Clarkson University
Department of Chemical and Biomolecular Engineering
SEMINAR (Graduate Student Presentation)

"Ammonia Decomposition In A Novel Pd-Ag-Y Membrane Reactor"

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This study describes the application of the Pd-Ag-Y alloy membrane reactor to produce a high-purity hydrogen stream by ammonia decomposition. The Pd-Ag-Y membrane with a thickness of approximately 35 μm is fabricated by using cold rolling, and it is placed on top of a woven mesh during the testing, to improve mechanical stability. After heating up, the membrane showed a hydrogen permeability of $1.13 \cdot 10^{-8}$ mol $m^{-1}s^{-1}Pa^{-0.5}$ at 400 °C, and near-complete selectivity toward hydrogen permeation at each temperature and pressure investigated.

The ammonia decomposition is performed at different temperatures, from 350 °C to 450 °C, pressure, from 1.4 bar to 3 bar, and gas hourly space velocity, from 2160 h^{-1} to 8640 h^{-1}. A commercial Ni-based catalyst is used to carry out the reaction. Results in terms of ammonia conversion, hydrogen recovery, and hydrogen permeating yield are given. As best results, 88% ammonia conversion, 89% hydrogen recovery, and a highly pure hydrogen stream permeated through the membrane are achieved at 425 °C and 2.5 bar.

In addition, a comparison between this work and scientific literature is performed and the data are analyzed and discussed. A noteworthy aspect of the Pd-Ag-Y membrane is its excellent long-term stability (~600 hours), with no considerable decline in performance over extended periods of operation. These findings indicate that the Pd-Ag-Y membrane is a promising candidate for producing a pure stream of hydrogen from ammonia decomposition.

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CAMP 175

Temirlan Shildebayev is an M.S. student in the Department of Biomolecular Engineering working with Professor Simona Liguori's group. His research focuses on the application of a Pd-based membrane reactor. Temirlan earned his bachelor's degree in chemical engineering from Nazarbayev University, Astana, Kazakhstan, in 2020.