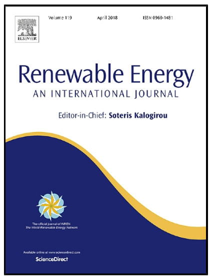
Accepted Manuscript



Co-Combustion Performance and Kinetic Study of Solid Digestate With Gasification Biochar

M. Barbanera, F. Cotana, U. Di Matteo

PII:	S0960-1481(18)30086-7
DOI:	10.1016/j.renene.2018.01.076
Reference:	RENE 9681
To appear in:	*Renewable Energy*
Received Date:	25 September 2017
Revised Date:	14 December 2017
Accepted Date:	19 January 2018

Please cite this article as: M. Barbanera, F. Cotana, U. Di Matteo, Co-Combustion Performance and Kinetic Study of Solid Digestate With Gasification Biochar, *Renewable Energy* (2018), doi: 10.1016/j.renene.2018.01.076

CO-COMBUSTION PERFORMANCE AND KINETIC STUDY OF SOLID DIGESTATE WITH GASIFICATION BIOCHAR

M. Barbanera[a], F. Cotana[a], U. Di Matteo[b]
[a] CRB - Biomass Research Centre, Via G. Duranti, 63, 06125 Perugia, Italy
[b] Department of Sustainability Engineering, Guglielmo Marconi University, Via dei Banchi Vecchi 58, Rome 00186, Italy

Abstract

Thermogravimetric (TG) analysis was carried out to evaluate the interactions and kinetics of char from biomass gasification, solid digestate and their blends under combustion condition. The gasification char was blended with solid digestate in the range of 10–90 wt.% to analyze the co-combustion performance. Based on the thermal degradation experiments which were performed at three heating rates 5, 10, and 15 °C/min, the OFW model-free method was used to determine the activation energy, based on which the pre-exponential factor, the enthalpy, the Gibbs free energy and the entropy were also calculated to label the combustion process directly.

Blending gasification char with solid digestate tends to reduce the activation energy, but the overall analysis of combustion, kinetic and thermodynamic parameters reveals the complexity of the degradation process of all blends. Results showed that the blending proportion of 50% was regarded as the optimum blend in according to the limitations of activation energy, comprehensive performance index and Gibbs free-energy.

Keywords

Thermogravimetric analysis; Kinetics; Co-combustion; Biomass char; Solid digestate; Isoconversional

1. Introduction

Biomass conversion into energy consists of different technologies, because biomass resources have varying ratios of different molecular structures; therefore the choice of technology has to be tailored to the biomass type in order to achieve optimum outcomes. Two of the most interesting technologies are gasification and anaerobic digestion which allows to exploit biomass in a sustainable way, obtaining useful energy vectors such as syngas and biogas respectively. However, both processes generate also byproducts such as char and digestate respectively, requiring the definition of adequate strategies for their utilization and management in order to reach the economic and environmental sustainability of the bioenergy chains.

A critical aspect for the management of the existing gasification plants is the disposal of char, which, presently, has to be treated as a waste - representing thus an actual loss for the plant owner [1]. The need to find alternative and innovative applications for char residues from an industrial point of view, has lead the scientific community to explore different viable pathways for their valorization (e.g. dye adsorption, catalyst preparation, tar cracking, soil fertilization) [2]. Char from biomass gasification is a residue mainly composed by carbon, minerals and metals that are present in the raw material which are not transformed into syngas [3]. Despite its interesting calorific value, the main drawback of char use in combustion systems is the high content of alkali and alkaline earth