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Žák, Michal  
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## Single-step purification of raw biogas to biomethane quality by hollow fiber membranes without any pre-treatment - a radical innovation in biogas upgrading

M. Žák<sup>1</sup>, H. Bendová<sup>2</sup>, K. Friess<sup>3</sup>, J. E. Bara<sup>4</sup>, P. Izák<sup>1</sup>

<sup>1</sup> Institute of Chemical Process Fundamentals of the CAS, v.v.i. Rozvojová 135, 165 02 Prague 6, Czech Republic

<sup>2</sup> University of Pardubice, Institute of Environmental and Chemical Engineering, Studentská 573, 532 10 Pardubice, Czech Republic

<sup>3</sup> University of Chemistry and Technology Prague, Technická 5, 166 28 Prague 6, Czech Republic

<sup>4</sup> University of Alabama, Department of Chemical and Biological Engineering, Tuscaloosa, AL 35487, USA

Herein, a radical innovation in biogas production is presented using a single-step membrane purification technology without any necessary pre-treatment steps for contaminant removal. Asymmetric hollow fiber membranes with a thin, selective, non-porous layer made from polyester carbonate on the bore side were successfully used in a single-step raw biogas upgrading process at biogas plant Chořovice in Czech Republic. A double-stage arrangement operated at 17 °C exhibited the best CO<sub>2</sub>/CH<sub>4</sub> separation factor ( $\beta \sim 23$ ) with 96 vol. % CH<sub>4</sub> purity. This single-step biogas upgrading technology with highly H<sub>2</sub>S and water-resistant membrane modules allows reductions in capital expenditures of ~20% and in operational expenditures of ~50% compared to high pressure water scrubbing (HPWS) and ~70% compared to pressure swing absorption (PSA). Due to small energy consumption required merely for biogas compression, our units consumed around only ~2 MJ/Nm<sup>3</sup> CH<sub>4</sub>. Thus, our approach with significantly improved performance and robustness of the membrane separation process can be seen as a major breakthrough of membrane gas separation for inexpensive biogas production.

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