**Simulation of methanol production from different point sources of CO2**

Tina Kegl1, Blaž Likozar2, Anita Kovač Kralj1, Rok Gomilšek3, Gregor Kravanja1, Lidija Čuček1

*1 Faculty of Chemistry and Chemical Engineering, University of Maribor, Smetanova 17,* *Maribor, Slovenia; 2 National Institute of Chemistry, Hajdrihova 19, Ljubljana, Slovenia; 3 Talum Inštitut d.o.o., Tovarniška cesta 10, Kidričevo, Slovenia*

*\*Corresponding author: lidija.cucek@um.si*

**Highlights**

* Methanol production is a promising option for significant CO2 emission reduction
* Influences of impurities and concentrations from point sources of CO2 are studied
* Various catalysts and the dynamics of catalyst deactivation are analyzed
* Sensitivity analysis is performed to obtain simple economic bound of alternatives

**1. Introduction**

Human activities have led to an increased concentration of greenhouse gas emissions in the atmosphere, mainly by burning of fossil fuels [Vooradi et al., 2018]. Since the beginning of the industrial revolution the concentrations of CO2, the principal greenhouse gas, has risen from 280 ppm to 400 ppm [Zhang and Huisingh, 2017]. In order to stabilize the global CO2 concentration in the atmosphere, carbon capture and sequestration are estimated to play a major role in the reduction of CO2 emissions [Kravanja et al., 2018]. However, more sustainable and economically-promising option for greenhouse gas emission reduction is CO2 utilization [Roh et al., 2016], which is also in line with industrial ecology and circular economy. Captured CO2 at different large point sources [Meylan et al., 2015] could be converted by chemical pathways [Rafiee et al., 2018] into commercial products such as syngas, methane, methanol, ethanol, organic acids and many other fuels and chemicals [Norhasyima and Mahlia, 2018]. It could also be used directly (by physical pathway) [Rafiee et al., 2018] in carbonated beverages, fire extinguishers, as a refrigerant, extractant, in enhanced oil and gas recovery, in algae farms and other applications [European Commission, 2018]. CO2 emission reduction opportunities from point sources are shown in Figure **1**.

Point sources of CO2

CO2 capture

CO2 sequestration

Chemical pathway

Fuels and chemicals

CO2 utilization

Direct application

Physical pathway

**Figure** **1**: Schematic of CO2 capture, sequestration and utilization from point sources

**2. Methodology and results**

This contribution presents simulation of methanol production as a promising option for significant CO2 emission reduction. Methanol, as one of the most useful products, has multiple industrial applications, such as it could be used for production of formaldehyde, acetic acid, dimethyl ether and other chemicals [Van-Dal and Bouallou, 2013], as a fuel, solvent, energy carrier and in many other applications [Dalena et al., 2018]. Simulation is performed for different point sources of CO2, from power plants, cement factories and aluminium industry. Influences of impurities and CO2 concentrations in the flue gas on methanol production are investigated. As the feasibility of the process largely depends on the catalyst, simulation also considers various catalysts and the dynamics of catalyst deactivation. Finally, sensitivity analysis is performed in terms of CO2 capture cost, prices of CO2 allowances and methanol prices to obtain simple economic bound [Biegler et al., 1997] of various studied alternatives.

Preliminary results show that by MEA absorption about 50 % CO2 was captured from flue gas, and methanol conversion from captured CO2 was around 30 %. Furthermore, the effect of impurities content on the methanol productivity was determined in the packed bed reactor. It was found, that the reaction rate of methanol formation decreased significantly with the addition of higher percentages of impurities. In terms of the stability of catalyst in the parallel packed bed reactor in the aging tests, it was found that aging does not influence CO2 conversion significantly.

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