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Effects of CO on Hydrogenotrophic Methanogenesis under Thermophilic and Extreme-thermophilic Conditions: Microbial Community and Biomethanation Pathways

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Abstract

Coke oven gas is considered as a potential hydrogen source for biogas bio-upgrading. However, the contained CO may impose toxicity to methanogens. In this study, the effects of CO on biomethanation performance and microbial community structure of hydrogenotrophic mixed cultures were investigated under thermophilic (55°C) and extreme-thermophilic (70°C) conditions. 5% (v/v) CO did not inhibit hydrogenotrophic methanogenesis during semi-continuous operation, and 83-97% CO conversion to CH_4 was achieved. *Methanothermobacter thermoautotrophicus* was the dominant methanogen at both temperatures and was the main functional archaea associated with CO biomethanation. Specific methanogenic activity test results showed that long-term 5% CO acclimation shortened the lag phase from 5 hrs to 1 hr at 55°C and 15 hrs to 3 hrs at 70°C. CO_2 was the preferred carbon source over CO for hydrogenotrophic methanogens and CO consumption only started when CO_2 was completely depleted. *M. thermoautotrophicus* dominated mixed cultures showed a great potential in simultaneous hydrogenotrophic methanogenesis and CO biomethanation.

Keywords

Biogas upgrading; hydrogenotrophic methanogenesis; carbon monoxide; extreme-thermophilic, microbial community

1. Introduction

Biogas produced via anaerobic digestion (AD) consists of (% by volume) 50-75% CH_4 and 25-40% CO_2, and can be used mainly for on-site heat and power generation (Li