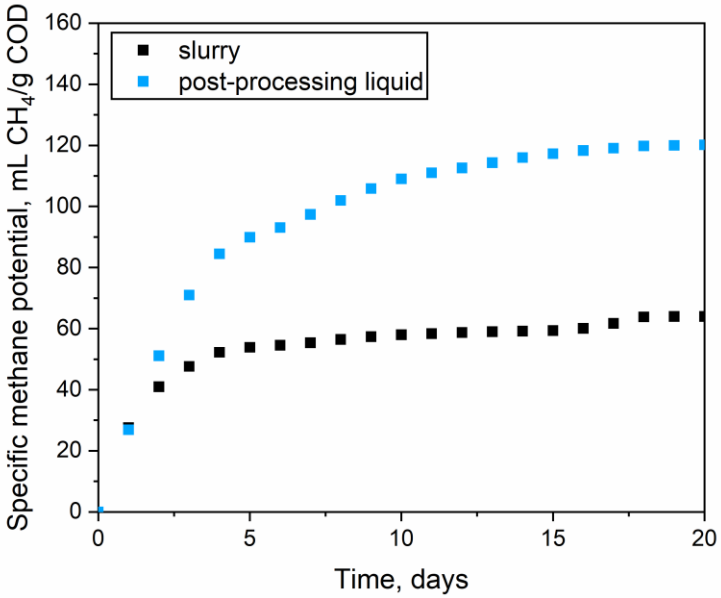
Parameters	Post-processing liquid	Aparatus
COD, mg/L	**28,600**	
TOC, mg/L	**12,800**	
Phenol	101.00	
PO_4-P, mg/L	480	Prove 100
PO_4^{3-}, mg/L	1,460	Spectrophotometer VI 1
P_2O_5, mg/L	1,090	UNIT VIS.BR wavelength
NH_4^+, mg/L	1150	range 320-1100 nm,
Mg, mg/L	315	Spectral bandwidth 4nm
Ca [mg/l]	47.5	Spectroquant
Cl free, mg/L	31.5	
Cl total, mg/L	36.5	
N total, mg/L	2,125	
pH	7.01	Multifunction Laboratory
Conductivity, mS/cm	7.47	Meter CX-505 ELMETRON

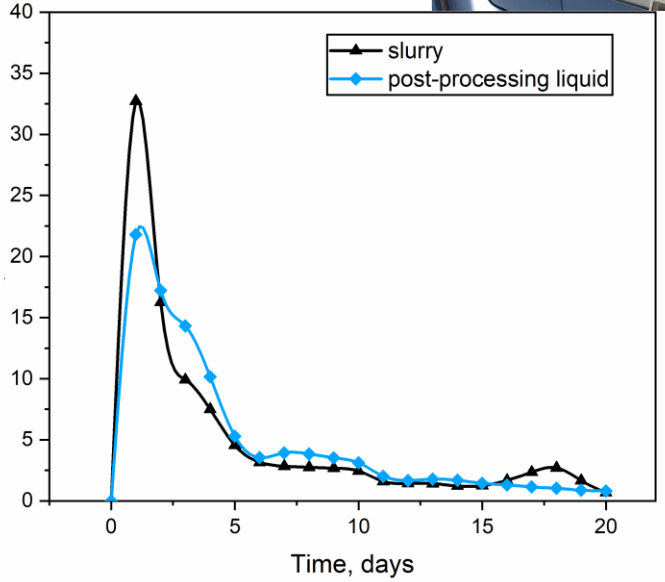


BIOMETHANE POTENTIAL TEST



Automatic Methane Potential Test System Bioprocess Control





	slurry	post-processing liquid
COD, mgO_2/L	62,000	28,600
Methane potential, mL CH_4/gCOD	64	120

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CONCLUSIONS

HYDROTHERMAL CARBONIZATION PROCESS:

- Improves dewaterability of sewage sludge
- Decreases its volume
- Generates slurry of suspended hydrochar in post-processing liquid
- COD level of filtrated post-processing liquid indicates high toxicity
- BMPs of post-processing liquid exhibited higher methane potential
- 80% of methane was produced in first 10 days of BMP test for all samples
- **MEETS A CRITERIA OF CIRCULAR ECONOMY CONCEPT**

THANK YOU FOR YOUR ATTENTION

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