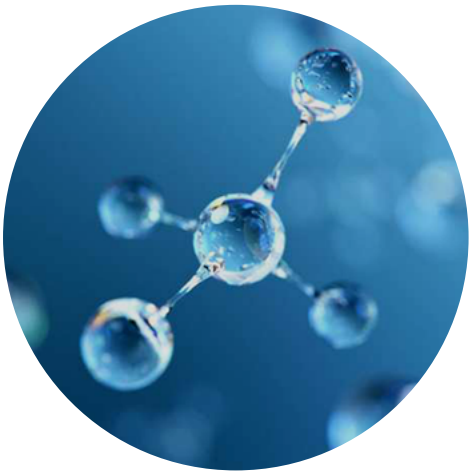
Direct conversion of methane to methanol with improved efficiency

by selective oxidation of methane to methanol by molecular oxygen



Overview

The effective utilization of the still abundant natural gas is challenging, among other things, because of its demanding transportation. Processing the methane contained in natural gas to liquid product which is easier to transport can be further augmented by its transformation into methanol, widely sought after industrial precursor and a promising energy carrier.

Our technology of direct oxidation of methane into methanol using a cheap oxidant like oxygen, represents the most progressive approach to natural gas utilization. Current alternatives have limited efficiency and typically require cycling of temperatures between 250°C and 450°C as well as the help of a water effluent to enable the release of methanol from the active material.

The technology developed at JHI is able to significantly improve the efficiency of the methane conversion at much lower temperatures, with methanol directly evolving into gas phase thus eliminating the necessity to use any effluent. The reached level of the methanol production is up to 80 times higher than any currently disclosed alternatives. These findings have been presented at several scientific conferences (see below).

Scientific conferences

- June 4 2019 at 12th Natural Gas Conversion Symposium, San Antonio (Oral 4216, Session Methane to Methanol II)
- July 8 2019 at 19th International Zeolite Conference, Perth (Oral #59)
- August 20 2019 at Europacat, Aachen (Worskshop Materials for Oxidation)
- September 26 2019 at Innovative Catalysis Development Forum, Frankfurt

Benefits

- High activity in methane selective oxidation at low temperatures under isothermal regime
- Release of oxygenate product without need of added effluent
- Highly stable system under cycling procedures
- “Super” dry conditions not required

Performed tests

Stoichiometric tests of methane conversion to methanol over Fe-, Co-, Mn-, Ni-zeolites in cyclic regime were performed in temperatures between 20–250°C.

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about us

Basic facts

Owner
J. Heyrovský Institute
of Physical Chemistry
Czech Academy of Sciences
(JHI)

Applications
Transformation of methane
to methanol or other oxygenates

We are offering
- research collaboration
- option to Intellectual Property(license/assignment)
- exclusivity for negotiating the above

IPR Status
Patent filed, pending

Technology Readiness Level
1 2 **3** 4 5 6 7 8 9

Technology

Molecular oxygen and temperatures below 250°C are sufficient to form highly active oxo-species in zeolite based material with the potential to selectively oxidize methane to gas phase methanol released without necessity of added effluent.

All reported systems for direct selective oxidation of methane by molecular oxygen to methanol exhibit very low conversion of methane both in stoichiometric and catalytic regime. Moreover, the proposed procedures require water effluent for release of methanol from the active material further decreasing methane production. Thus a new material with an ability to utilise molecular oxygen at temperatures below 250°C, transforming methane into methanol while preventing methane over oxidation and guaranteeing easy evolution of produced methanol at the same time is required.

The material developed at JHI is able to split oxygen between 20–300°C to highly active species which are subsequently oxidizing methane to methanol in the same temperature range. The splitting of oxygen and formation of highly active species occurs due to presence of cooperating pair of transition metal ions stabilized in proper distance by unique local structure of a zeolite matrix. Produced oxygen species in a form of neighbouring pair and similar to the so called α-oxygens (M=O) are able to selectively oxidize methane to methanol. High activity of active sites to methanol oxidation together with the specific properties of the used zeolite channel structure prevents total oxidation of methane while unique structural arrangement allows direct methanol release into gas phase. Methanol is therefore evolved to the methane stream without the need of temperature increase and addition of any effluent. Spontaneous evolution of methanol suggests potential for further development of a catalytic process.