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Comprehensive two-dimensional gas chromatography for biogas and biomethane analysis

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Highlights for submission of "Comprehensive two-dimensional gas chromatography for biogas and biomethane analysis"

- First report of GCxGC applied to biogas and biomethane analysis
- Access to detailed composition of biogas versus biomass inputs
- Qualify the performances of biogas purification processes

ABSTRACT

The gas Industry is going to be revolutionized by being able to generate bioenergy from biomass. The production of biomethane – a green substitute of natural gas – is growing in Europe and the United-States of America. Biomethane can be injected into the gas grid or used as fuel for vehicles after compression. Due to various biomass inputs (e.g. agricultural wastes, sludges from sewage treatment plants, etc.), production processes (e.g. anaerobic digestion, municipal solid waste (MSW) landfills), seasonal effects and purification processes (e.g. gas scrubbers, pressure swing adsorption, membranes for biogas upgrading), the composition and quality of biogas and biomethane produced is difficult to assess. All previous publications dealing with biogas analysis reported that hundreds of chemicals from ten chemical families do exist in trace amounts in biogas. However, to the best of our knowledge, no study reported a detailed analysis or the implementation of comprehensive two-dimensional gas chromatography (GC x GC) for biogas matrices. This is the reason why the benefit of implementing two-dimensional gas chromatography for the characterization of biogas and biomethane samples was evaluated. In a first step, a standard mixture of 89 compounds belonging to 10 chemical families, representative of those likely to be found, was used to optimize the analytical method. A set consisting of a non-polar and a polar columns, respectively in the first and the second dimension, was used with a modulation period of six seconds. Applied to ten samples of raw biogas, treated biogas and biomethane collected on 4 industrial sites (two MSW landfills, one anaerobic digester on a wastewater treatment plant and one agricultural biogas plant), this analytical method provided a "fingerprint" of the gases composition at the molecular level in all biogas and biomethane samples. Estimated limits of detection (far below the µg.Nm^{-3}) coupled with the resolution of GC x GC allowed the comparison of the real samples considered. This first implementation of GC x GC for the analysis of biogas and biomethane demonstrated unambiguously that it is a promising tool to provide a "fingerprint" of samples, and to monitor trace compounds by families.

Keywords: biogas; biomethane; biomass; comprehensive two-dimensional gas chromatography (GC x GC); landfill; anaerobic digestion

1. INTRODUCTION

Due to the increasing fossil fuel prices and their harmful effect on the environment, current waste management policies favor the development of renewable energies. The great worldwide challenge