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Toor, Saqib Sohail; Rosendahl, Lasse; Nielsen, Mads Pagh; Rudolf, Andreas

Publication date:
2008

Document Version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Toor, S. S., Rosendahl, L., Nielsen, M. P., & Rudolf, A. (2008). *Structural analysis of Catliq® bio-oil produced by catalytic liquid conversion of biomass*. Poster presented at 4th International Conference on Renewable Resources and Biorefineries (RRB4), Rotterdam, Netherlands.

Structural analysis of Catliq® bio-oil produced by catalytic liquid conversion of biomass

SCF Technologies A/S

Toor, S. S.[1], Rosendahl, L.[1], Nielsen, M.P.[1] and Rudolf, A.[2]

[1]Institute f Energy Technology, Aalborg University, DK-9220 Aalborg, Denmark

[2]SCF Technologies A/S, Smedeholm 13 B, DK-2730 Herlev, Denmark

Introduction

The potential offered by biomass for solving some of the world's energy problems is widely recognized. The energy contained in biomass can be utilized either directly as in combustion or by converting the biomass into a liquid fuel for transportation. The Catliq® (catalytic liquid conversion) process is a second generation process for the production of bio-oil from different biomass-based waste materials. The raw material used in this study was DDGS (Dried Distilled Grain with Solubles), a residual product in 1st generation ethanol production.

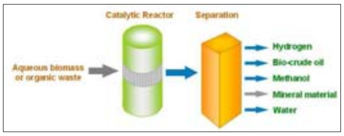

Figure 1. Catliq® process concept

Aim

- Production of bio-oil from DDGS (Dried Distilled Grain with Solubles).

Method

- Catalytic conversion of DDGS was performed in a pilot plant with a capacity of 10-20 L/h of wet biomass (see Fig. 2 & 3).
- The Process was carried out at subcritical conditions (280-350 °C and 180-250 bar).
- In the presence of homogeneous (KOH) and heterogeneous (ZrO_2) catalysts.
- DDGS transformed to bio-oil (see Fig. 6), combustible gases and water soluble organic compounds.
- Bio-oil from DDGS was characterized by using equipment Avatar FT-IR 370 and GC/MS Varian CP-3800.

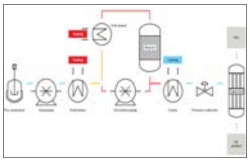

Figure 2. Catliq® process scheme

Figure 3. Catliq® pilot plant

Figure 4. DDGS (Dried Distilled Grain with Solubles)

Figure 5. Oil, water and salts after the reactor loop

Figure 6.Catliq® bio-oil

Results

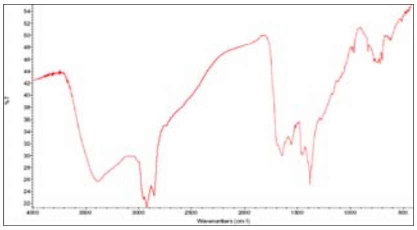

Figure 7. FT-IR spectra of the bio-oil

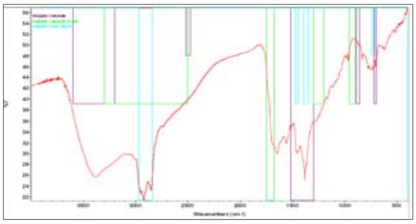

Figure 8. FT-IR spectra with group identification

Type of functional group	Wavenumber (cm^{-1})
Low frequency –OH group stretch, Phenols (aromatic ring) and Alcohols	3600-3300
Inorganic Carbonates, bending vibration	3580-3200, 1510-1300
O-H stretch of the Carboxyl group	3250-2500
Symmetrical and asymmetrical C-H stretching, Aliphatic $-CH_3$ and $-CH_2$ groups	2960-2840
Inorganic Carbonates, absorption peaks	2515-2490, 890-860
C = O stretch, Carbonyl	1725-1680
Ketone and Aldehyde stretching	1680-1620
C-H bending vibrations, alkane groups	1465-1380

Table 1. Results of FT-IR for the bio-oil

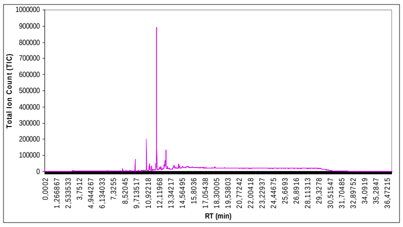

Figure 9. GC/MS spectrum for the bio-oil

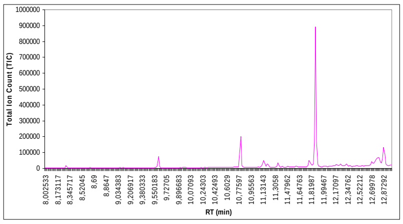

Figure 10. GC/MS spectrum for the specific compound peaks

Compound	RT (min.)
Hexadecanoic acid	11.885
Tetradecanoic acid	10.809
Octadecanoic acid	12.873
11-cis-Octadecenoic acid	12.793
Dodecanoic acid	9.616
Tridecanoic acid	11.147
Palmitelaidic acid	11.79
n-Pentadecanoic acid	11.352
β -D-Glucopyranoside, methyl 2,3-bis-O-(trimethylsilyl)-, cyclic methylboronate	12.332
Decanoic acid	8.299

Table 2. Identification of compounds in the bio-oil by GC/MS

Conclusion

- The oil mainly consists of long-chain aliphatic acids.
- The content of oxygen was low, and the oxygen was mainly present in the form of acid groups
- The oil has a heat value of 36 MJ/kg.

Acknowledgements

The authors are very grateful to the SCF Technologies A/S for providing the bio-oil sample and special thanks go to Erik G. Søgaard and Rudi P. Nielsen at the CIChem research group, Aalborg University Esbjerg.