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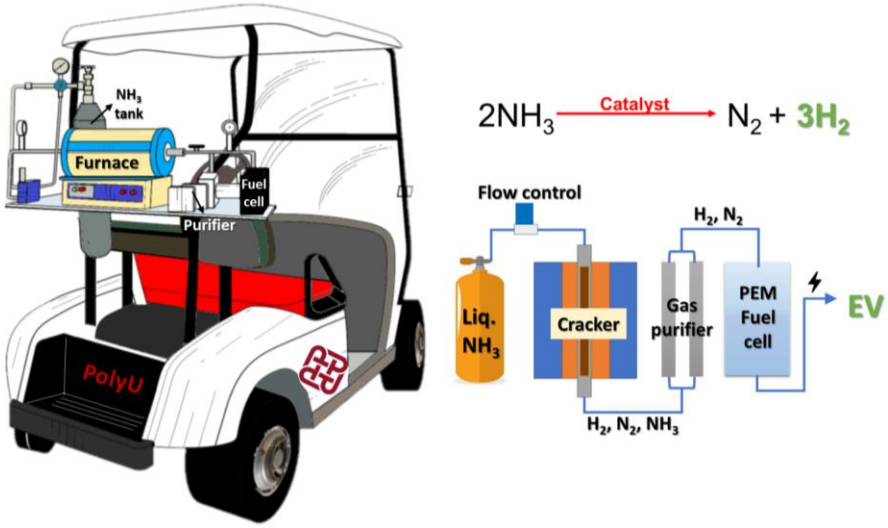
From Lab to Practical: An ammonia-powered Fuel Cell Electric Golf Cart System

Ammonia (NH_3) is a carbon-free hydrogen (H_2) carrier, which enables liquid-phase H_2 storage and transport under mild conditions. Although the concept of NH_3-to-H_2 has been frequently proposed, the practical application of NH_3 as the energy source for H_2 power automotive systems is rarely reported. To close the gap between NH_3 supply and H_2 utilization, we demonstrated an NH_3-powered fuel cell electric golf cart as a proof of concept. The integration of NH_3 cracker (installed with catalyst), gas purifier, fuel cell, and energy management system formed a successful powertrain that could thrust a golf cart into motion. The catalytic performance of both nickel (Ni) and iron (Fe)-based catalysts was measured (cracker gas evolution monitored by HPR-20 EGA, Hiden), and the optimal catalyst demonstrated a > 99.9% NH_3 conversion at 600 ℃. The gas purifier was confirmed to be capable of removing the residual NH_3 for a proton exchange membrane fuel cell (PEMFC). The fuel cell, when powered by the cracked and purified gas mixture, revealed comparable performance and power output as compared with the pre-mixed fuel gas mixture (75%H_2/25%N_2), demonstrating the feasibility of the whole system. The demonstrated NH_3-powered fuel cell prototype with an energy level of 17.5 kWh gives total system-specific energy of 379.4 Wh/kg. When equipped with 15 kg NH_3, the integrated power system is expected to meet the US Department of Energy's 2020 gravimetric hydrogen capacity target for onboard automotive hydrogen storage systems. During the operation, only N_2 and water are generated in the chemical processes of the system and emitted into the atmosphere, demonstrating that this power-generating technology is clean and carbon-free. Our proof-of-concept prototype represents an innovative demonstration of the NH_3-powered fuel cell vehicle system, giving rise to a future reference and inspiration for the practical developments of NH_3-based H_2 fuel applications.



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Paper Reference: "From lab to practical: An Ammonia-powered fuel cell electric golf cart system" *Chemical Engineering Journal* (2023) 452, Part 2, 139390

Hiden Product: HPR-20 EGA