Fraunhofer UMSICHT

THERMO-CATALYTIC REFORMING OF BIOLOGICAL WASTE AND WOODY BIOMASS RESIDUES

Mohamed Elmously[1,3,4] *, Johannes Neidel[1], Andreas Apfelbacher[1], Robert Daschner[1], Andreas Hornung[1,2,3]
[1]Fraunhofer UMSICHT, Institute Branch Sulzbach-Rosenberg, An der Maxhütte 1, D-92237 Sulzbach-Rosenberg, www.umsicht-suro.fraunhofer.de
[2] University of Birmingham, [3]Friedrich-Alexander-University Erlangen-Nuremberg
[3] Friedrich-Alexander University Erlangen-Nürnberg
[4] Faculty of Engineering-mataria branch, Helwan University, Cairo, Egypt

INTRODUCTION

Pyrolysis has a great potential for the conversion of different biomass wastes into bio-fuels and bio-refineries products. The aim of the present work is to investigate the potentials of different categories of biomass waste for bio-fuels production by using the Thermo-catalytic reforming technology (TCR®). The TCR® system is an intermediate pyrolysis unit combined with an additional post-reformer, while the post-reformer is the stage where the produced char acts as a catalyst at high temperatures range. The trails have been carried out with low ash containing feedstocks such as woody biomass, olive waste, spent coffee grounds, and feed materials with high ash content (digestate and sewage sludge).

RESULTS

The results of the TCR® trials reveal that the highest non-condensable gas yield (64wt.%) is achieved with wood pellets followed by the food waste (52-58wt.%). It can be explained by the hemicellulose and cellulose components that lead to produce more of CO and CO_2. In contrary, the high hydrogen concentration is achieved with the biological waste. Regarding the types of the feedstock, the bio-oil obtained from TCR® system has a relative high HHV between 34.4 – 36.8 MJ/kg, and comparing to the fast pyrolysis, the TCR® bio-oil shows less oxygen content lower than 10wt.% and lower acidity. However the high ash content feedstock produce the highest bio-char yields.

CONCLUSION

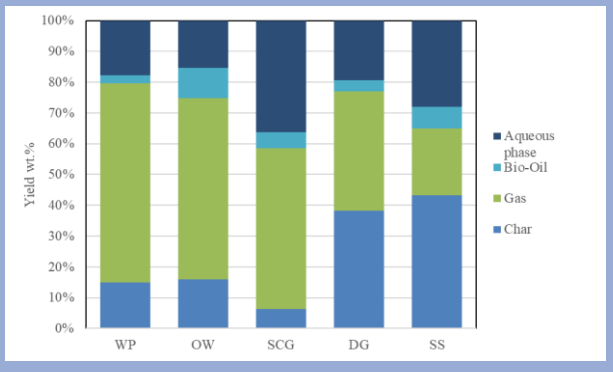
- Thermo-catalytic reforming (TCR®) has a great potential for the conversion of different biomass wastes into high quality bio-oil and clean and rich hydrogen syngas.
- The ash content in the feedstock has a notable influence on the bio-char yield and quality and has low influence on the methane reforming and water gas shifting reactions.
- In general, the products distribution and qualities are depend on the ash content and the initial organic compounds in the feedstocks.
- Unique value proposition of TCR® liquid and gaseous products.

Oil		Wood Pellets	Olive Waste	Spent Coffee Grounds	Digestate	Sewage Sludge
C	wt%	82.26	80.60	79.32	79.60	76.67
H	wt%	6.79	7.15	6.81	7.02	8.62
N	wt%	1.85	4.69	3.86	5.17	7.84
S	wt%	0.35	0.34	0.76	0.79	1.11
O*	wt%	8.75	7.21	9.25	7.15	5.77
HHV	MJ/kg	36.64	35.73	36.83	35.24	34.47
H_2O	wt%	1.78	1.54	1.94	<2	2.65
TAN	mgKOH/g	3.83	3.05	8.10	4.11	8.06

TCR® oil characterization from different feedstocks (*calculated by difference)

Gas		Wood Pellets	Olive waste	Spent Coffee Grounds	Digestate	Sewage Sludge
H_2	vol%	29.16	37.81	38.73	37.31	40.41
CO	vol%	22.26	19.68	12.12	11.38	11.44
CO_2	vol%	23.57	13.33	22.65	25.36	29.71
CH_4	vol%	14.26	4.97	0.23	1.74	1.05
C_xH_y	vol%	8.41	2.42	3.75	2.20	3.57
HHV	MJ/kg	16.87	19.35	20.66	18.5	19.86
LHV	MJ/kg	14.8	17.37	19.15	16.3	17.8

TCR® gas characterization from different feedstocks



Mass balance of the TCR® process for different feedstocks

*Phone: +49 9661 908-446,
E-Mail: mohamed.elmously@umsicht.fraunhofer.de