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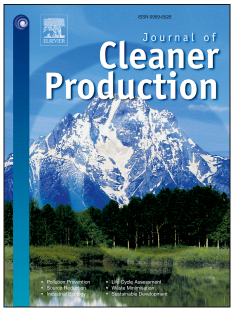

Pressure swing adsorption for biogas upgrading. A new process configuration for the separation of biomethane and carbon dioxide

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Pressure swing adsorption for biogas upgrading. A new process configuration for the separation of biomethane and carbon dioxide

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Abstract

Pressure swing adsorption (PSA) is an interesting technology for biogas upgrading, due to compactness of the equipment, low energy requirements, low capital cost, and safety and simplicity of operation. Unfortunately, some shortcomings penalize its diffusion in comparison with other technologies; in particular, conventional PSA has a low methane recovery and cannot compete in this field with other processes such as amine scrubbing; furthermore, it produces an off gas stream with a significant methane content, which requires further treatment to avoid the emission of residual methane into the atmosphere. In this framework, this study focuses on the feasibility of a PSA based separation process able to obtain a biomethane stream suitable to be injected in the natural gas grid (CO_2 $<3\%$ by volume) with a high methane recovery and an almost pure CO_2 stream ($CO_2 > 99\%$). The proposed process uses Zeolite 5A as adsorbent material in two PSA units; the biogas is fed to the first unit which produces biomethane; the off gas of the first unit is sent to a second PSA unit which separates carbon dioxide from a residual gas stream, recycled to the first to enhance methane recovery. A dynamic non-isothermal model, based on the linear driving force approximation, is employed to demonstrate the technological feasibility of the separation units and to assess the performance of the whole process. In particular a methane recovery greater than 99% can be obtained with energy consumption of about 1250 kJ per kg of biomethane.

Keywords

Biogas upgrading, pressure swing adsorption, biomethane, complete separation, methane recovery.

Introduction

In the last decades biogas has achieved a significant importance in the field of renewable energy, especially as a heat source; biogas is a gaseous mixture produced by methanogenic bacteria through anaerobic fermentation of organic matter. Biogas from anaerobic digesters contains mainly methane and carbon dioxide, while other contaminants (hydrogen sulphide, ammonia, oxygen, nitrogen, dragged solid particles, siloxane) almost always do not exceed the threshold of 4%; it is also saturated with water at the temperature at which it is produced. Biogas constitutes an important methane resource, especially for those countries that have to import natural gas and other fossil fuel; in 2013 in Italy the production of biogas was around 1815 kteq, while in Europe it reached 14400 kteq (1kteq=1000 tonnes of oil equivalent) (*Biogas barometer*, 2014).