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Direct injection mass spectrometry technique to monitor the removal of biogas trace compounds: biochar and ashes

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1. Introduction

Biogas from organic waste treatment could be used for the distributed energy production systems. SOFCs could be plausible due to high efficiency and reliability values. One of the main drawbacks concern the trace compounds impact. Waste derived materials as wood biochar and wood ashes could be adopted for the trace compounds removal. Their performance are monitored online with a PTR-ToF-MS instrument.

2. Material and methods

Organic fraction (OF) of municipal solid waste MSW was adopted as organic source to produce biogas with an anaerobic digester (AD) pilot plant located at FEM[1,2,3]. Table 1 summarizes the composition and physicochemical characteristics of the OFSMW batch used.

Table 1. Dry anaerobic digestion recipe.

	Mass	Water	Vol Sol	pH	
	(t)	(%)	(%)	in	off
Diges.	6.67	61.6	55.3	8.7	
OF + Wood	5.34	59.5	82	5.8	
Mix	12.0	58.8	59.8	7.8	8.3

Ashes from a forestry wood-chips boiler (3.3 MW, Viessman, Allendorf Germany) were tested in a glass reactor filter of 340 ml. Biochar from the pyrolysis of wood was produced by Gruppo RM Impianti srl. (Italy), in a 200 kWe reactor at lower temperature 150 °C. The experimental set-up is described in figure 1.

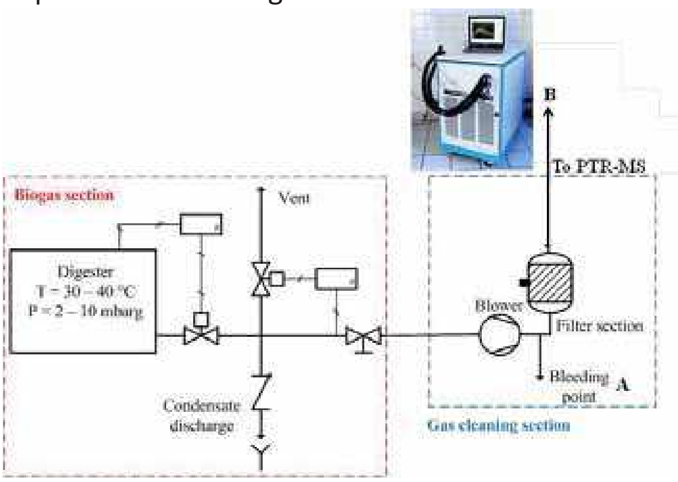

Figure 1. Biogas to gas cleaning section.

The pilot plant is equipped with pressure controller, automatic valves, a blower to increase the biogas pressure up to 80 mbar and a glass filter section. The PTR-MS adopted is described elsewhere [4,5].

3. Results

The study shows that char from the pyrolysis of wood waste is more promising for the trace compounds removal than using ashes as sorbent material. Ashes prove to be too dense, with an active surface area of 1 m^2/g for the trace compounds removal compared to biochar. The active surface area and the microporous volume appear to be more important than the elemental composition for the removal performance. In the following tables are reported the adsorption capacity for the most important trace compounds detected.

Table 2. Adsorption capacity - Biochar.

CH_2O	H_2S	C_2H_4O	C_2H_6O	CH_4S	C_3H_6O	CH_3COOH
1.46	3.4	0.13	0.06	0.15	28.2	0.22
C_2H_6S	C_5H_8	C_4H_8O	C_3H_8S	C_6H_6	$C_4H_8O_2$	$C_4H_{10}S$
0.11	4.3	272.01	0.76	0.71	0.81	13.35
C_7H_8	C_8H_8	C_8H_{10}	C_9H_{12}	$C_{10}H_{14}$	$C_{10}H_{16}$	$C_6H_{18}O_3Si_3$
433.83	0.9	0.35	1.25	97.6	101.6	13.15

Table 3. Adsorption capacity - Ash.

CH_2O	H_2S	C_2H_4O	C_2H_6O	CH_4S	C_3H_6O	CH_3COOH
0.001	0.014	0.007	0.015	0.001	0.033	0.001
C_2H_6S	C_5H_8	C_4H_8O	C_3H_8S	C_6H_6	$C_4H_8O_2$	$C_4H_{10}S$
0.001	0.01	0.207	0.001	0.001	0	0.045
C7H8	C_8H_8	C_8H_{10}	C_9H_{12}	$C_{10}H_{14}$	$C_{10}H_{16}$	$C_6H_{18}O_3Si_3$
0.311	0.001	0.008	0.003	0.23	0.242	0

The adsorption capacity, for example of H_2S using biochar shows a value around 3.39 mg/g and 0.014 mg/g using ashes.

4. Conclusions

The biogas coming from the AD of OFMSW was sent to a gas cleaning section was filled with waste derived materials: biochar and ashes. The best performance is achieved considering biochar as sorbent material. This is due to the structure of the sorbent more than the elemental composition. In fact, elements able to remove trace compounds are contained in larger way in ash sample. The active surface area and microporous volume play a crucial role for the trace compounds removal. Future works are related to the activation procedures for the char in order to compare it with commercial sorbents.

5. References

[1] D. Papurello, C. Soukoulis, E. Schuhfried, L. Cappellin, F. Gasperi, S. Silvestri. Monitoring of volatile compound emissions during dry anaerobic digestion of the Organic Fraction of Municipal Solid Waste by PTR Time-of-Flight Mass Spectrometry, in: Biores. Technol., 2012: pp. 254–265.

[2] D. Papurello, E. Schuhfried, A. Lanzini, A. Romano, L. Cappellin, T.D. Märk. PTR-MS as a rapid inline tool for filter efficiency of activated charcoal in support of the development of Solid Oxide Fuel Cells fueled with biogas, Fuel Proc. Techn. 130 (2015) 78–86.

[3] D. Papurello, E. Schuhfried, A. Lanzini, A. Romano, L. Cappellin, T.D. Märk. Influence of co-vapors on biogas filtration for fuel cells monitored with PTR-MS. Fuel Proc. Techol. 118 (2014) 133–140.

[4] D. Papurello, A. Lanzini, E. Schufried, M. Santarelli, S. Silvestri. PTR-MS as a rapid online tool for biogas VOCs monitoring in support of the development of Solid Oxide Fuel Cells. 6th Int. PTR-MS Conf. 130 (2013) 144–150.

[5] D. Papurello, S. Silvestri, L. Tomasi, I. Belcari, F. Biasioli. Natural gas trace compounds analysis with innovative systems : PTR-ToF-MS and FASTGC, Energy Procedia. 101 (2016) 536–541.