Data in Brief 18 (2018) 422–431

Contents lists available at ScienceDirect

Data in Brief

journal homepage: www.elsevier.com/locate/dib

Data Article

Effects of pressure on morphology and structure of bio-char from pressurized entrained-flow pyrolysis of microalgae

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ARTICLE INFO

Article history:
Received 8 February 2018
Received in revised form
5 March 2018
Accepted 12 March 2018
Available online 16 March 2018

Keywords:
Microalgae
Bio-char
Particle swelling
Pressurized pyrolysis

ABSTRACT

The present dataset describes the entrained-flow pyrolysis of Microalgae *Chlorella vulgaris* and the results obtained during bio-char characterization. The dataset includes a brief explanation of the experimental procedure, experimental conditions and the influence of pyrolysis conditions on bio-chars morphology and carbon structure. The data show an increase in sphericity and surface smoothness of bio-chars at higher pressures and temperatures. Data confirmed that the swelling ratio of bio-chars increased with pressure up to 2.0 MPa. Consequently, changes in carbon structure of bio-chars were investigated using Raman spectroscopy. The data showed the increase in carbon order of chars at elevated pressures. Changes in the chemical structure of bio-char as a function of pyrolysis conditions were investigated using FTIR analysis.

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https://doi.org/10.1016/j.dib.2018.03.048

Specifications Table

Subject area	Chemical Engineering, Carbon Materials
More specific subject area	Biomass utilization; Pyrolysis
Type of data	Table and Figure
How data was acquired	Pressurized entrained-flow pyrolysis, SEM-image analysis, Elemental Analysis, Raman spectroscopy, FTIR spectroscopy
Data format	Raw original data was collected and analyzed
Experimental factors	Pyrolysis experimental factors including pressure and temperature
Experimental features	Triplicate experiment. Prior to each trial, collected data was averaged and calculated to ensure repeatability
Data source location	Liaoning province, China
Data accessibility	All data are included in this document
Related research article	Maliutina, K., Tahmasebi, A., Yu, J., Saltykov, S.N. 2017. Comparative study on flash pyrolysis characteristics of microalgal and lignocellulosic biomass in entrained-flow reactor. *Energy Conversion and Management*, 151, 426–438. [1]

Value of the Data

- Data compares the results obtained under atmospheric and pressurized fast entrained-flow conditions.
- Data illustrated innovative information on changes in carbon structure and surface morphology of bio-chars.
- Data provided valuable information on changes in chemical structure of bio-chars as a function of pyrolysis conditions.
- The dataset is valuable for the development of efficient and innovative technologies for the production of biomass-based carbon materials.

1. Data

The properties of raw microalgae biomass are presented in Table 1. Fig. 1 illustrates the schematic diagram of pressurized entrained-flow pyrolysis experimental setup. Fig. 2 and Figs. 3–6 shows the scanning electron microscopy (SEM) images of microalgae and its bio-chars prepared under different temperatures and pressures at various magnifications, respectively. Swelling ratios of microalgae bio-chars under pressurized pyrolysis was measured from the SEM analysis data and are shown in Fig. 7. Fig. 8 shows the Raman spectra of microalgae and its bio-char samples prepared under different experimental conditions, while Fig. 9 shows the typical curve-fitted Raman spectra corresponding to D1, D2, D3, D4 and G1 bands, respectively. The FTIR curve-fitting analysis results of bio-chars are presented in Table 2.

2. Experimental design, materials and methods

2.1. Sample preparation

Fresh water Microalgae *Chlorella vulgaris* was purchased from Spirulina Bio-Engineering Co. Ltd., China. The average particle size of microalgal sample was around 45 μm. Samples were prepared by drying in the oven at 105 °C for 24 h. Then, biomass samples were stored in a desiccator to avoid the moisture reabsorption prior to the further proximate and ultimate analyses. Characterization of microalgae was performed following ASTM standards of D3173 for the moisture, D3174 for the ash,