Silesian University of Technology

Use of combustion by-products in construction

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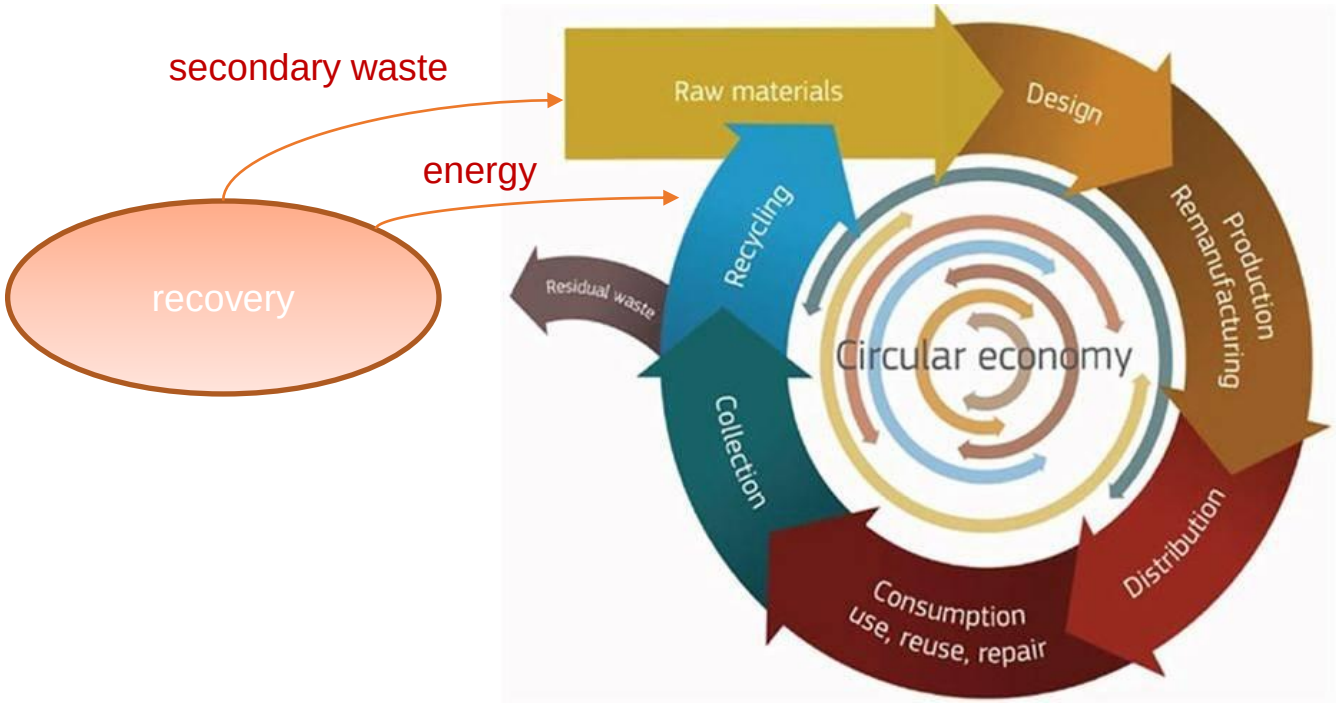
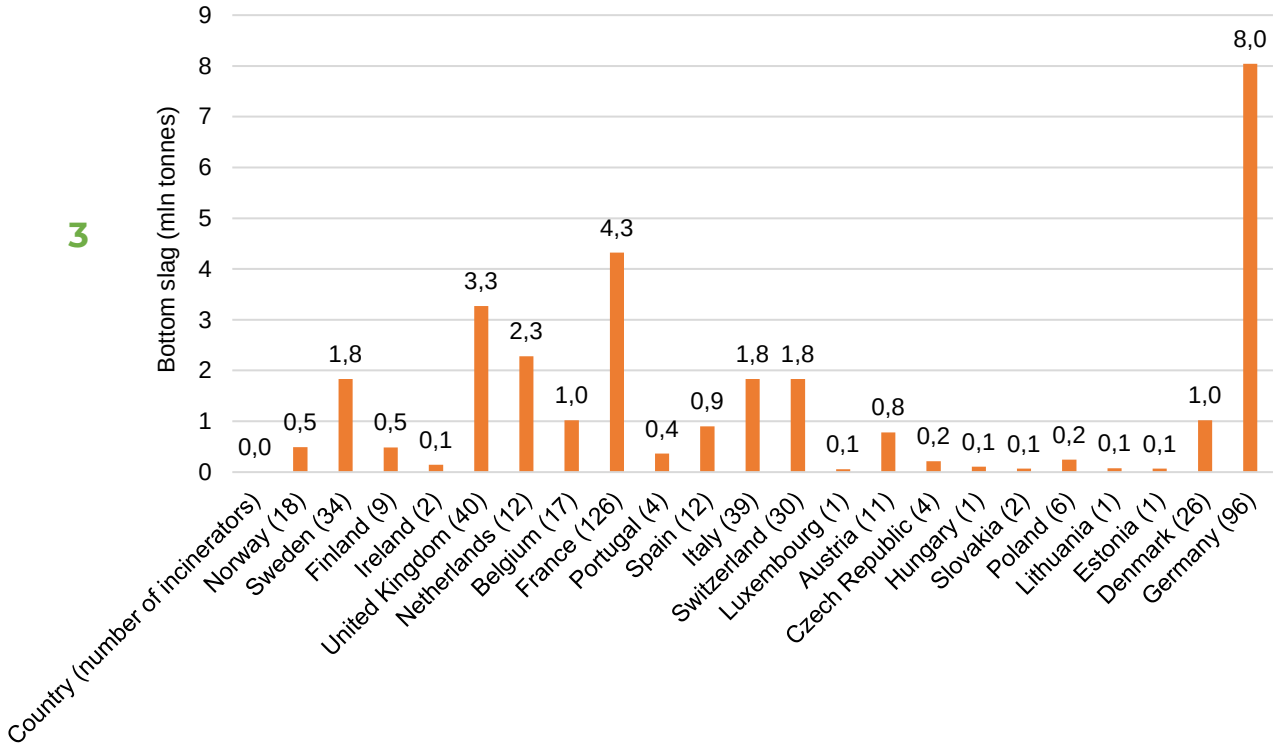
Recovery in circular economy



Incineration plants are also known as waste-to-energy (WTE) plants. The **heat** from the combustion generates superheated steam in boilers, and the steam drives turbogenerators to produce **electricity**.

MSWIP problem



In incineration plants, secondary waste is generated in the amount of **over 30%** of the input.

- **slag 30%,**
- Fly fsh and bottom is **3.6 - 4.2%** (ash 0.5%, fly ash 0.5%, dust from dedusting 2%, products from flue gas treatment 1.2%).

In Europe was created approx **29,4 mln Mg** MSWIP in 2017 from **492 mln Mg** of municipal solid waste.

The biggest Europe's producer of MSWIBA was Germany, which created 8,04 million Mg. In Poland was created 0,24 million tones MSWIBA from 6 incineration plants.

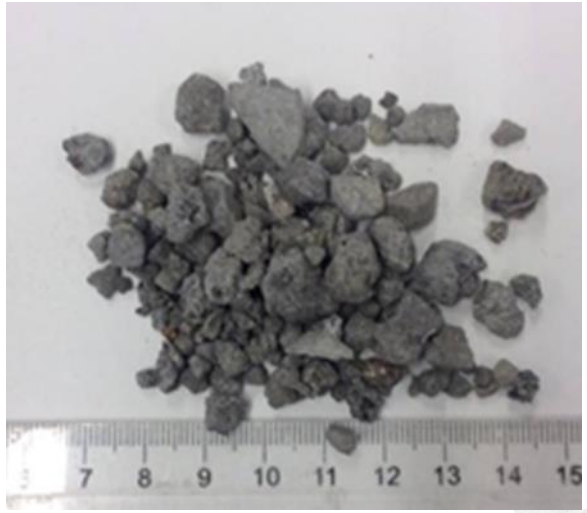
Secondary waste as substitute

Fly ash

Cement

Bottom ash

Cement



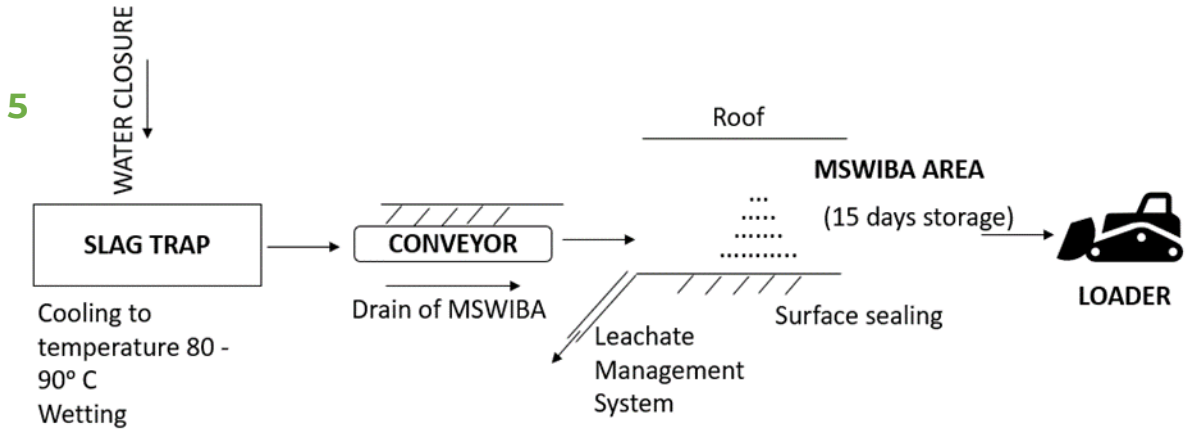
grining

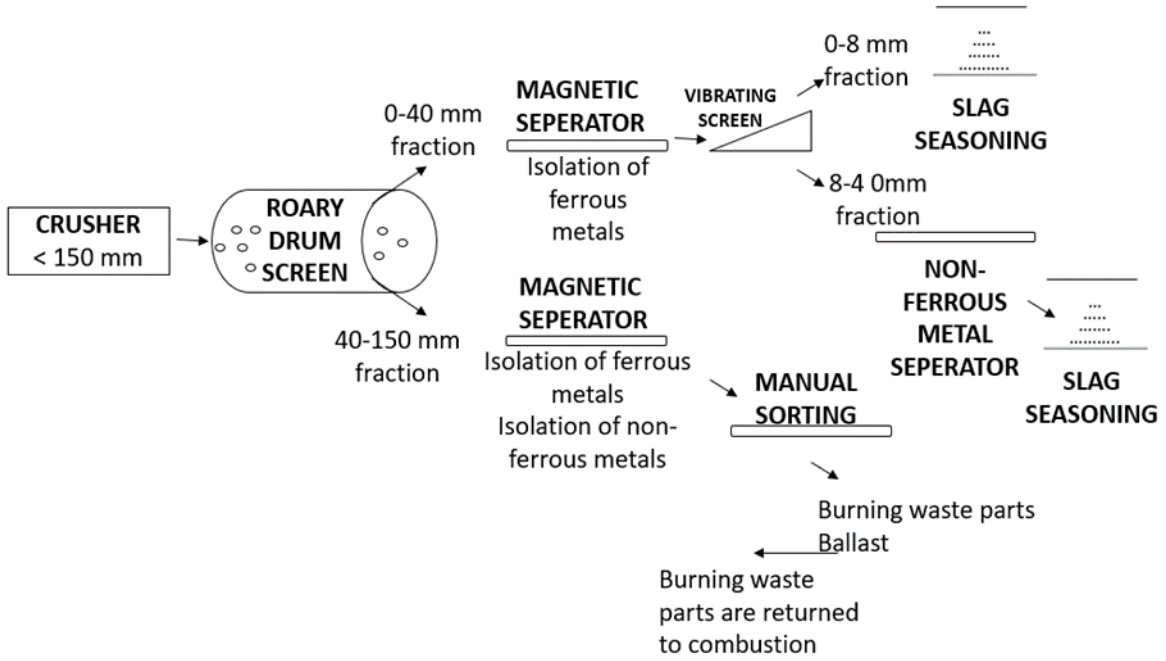
Slag

Aggregate

Cement
or sand

valorization





Current situation

The direct factor determining the selection of the neutralization method (from the point of waste producer) is the unit cost of processing a ton of material.

Stabilization, solidification and storage:

- A mixture of waste, cement, water and stabilizing substances.
- Not very effective solution.
- High-emission - lack of suitable storage facilities in the country - transport.
- Post-operational workings have a specific volume.
- Storage is at the last place in the waste management hierarchy and is not part of the circular economy.
- Rising prices of CO2 emission allowances (increased from EUR 7 per ton at the beginning of 2018 to almost EUR 30 in 2019 - reports rp.pl) - an increase in the price of cement.

Current problems

Leachability:

- Regulation of the Minister of Environment of 18 July 2014 on the conditions to be met when discharging sewage into waters or into the ground, and on substances particularly harmful to the aquatic environment. (**Journal of Laws, item 1800**),
- Ordinance of the Minister of Economy of 16 July 2015 on allowing waste to be stored in landfills. (**Journal of Laws, item 1277**).
- Building mixture swelling.
- Low immobilization of pollutants after basic stabilization and solidification.
- Legal problems, e.g. waste transfer (decisions, permits for waste processing).

Immobilization (challage for scientist)

Immobilization of contaminants is necessary to obtain a product from secondary waste. First of all, secondary waste should be properly prepared, in order to change its parameters. The better the parameters, the greater the mechanical strength of the materials, lower absorbability, and better frost resistance. Different methods of valorization are used to achieve better parameters of waste:

- valorization, cementation,
- bituminization,
- vitrification,
- alkali pre-treatment (NaOH, CaOH2, Na2SiO3 + NaOH, Na2CO3 + NaOH pre-treatment),
- solidification, stabilization,
- others technologies (Synrock, Geodur),
- creation geopolymers.

NaOH (alkali pre-treatment)

Leaching of heavy metals from MSWIBA after NaOH pre-treatment.

	As	Ba	Cr	Cu	Pb	Ni	Se	Zn
2 week NaOH treated	60,00%	92,23%	>99%	96,85%	>99%	70,98%	70,00%	98,52%
3-h NaOH treated	50,00%	85,92%	>99%	94,49%	>99%	45,08%	72,50%	94,39%

Possibilities – new concrete mix

Create a concrete mix:
Probable small share of hazardous waste (approx. 5%) in the basic mixture.
A relatively expensive process that will only become more expensive - mainly due to cement (e.g. CO2 emission allowances),
The use of natural resources - aggregate, sand.

Development in terms of increasing the share of waste:
Need to compact the matrix structure (w / c ratio - the smaller the better)
Adequate pH (mobility of heavy metals)
The use of additives and admixtures
Chemical activation ("pre-treatment"): The use of relatively cheap reagents, the need to "rinse" the reagent, it works best for slag, ashes tend to clump.
Solving the problem of swelling (not always).

Possibilities – geopolymer, zeolite

Creation of a geopolymer:
No or traces of cement,
Activator based on sodium or potassium,
It can be combined with the degassing process in principle, but it has to be rinsed with water,
Relatively new materials on the market.
Expertise knowledge to prevent swelling.

Creation of zeolite:
- Hydrothermal method (relatively simple): 80-200 ℃, ash-base ratio, pressure, temperature, time.
Problem with obtaining zeolite phases.

LCA

Without closing the loop	With closing the loop
Chemicals and energy use	Chemicals and Energy use (it depends on method)
Emissions of heavy metals to soil	Saving resources
Emissions of heavy metals to water	Circular economy
Storage	Save money
Cost of utilization + CO2	Better quality of product (Compressive Strength and Flexural Strength)
Cost of transport + CO2	Reducing the amount of CO2

market

- Dialogue with residents regarding planned investments
- New technologies - the possibility of obtaining funds for the construction or expansion and modernization of the existing infrastructure
- Possibility of technology development and "closing" other wastes in the construction mixture.

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Thank you

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