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EVALUATING THE POTENTIAL FOR COMBUSTION OF FUELS FROM SEWAGE SLUDGE IN GRATE FURNACES

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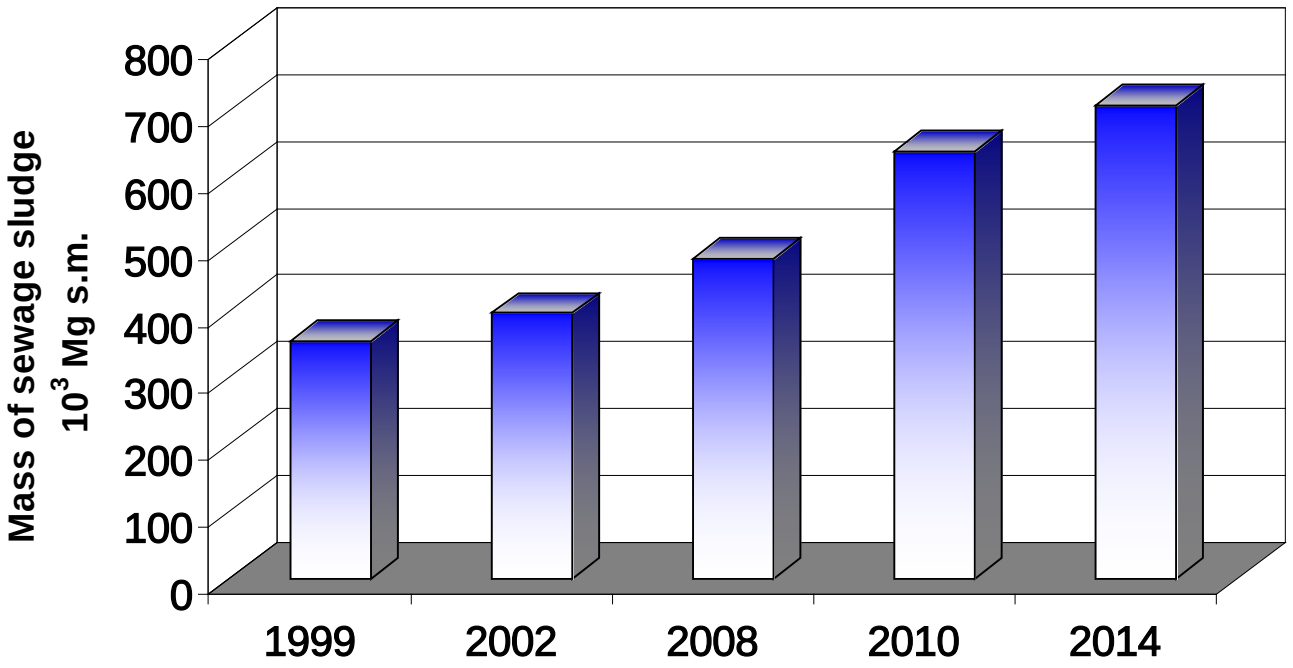
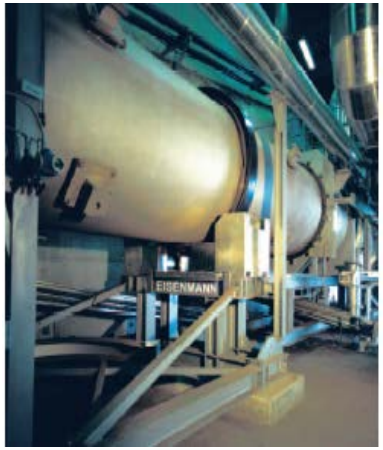
Wastewater treatment plants

Mass of sewage sludge in Poland



Utilization of sewage sludge

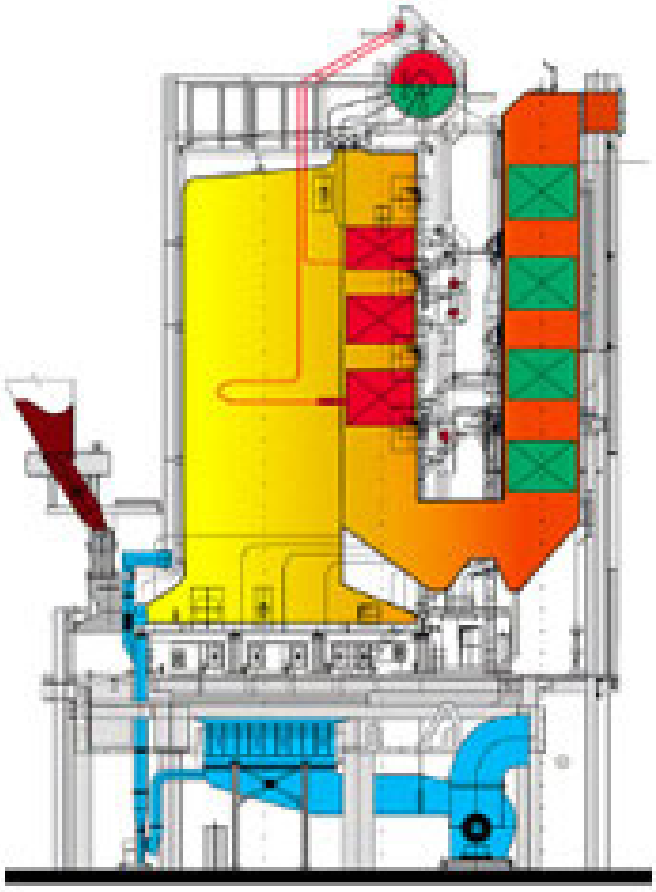
- Landfilling
- Agriculture application
- Thermal utilization



Incineration plants

Co-combustion processes

Boilers with grate furnace

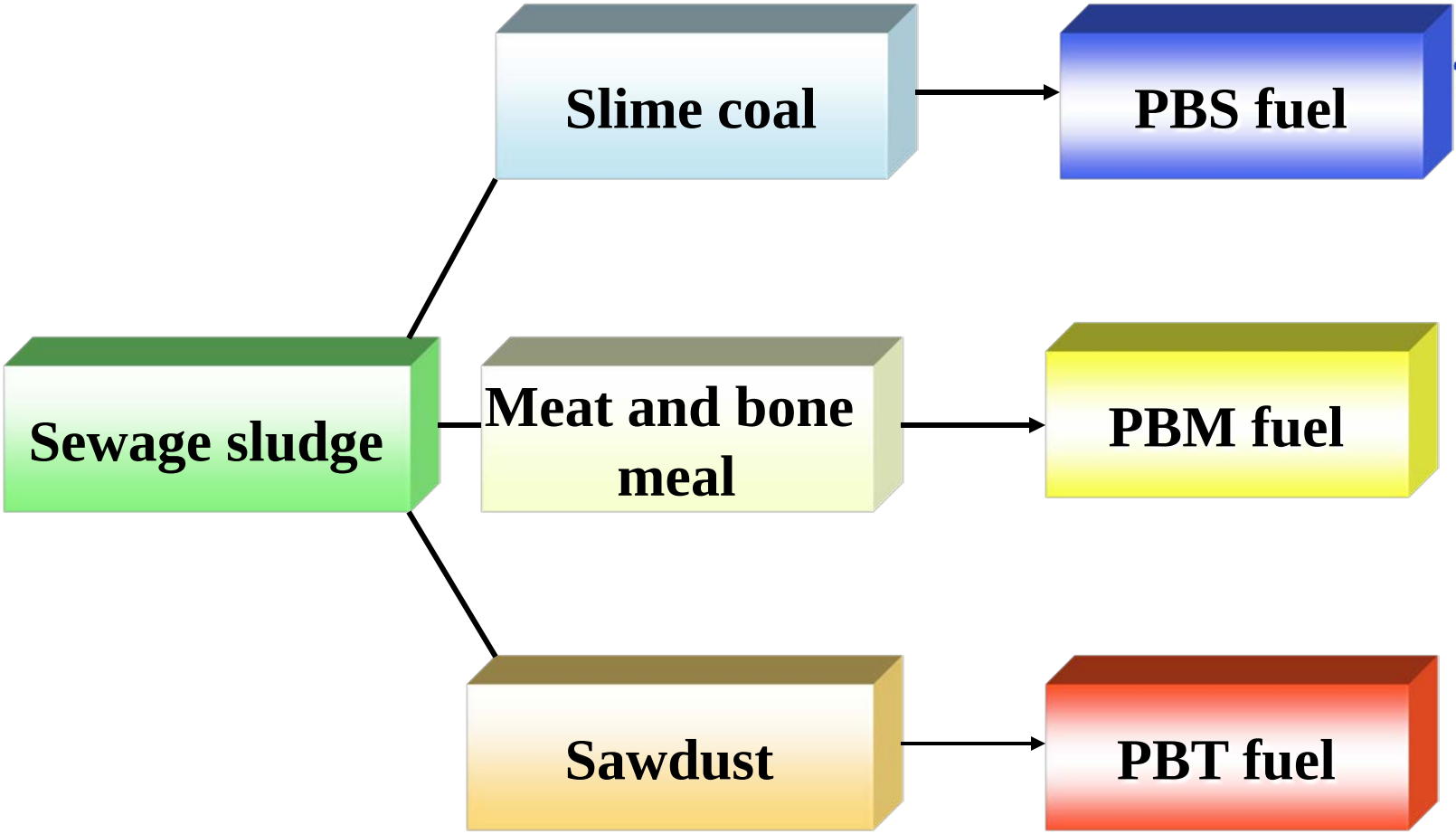


Requirements specified by power industry

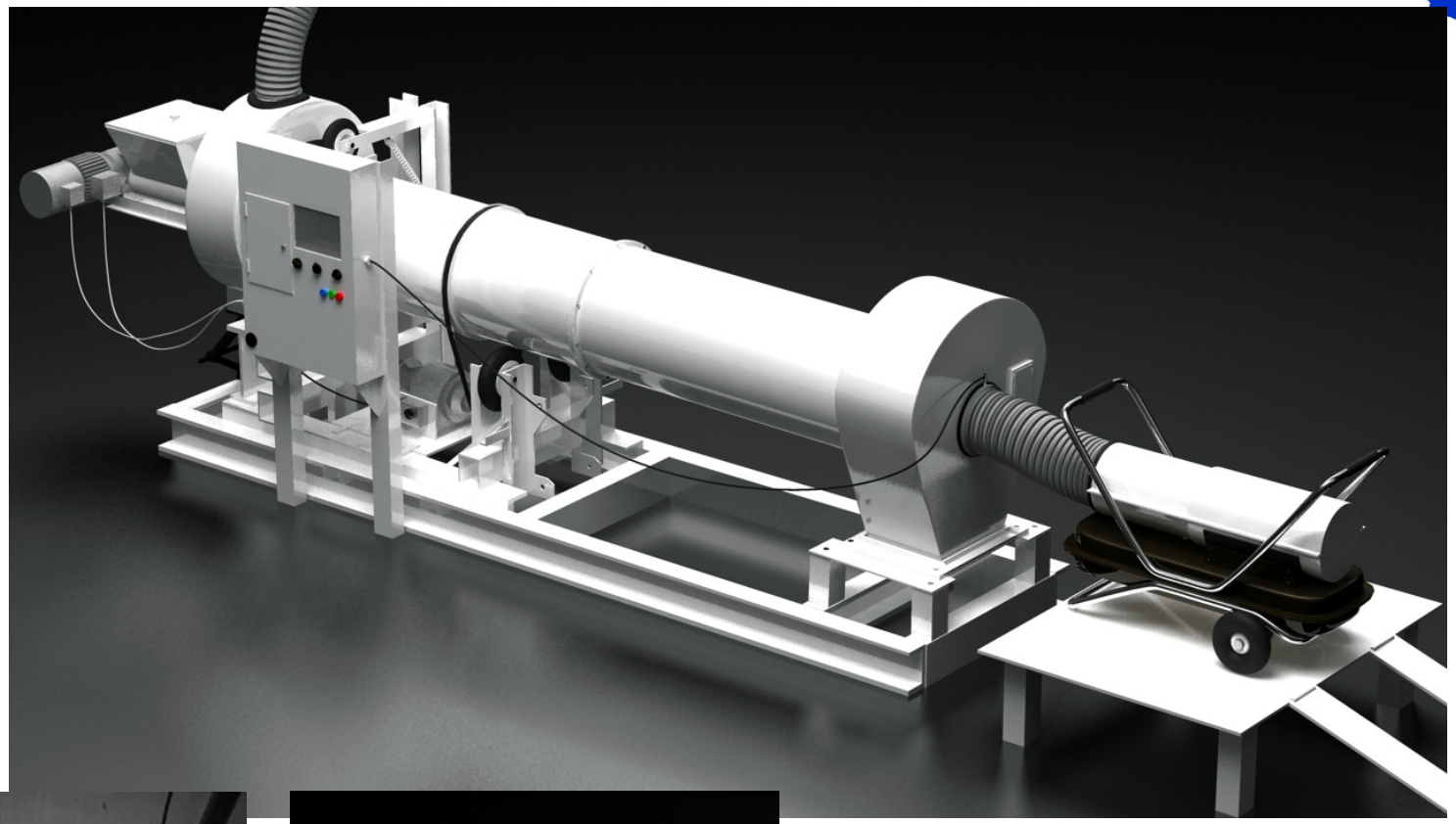
- Stable energy parameters such as HHV, content of sulphur and chlorine,
- Uniform in size and bulk density determined individually for each type of boiler systems,
- No metal contaminants and minerals damaging the grinding and dosing systems.

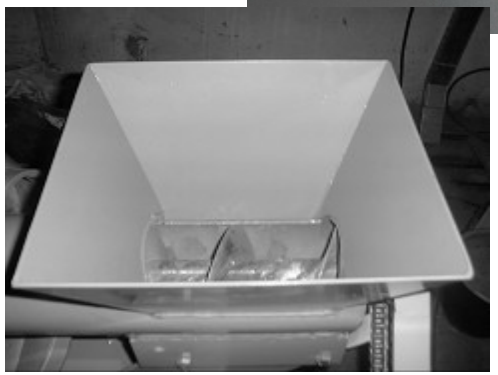
Fuels from waste

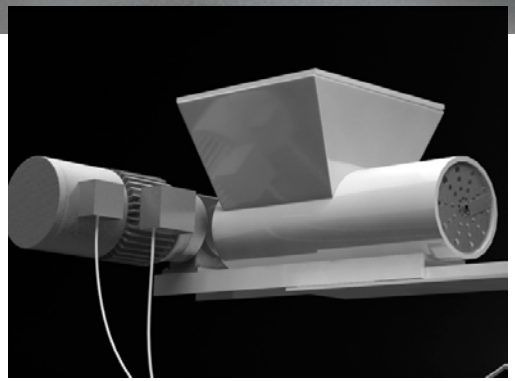
Fuels based on sewage sludge



Drum granulator







PBS fuel

PBM fuel

PBT fuel

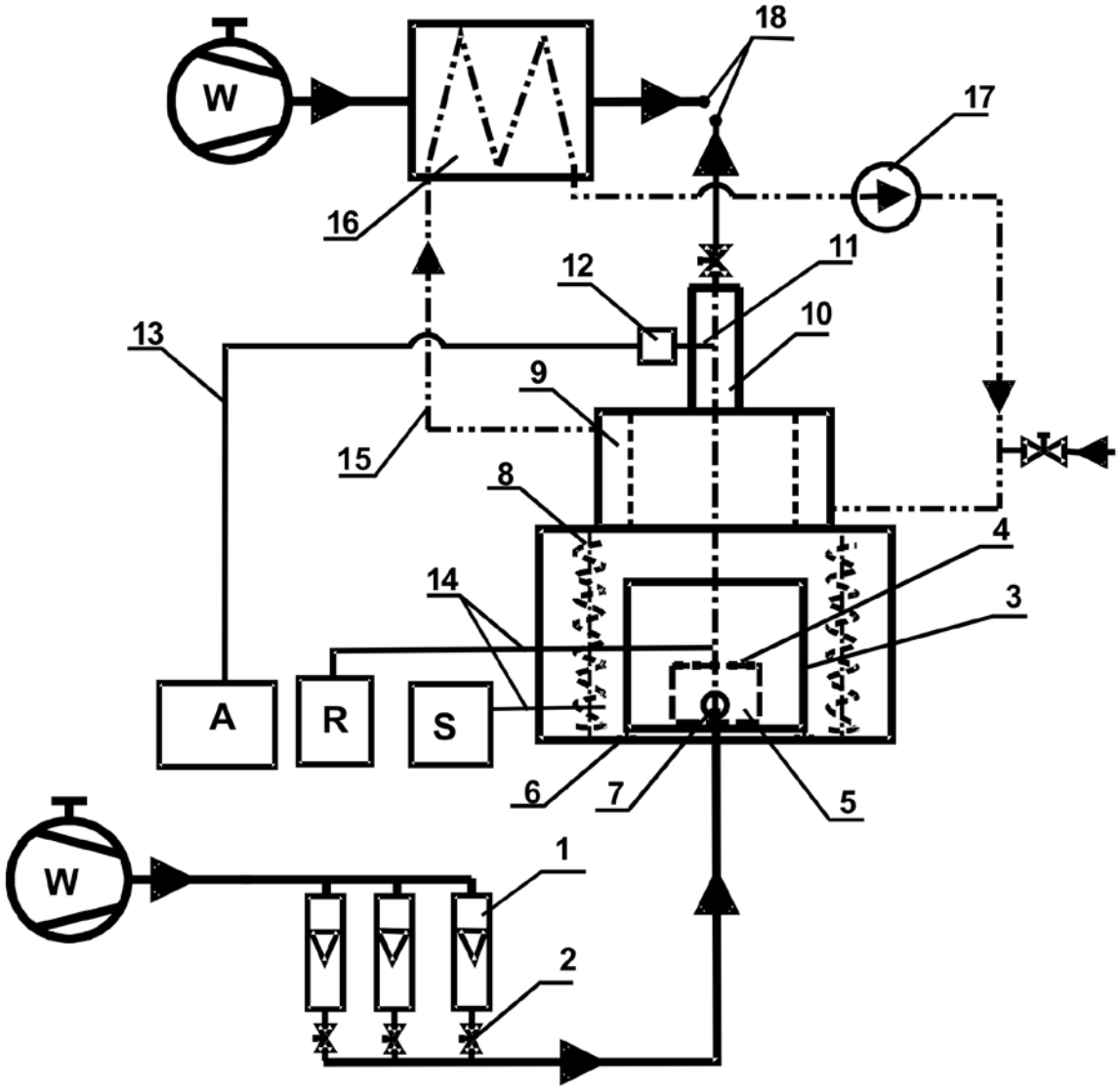
Energy characteristics of fuels from sewage sludge

Parameter	Unit	PBS fuel	PBM fuel	PBT fuel	Hard coal
LHV	MJ/kg	19.30	14.59	13.23	23.7 – 26.9
HHV	MJ/kg	21.71	15.97	15.54	26.0 – 28.3
Water	%	8.58	8.67	10.37	5.0 – 10.0
Volatile matter	% d.m.	34.44	55.29	59.87	25.0 – 40.0
Ash	% d.m.	27.26	33.72	20.36	8.5 – 11.3
Elementary analysis					
C	% d.m.	50.28	36.64	31.42	76.0 – 87.0
H		3.91	4.12	4.43	3.5 – 5.0
O		15.01	17.95	40.50	2.6 – 12.8
N		1.72	6.67	2.61	0.8 – 1.5
S		1.16	0.68	0.65	0.5 – 3.1
Cl		0.06	0.02	0.03	<0.10

Materials and Methods

Fuels from sewages sludge with grain sizes: **35 mm and 15 mm** where tested in order to evaluate the effect of grain size on the combustion process and emission of pollutants.

Test stand



A – flue gas analyser,
S – furnace control system,
R – recorder,
W – ventilator,
1– rotameter,
2 – valve,
3 –reciprocal bed with a grate,
4 – grate,
5 – plenum system (ash pit),
6 – rail, 7 – air nozzle,
8 – heating element (electrical),
9 – water jacket,
10 – stack,
11 – measuring probe,
12 – probe head,
13 – heated hose,
14 – thermo elements with compensating cables,
15 – cooling water circuit,
16 – water/air heat exchanger (cooler),
17 – circulation pump,
18 – ambience

Materials and Methods

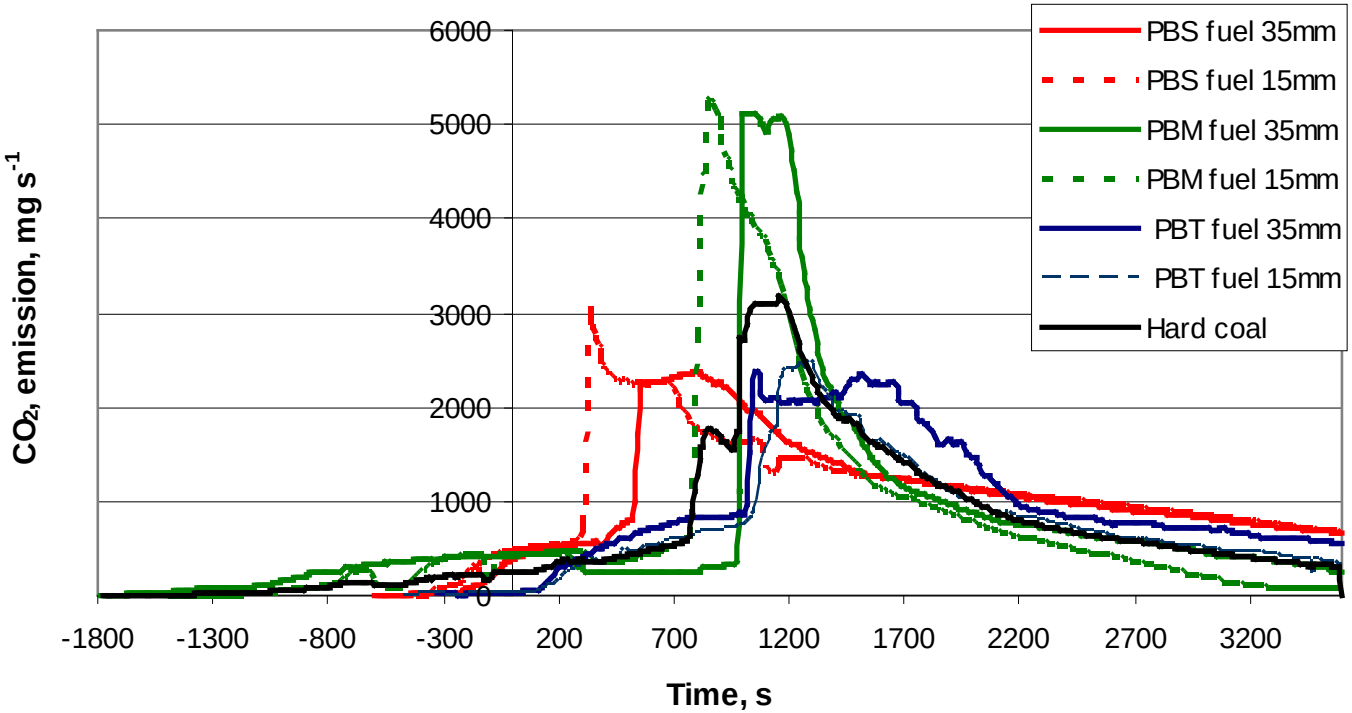
System operating parameters:

- thickness of the bed of fuel being burnt – ca. 75 mm (each time 2.5 kg sample was burnt);
- process duration – 3600 s from starting fuel feeding to the combustion chamber;
- air excess ratio in the furnace chamber λ=1.8;
- secondary air stream – 5 $Nm^3\ h^{-1}$;
- initial temperature in the combustion chamber – 900°C $\pm$ 10K;
- minimum temperature during the combustion process – 800°C.

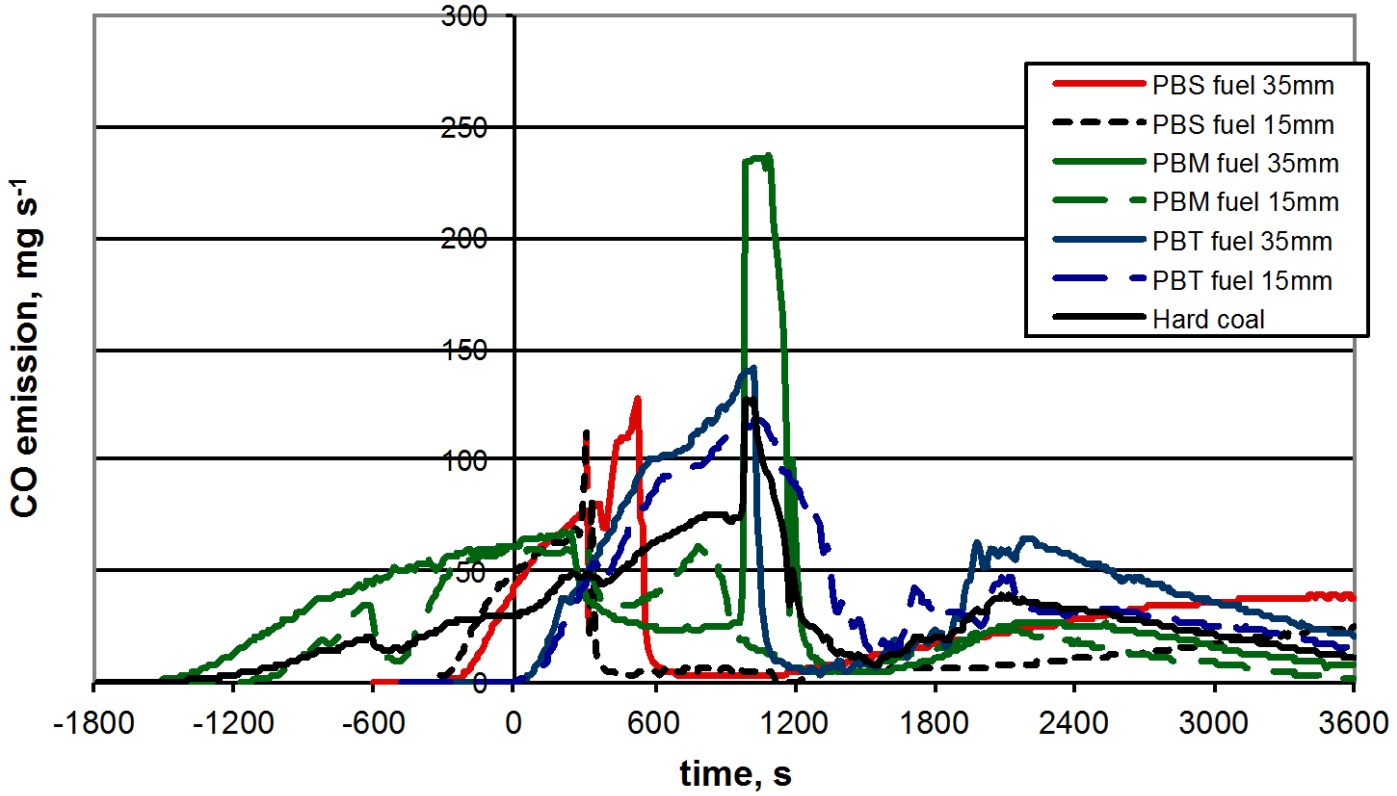
Measurement of flue gas composition (MGA 5 MRU flue gas analyser):

- CO_2 and CO emission,
- NO emission,
- NO_2emission,
- SO_2 emission.

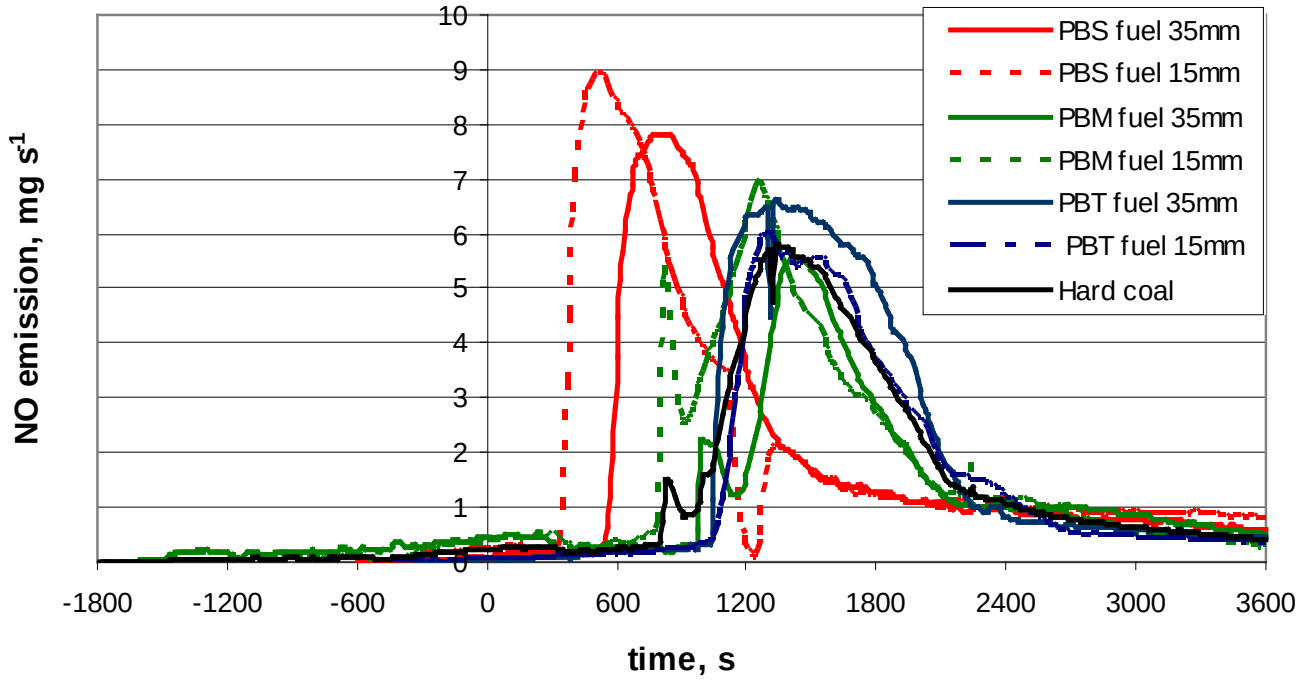
Variations of CO_2 emissions during combustion of fuels



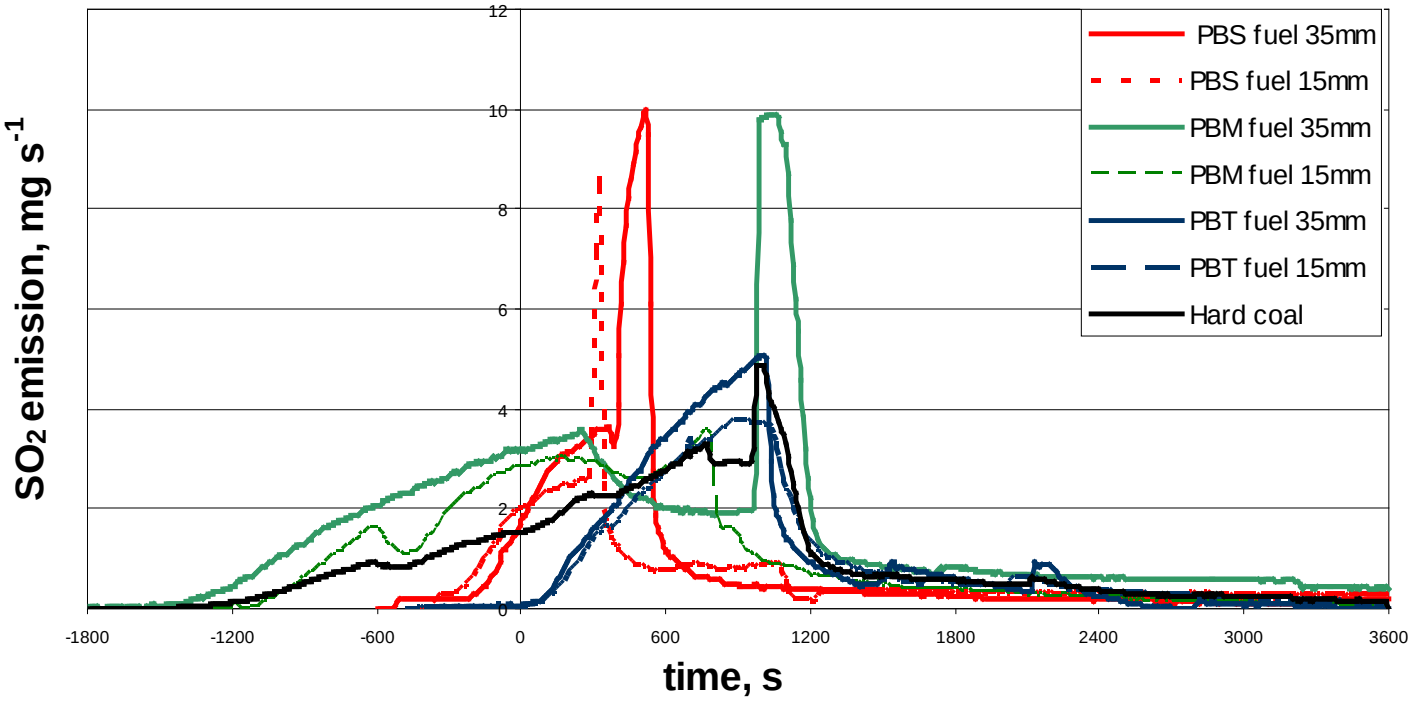
Variations of CO emissions during combustion of fuels



Variations of NO emissions during combustion of fuels



Variations of SO_2 emissions during combustion of fuels



Combustible matter content in slag and ash from sewage sludge fuels

Fuel type		Combustible matter content, %
PBS fuel	35 mm	2.61
	15 mm	1.60
PBM fuel	35 mm	2.80
	15 mm	1.30
PBT fuel	35 mm	1.43
	15 mm	1.49

Ash and slag from PBS fuel - size 15 mm

Analysis of water extracts from the residues after combustion of sewage sludge fuels

Parameter	Unit	PBM fuel	PBM fuel	PBT fuel	Limit value[a]
pH	-	9.60	9.80	9.00	-
Phosphates	mg PO_4 dm^{-3}	<0.03	<0.03	<0.03	-
Chlorides	mg Cl dm^{-3}	699.5	216	585	800
Sulphides	mg SO_4 dm^{-3}	960	553	994	1000
As	mg dm^{-3}	0.10	0.10	0.10	0.5
Cr		0.43	0.28	0.32	0.5
Zn		0.10	0.10	0.10	4.0
Cd		0.01	0.01	0.01	0.04
Cu		0.10	0.10	0.10	2.0
Pb		0.10	0.10	0.10	0.5
Hg		0.01	0.01	0.01	0.01
Se		0.30	0.30	0.30	0.1
Fe		0.01	0.14	0.47	-
Mn		0.10	0.10	0.10	-
Ba		0.33	10.0	14.0	20
B		0.30	0.30	0.30	-

[a] – limit values for substance leaching according to Annex 3 of the Regulation of the Minister of Economy and Labour on the criteria and procedures for referring waste deposition on neutral waste landfill

Conclusions

- Grain size composition of the sludge fuels is close to that of pea coal and adjusted to the grate firing process.
- While combustion of the sewage sludge transformed into granulated fuel, typical problems of co-combustion of dried sludge with coal can be avoided.
- To sum up, it can be concluded that the tests performed showed some difference of the process of burning sewage sludge fuels as compared to hard coal.
- Momentary emission of CO_2, NO and SO_2 while combustion of fuels with the same composition, differing as to the grain size is similar. A noticeable difference between both particle sizes was the reduced ignition time and reduced emission of CO for fuels with smaller particles (15 mm).
- Unfortunately, as in the case of co-combustion of dried sludge, the problem of NOx emission still remains. However, while burning sludge fuels with coal, reducing the emission of nitrogen compounds can be expected, and the NOx emission will limit the share of sewage sludge fuels in the mixture being burnt.
- It can be concluded that the test performed proved the potential of utilising sewage sludge fuels in co-combustion processes with coal in grate furnaces.

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THANK YOU FOR YOUR ATTANTION