Comparative analysis of the industrial dust efficiency use as a filler in building composite materials

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Relevance

- Lack of complex use of raw materials at the enterprises of metallurgy, thermal power engineering, etc.
- Significant disposal costs due to heavy metals and other pollutants in industrial dusts
- Accumulation of large-tonnage waste from gas cleaning enterprises
- The need to dispose of large-tonnage industrial waste from energy, metallurgy, MSW incineration

Existing dust recycling solutions

- Extraction of metals by magnetic, electrical separation and leaching

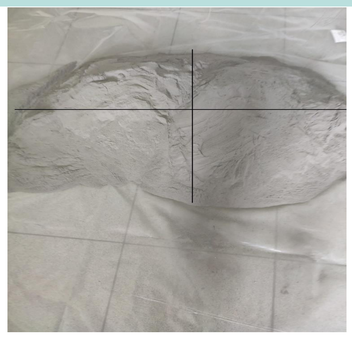
Problems: use of chemicals; extraction of a small amount of compounds - most for disposal; questionable economy

- Production of building materials: cement, concrete, ceramics, road construction, technogenic soil

Problems: emissions of heavy metals and other pollutants into the environment

Suggested Solution

The development of new polymer compositions using dispersed wastes from various industries as fillers is one of the main modern trends in the development of the production of structural and building materials.



Goal

- Study of technologies for the utilization of fine industrial dusts in building materials with minimal impact on the environment

Benefits

- Reduction in the need for polymers - saving resources and reducing economic costs
- Improvement of the mechanical characteristics of polymer compositions
- Competitive composite materials
- Minimization of negative anthropogenic impact

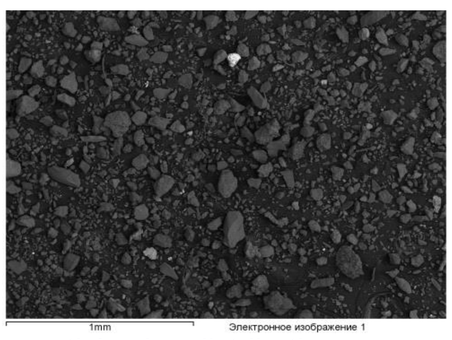
Research

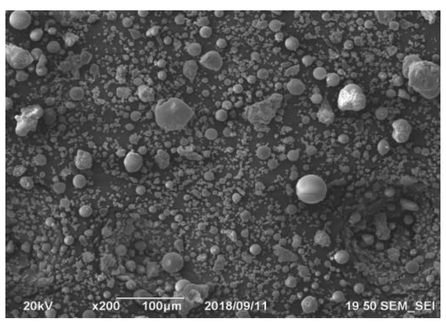
The following wastes were used as a filler:

- Dust from gas cleaning of refined silicon production (silicon dust)
- Ash and slag mixture from heat-power plant (coil ash and slag)
- Dust from the aspiration system of an enterprise for processing slag from the incineration of municipal waste (dust of MSWI)

Main researched characteristics

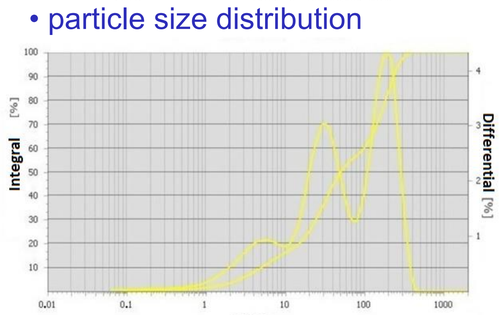
- particle shape

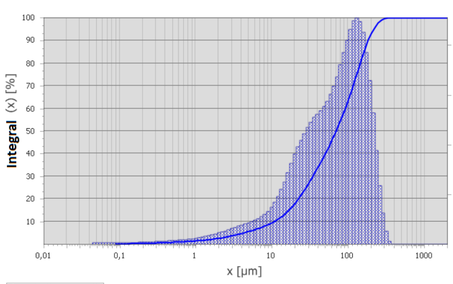


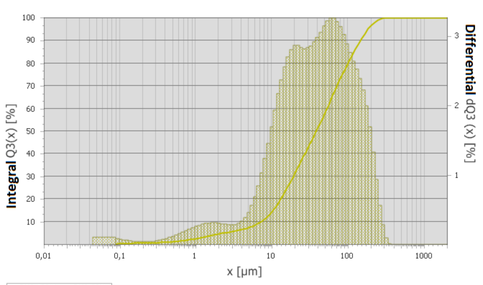


- bulk and true density

- particle size distribution







- particle packing density
- specific surface area of particles
- chemical composition

Indicators of dispersed fillers

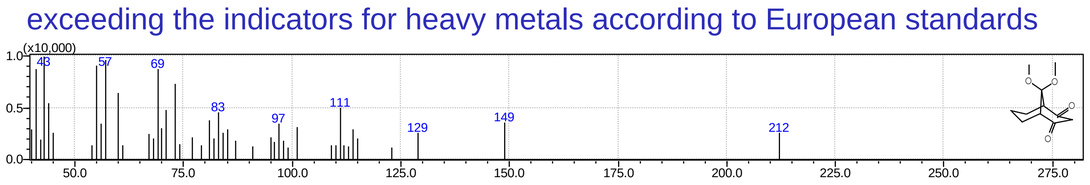
Indicator	Type of filler			
	Silicon dust	Ash and slag coal CHP	Dust from MSW incineration	Calcium carbonate*
Mass average diameter, $D_w \cdot 10^{-6}$, m	99,2	55,057	67,551	93,7
Bulk density, ρ_{bulk}, kg/m^3	710	813	1085	575
Solid density, ρ_{solid}, kg/m^3	2650	2000	2306	2200
Shape factor, K	6	6	9	6
Specific surface area, S_{sp}, m^2/kg	189	592,108	441,298	565
Estimated ultimate packing of filler particles, φ_m	0,48	0,256	0,471	0,48

* For comparison

An analysis of all the necessary properties of the studied waste confirms the fundamental possibility of their use for the production of polymer composites.

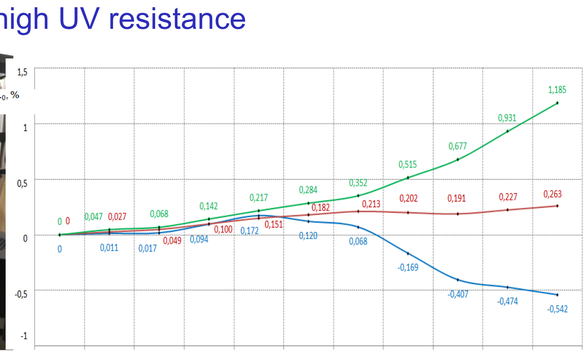
Chemical analysis

- Silicon dust and ash and slag from thermal power plants - no toxic components were found
- Dust aspiration from the processing of slag from MSW incineration showed exceeding the indicators for heavy metals according to European standards



Tests

- Tests have shown a significant advantage of the developed composite in terms of strength properties, compared with the analogue material, wood-polymer composite
- The material does not spread flame and is self-extinguishing.
- Virtually zero water absorption and high UV resistance



Fabrication and study of composite samples Manufacturing technologies

extrusion

injection molding

Resulting composites

Conclusions

- Dust from silicon production and ash and slag waste from coal combustion can be used as a filler for the polymer composition.
- The content of heavy metals in aspiration dust from the processing of waste incineration slag is important, however, when it is used in a polymer composite, it will be in a bound state, which will make it possible to conserve heavy metals - further research is needed.

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