BRNO UNIVERSITY OF TECHNOLOGY
FACULTY OF CIVIL ENGINEERING

AdMaS®

AdMaS Research Centre
Faculty of Civil Engineering
Brno University of Technology
Czech Republic

Energy Efficiency of Dry Sewage Sludge before and after Low-temperature Microwave Pyrolysis

Ing. Jakub Raček, Ph.D.

6th International Conference on Sustainable Solid Waste Management, Naxos Island, Greece, 13–16 June 2018

Outline:

1. Introduction: legislation, MP technology, products;

2. Materials and Methods: MP unit, samples of sewage sludge;

3. Results and discussion: combustion tests;

4. Summarizing discussion: summary;

5. Conclusion: current state of Research;

6. Implementation: CMPUD.

AdMaS

1. Introduction

- Disposal of the sewage sludge (SS) is one of the important issues in EU, CR of waste management;
- disposal of SS is managed by landfilling, agricultural use and incinerations;
- landfilling is not supported by EU and direct agriculture application is limited;
- search for new ways of waste recycling and energy gain by incineration and thermal treatment of SS.

AdMaS

1. Introduction

- Thermal treatment: torrefaction, gasification and pyrolysis;
- pyrolysis of SS is one of the most significant challenges in WW treatment;
- content of HM, xenobiotics, micropollutants, microplastics present a hazard for direct agricultural use;
- based on the literature, the incineration and pyrolysis of SS seems to be a current suitable solution for WWTPs.

AdMaS

2. Materials and Methods of MP

- Laboratory (1 kg/batch) and full-scale tests (10 kg/batch) of low temperature slow microwave pyrolysis of sewage sludge were performed at AdMaS;
- the device works discontinuously, microwave generator of 3 kW power at the frequency 2.45 GHz, low pressure (800 hPa);
- level of microwave radiation depends (electromagnetic field) on the material itself, it is related to its composition, the content of dielectric components.

AdMaS

2. Materials and Methods of MP

- Dried sewage sludge from one WWTP from different time period (SS1, SS2);
- the products yields of SS by MP process:

- biochar yield - 86.5 %;
- pyrolysis oil - 7.8 %;
- pyrolysis gas - 5.7 %.

AdMaS

2. Materials and Methods of MP

- The combustion tests (SS, BC) were carried out according to the Czech standard ČSN EN ISO 1716 (7300883);
- the energy efficiency of samples was measured by semi-automatic device (IKA C 200) at standard laboratory conditions;
- small doses (0.4-0.8 g) were prepared for measurement of energy efficiency.

AdMaS

3. Results and discussion

- Energy efficiency in raw SS (SS1, SS2) before MP process:

Description			The energy efficiency ($MJ.kg^{-1}$)	
			Value	Average value
Laboratory MP unit	SS1	Dose 1	13.86	13.85
			13.86	
			13.83	
Small full-scale MP unit	SS2	Dose 2	12.14	12.15
			12.12	
			12.20	

AdMaS

3. Results and discussion

- Energy in biochar after MP process:

Description			The energy efficiency (MJ.kg^{-1})	
			Value	Average value
Laboratory MP unit	BC1	Dose 3	14.92	16.73
			15.05	
			15.02	
		Dose 4	16.59	
			16.49	
			16.41	
		Dose 5	18.88	
			18.58	
			18.67	
Small full-scale MP unit	BC2	Dose 6	13.22	13.20
			13.47	
			12.92	

AdMaS

4. Summarizing discussion

- SS1 = 13.85 MJ.kg^{-1} and BC1 = 16.73 MJ.kg^{-1}
- SS2 = 12.15 MJ.kg^{-1} and BC2 = 13.20 MJ.kg^{-1}
- combustion tests carried out by laboratory MP unit higher energy 2.88 MJ.kg^{-1} than before MP process;
- tests curried out by small full-scale unit higher energy 1.05 MJ.kg^{-1} after MP and its value closer to simulation real conditions at WWTP.

AdMaS

5. Conclusion

- The combustion tests of dried SS and biochar were carried out by the lab. and full-scale unit;
- due to legislation regulation of landfilling and agricultural use (with HM fixation) many owners and operators of WWTPs consider incineration as an immediate solution of SS disposal.

AdMaS

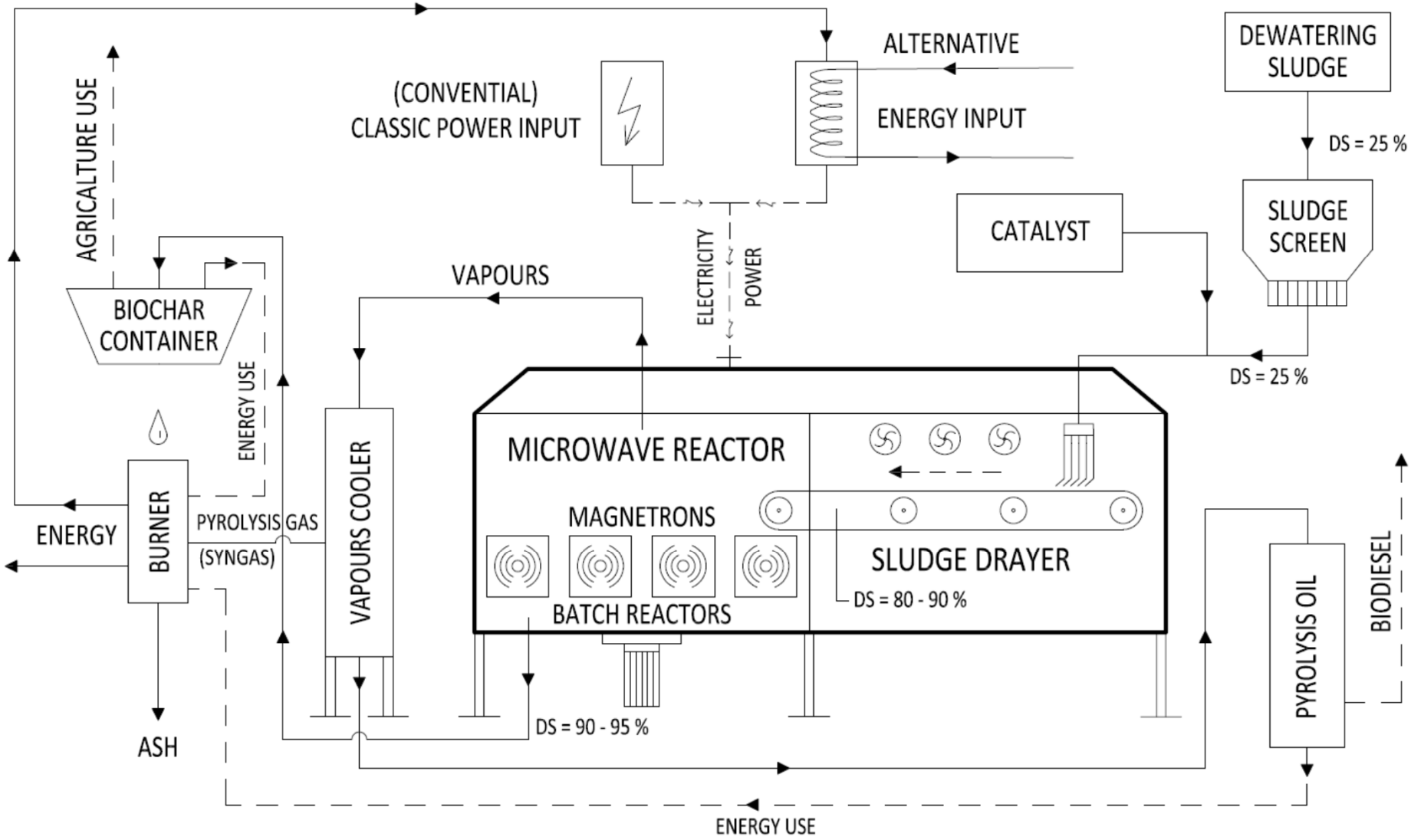
6. Implementation

- Based on the literature and our research, the compact MP unit with dryer (CMPUD) of SS was designed for energy efficiency and other use;
- we propose the implementation of this device by 3 stages at the WWTPs:

1) construction of SS dryer;
2) construction of CMPUD;
3) construction of biochar silo.

AdMaS

The scheme of the compact MP unit with dryer of SS (CMPUD)



AdMaS

6. Implementation

- Designed device CMPUD seems to be an acceptable solution;
- MP can be considered as suitable available technologies for eco-friendly disposal of SS for energy efficiency and agricultural use.

Energy Efficiency of Dry Sewage Sludge before and after Low-temperature Microwave Pyrolysis

Thank you for your attention

Questions???