

Pretreatment of sunflower stalks for biogas production

Josef Maroušek

Received: 13 August 2012 / Accepted: 2 November 2012 / Published online: 10 November 2012
© Springer-Verlag Berlin Heidelberg 2012

Abstract Sunflower stalks were subjected to commercial-scale pretreatment by hot-water maceration and steam-explosion technology to enhance biogas production. The technology involved does not require heavy construction nor does it consume any additional energy, chemicals, or rare catalysts. Process parameters regarding the mass flow, operating temperature, retention times, hydromodule, pressure, micropore area, formation of inhibitors, and especially the methane yields were plotted in detail to allow further optimization of the design. It was found that the optimal settings should come from both the macerator and steam-explosion subunits because various synergistic effects may be achieved.

Keywords Sunflower stalks · Underwater hot maceration · Steam-explosion · Biogas

Introduction

Opposite to purpose-grown phytomass, agricultural residues are an environmentally ideal substrate for bioconversions. To uphold good environmental practice, the applied technology should avoid using additional energy, chemicals (especially hazardous), rare catalysts, demanding constructions, etc. (Maroušek 2012). There are known works regarding hydrolysis (Du et al. 2012; Ruiz et al.

2008; Sharma et al. 2002; Zadrazil et al. 1996; Jiménez and Bonilla 1993; Jones et al. 1979) and following alcohol fermentation (Vaithanomsat et al. 2009; Caparrós et al. 2008; Ruiz et al. 2006; Sharma et al. 2004; Sharma et al. 2002; Jiménez and González 1991; Bonilla et al. 1990) from the sunflower stalks. However, both of these technologies are heat demanding. There are already works regarding the anaerobic fermentation of the sunflower silage (Nassab et al. 2011; Schittenhelm 2010; Amon et al. 2007), sunflower heads (Polat et al. 1993), sunflower seedcake (Raposo et al. 2009; Raposo et al. 2008), etc. However, due to its rigid structure, the sunflower stalks were successfully anaerobically fermented only after using either the sulfuric acid or sodium hydroxide pretreatment (Antonopoulou et al. 2010), which fails from an environmental and financial standpoint.

Once there were serious discrepancies about the ecological impacts of phytomass combustion (Kim et al. 2011; Demirbas 2007; Chagger et al. 1998; Björkman and Strömberg 1997) and an excess of otherwise unusable sunflower stalks, it was hypothesized that it would be beneficial to study their “non-chemical” pretreatment to enable the biogas (methane) utilization. Based on previous experimental failures, which were conducted in a laboratory scale, it was proposed to use a commercial-scale steam-explosion technology, running on the waste heat from the cogeneration unit linked to 1 MW_{el} biogas station.

Materials and methods

Sunflower stalks

The substrate examined was Barolo RM variety donated from farmer Ing. Štěpán Hladík (Hartvíkov, Czech

J. Maroušek (✉)
Department of Applied Plant Biotechnology, Agriculture
Faculty, University of South Bohemia, Studentská 13,
České Budějovice 37005, Czech Republic
e-mail: josef.marousek@gmail.com