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1 The transformation of nitrogen during pressurized entrained-flow
2 pyrolysis of *Chlorella vulgaris*

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7
8 **Abstract**

9 The transformation of nitrogen in microalgae during entrained-flow pyrolysis of *Chlorella vulgaris*
10 was systematically investigated at the temperatures of 600-900 °C and pressures of 0.1-4.0 MPa. It
11 was found that pressure had a profound impact on the transformation of nitrogen during pyrolysis.
12 The nitrogen retention in bio-char and its content in bio-oil reached a maximum value at 1.0 MPa.
13 The highest conversion of nitrogen (50.25 wt.%) into bio-oil was achieved at 1.0 MPa and 800 °C,
14 which was about 7 wt.% higher than that at atmospheric pressure. Higher pressures promoted the
15 formation of pyrrolic-N (N-5) and quaternary-N (N-Q) compounds in bio-oil in expense of nitrile-N
16 and pyridinic-N (N-6) compounds. The X-Ray photoelectron spectroscopy (XPS) and Fourier
17 transform infrared spectroscopy (FTIR) results on bio-chars clearly evidenced the transformation of
18 N-5 structures into N-6 and N-Q structures at elevated pressures. The nitrogen transformation
19 pathways during pyrolysis of microalgae were proposed and discussed.

20 **Keywords:** Microalgae; Nitrogen transformation; Pressurized pyrolysis; Nitrogen-containing
21 compounds; bio-char.

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