Complete oxidation of methane over Pd/zeolite catalysts for lowering the reaction temperature

Min Sik KIM[1], Younghwan IM[1], Youngmin KIM[1], Yeon Jin LEE[1], You-Jin LEE[1], Ho-Jeong CHAE[*,1]
[1]*Korea research institute of chemical technology, Hydrogen & C1 gas research center, 141 Gajeong-ro Yuseong-gu, Daejeon, South Korea.*
** hjchae@krict.re.kr*

Significance and Relevance

Zeolite supported Pd catalysts were tested for complete methane oxidation, achieving a high methane conversion of over 90% at 370°C. In addition, the catalyst demonstrated stable methane conversion performance over 100 hours of continuous operation, demonstrating its durability and effectiveness in long-term applications.

Preferred for the topic: "Automotive and stationary emission control"
Preferred presentation: "Poster"

Introduction and Motivations

In response to global warming, there is a shift towards the use of natural gas as a cleaner energy source for ships.[1] However, 'methane slip' is a major challenge and a significant environmental concern due to methane's high global warming potential.[2] Currently, there is no promising solution for methane slip in marine engines. Generally, palladium-based catalysts, such as Pd/Al_2O_3, are widely used for methane oxidation, but they face challenges under methane slip conditions due to the presence of water, which does not completely deactivate the catalyst but reduces its activity by covering active sites.[3] In this study, we prepared palladium catalysts supported on several zeolites, which have morphology properties to overcome water coverage.

Results and Discussion

Pd/zeolite catalysts were prepared by varying the parameters at the preparation step. The type of zeolite, Pd precursor, solvent and the Pd content were the main parameters for the catalyst synthesis. Among them, the best performing catalyst achieved about 95% methane conversion with containing about 7% H_2O at 370 °C. (**Figure 1**)

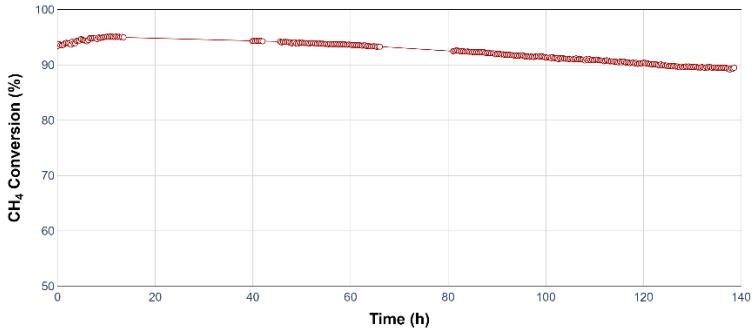

Figure 1. Complete oxidation of methane over Pd/zeolite catalyst at 370 °C for more than 100 hours, Reaction condition: 0.5% CH_4, 5% O_2, 7.1% H_2O in Ar balance, 120,000 $mL \cdot g_{cat}^{-1} \cdot h^{-1}$ GHSV

References

1. S. Ushakov, D. Stenersen, P. Einang, *Journal of Marine Science and Technology* **2019**, *24*, 1308.
2. R. Mortensen, H. Noack, K. Pedersen, S. Mossin, J. Mielby, *ChemCatChem* **2022**, *16*, e202101924.
3. P. Losch, W. Huang, O. Vozniuk, E. Goodman, W. Schmidt, M. Cargnello, *ACS Catalysis* **2019**, *6*, 4742.

Acknowledgements
This work was supported by the Korea Planning & Evaluation Institute of Industrial Technology (KEIT) (No. 20024949) from the Ministry of Trade, Industry and Energy (MOTIE) of the Republic of Korea and by the core KRICT project (KK2411-30) from the Korea Research Institute of Chemical Technology (KRICT).