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Title:

Development of a Zeolite Membrane Reactor for Reverse Water Gas Shift

Authors & affiliations:

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Abstract: (Your abstract must use **Normal style** and must fit in this box. Your abstract should be no longer than 300 words. The box will 'expand' over 2 pages as you add text/diagrams into it.)

Preparation of Your Abstract

1. The title should be as brief as possible but long enough to indicate clearly the nature of the study. Capitalise the first letter of the first word **ONLY** (place names excluded). No full stop at the end.

2. Abstracts should state briefly and clearly the purpose, methods, results and conclusions of the work.

Introduction: Clearly state the purpose of the abstract

Methods: Describe your selection of observations or experimental subjects clearly

Results: Present your results in a logical sequence in text, tables and illustrations

Discussion: Emphasize new and important aspects of the study and conclusions that are drawn from them

Reverse water gas shift (RWGS) is attracting attention as one of the promising technologies for CO₂ conversion. By selectively removing H₂O from the reaction system, RWGS is expected to exceed the equilibrium CO₂ conversion in a conventional reactor. In this study, we developed a conventional plug-flow reactor without membrane (*Case 1*), a single-stage membrane reactor (*Case 2*) and a two-stage reactor, a combination of a conventional plug-flow reactor and membrane reactor (*Case 3*), were developed, as shown in Fig. 1, and compared the results.

A tubular Na-ZSM-5 membrane was prepared by hydrothermal synthesis, and CuO/ZnO/ γ -Al₂O₃ catalyst was synthesized by a complex polymerization method [1]. The catalyst was packed on the outside of the membrane and activated by H₂ flow at 623 K for 1 h before the reaction. The mixture of H₂ and CO₂ (H₂:CO₂ = 3:1) was used as a feed gas.

Fig. 2 shows the yield of CO in each reactor. In *Case 1*, the CO yield was almost the same as the equilibrium conversion. *Case 2* showed CO yields 2–3% above that of a conventional reactor. From the results, the effectiveness of the dehydration membrane reactor for RWGS was verified. In addition, CO yield was further increased in the two-stage reactor (*Case 3*). For example, the CO yields in *Cases 1, 2, and 3* at 560 K were 21.8, 24.9, and 29.0%, respectively. Although the CO yield increased in *Case 2*, a large fraction of raw materials was lost as permeating through the membrane to the permeation side. In *Case 3*, the losses of H₂ and CO₂ in the first reactor were suppressed because of a pore-blocking effect by H₂O generated, resulting in a higher CO yield.

1. Motomu, S.; Kyoka, T.; Masahiko, M. An Experimental Study of a Zeolite Membrane Reactor for Reverse Water Gas Shift. *Membranes*. **2022**, *12*, 1272.

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