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Wastewater-derived Ammonia for a Green Transportation Fuel

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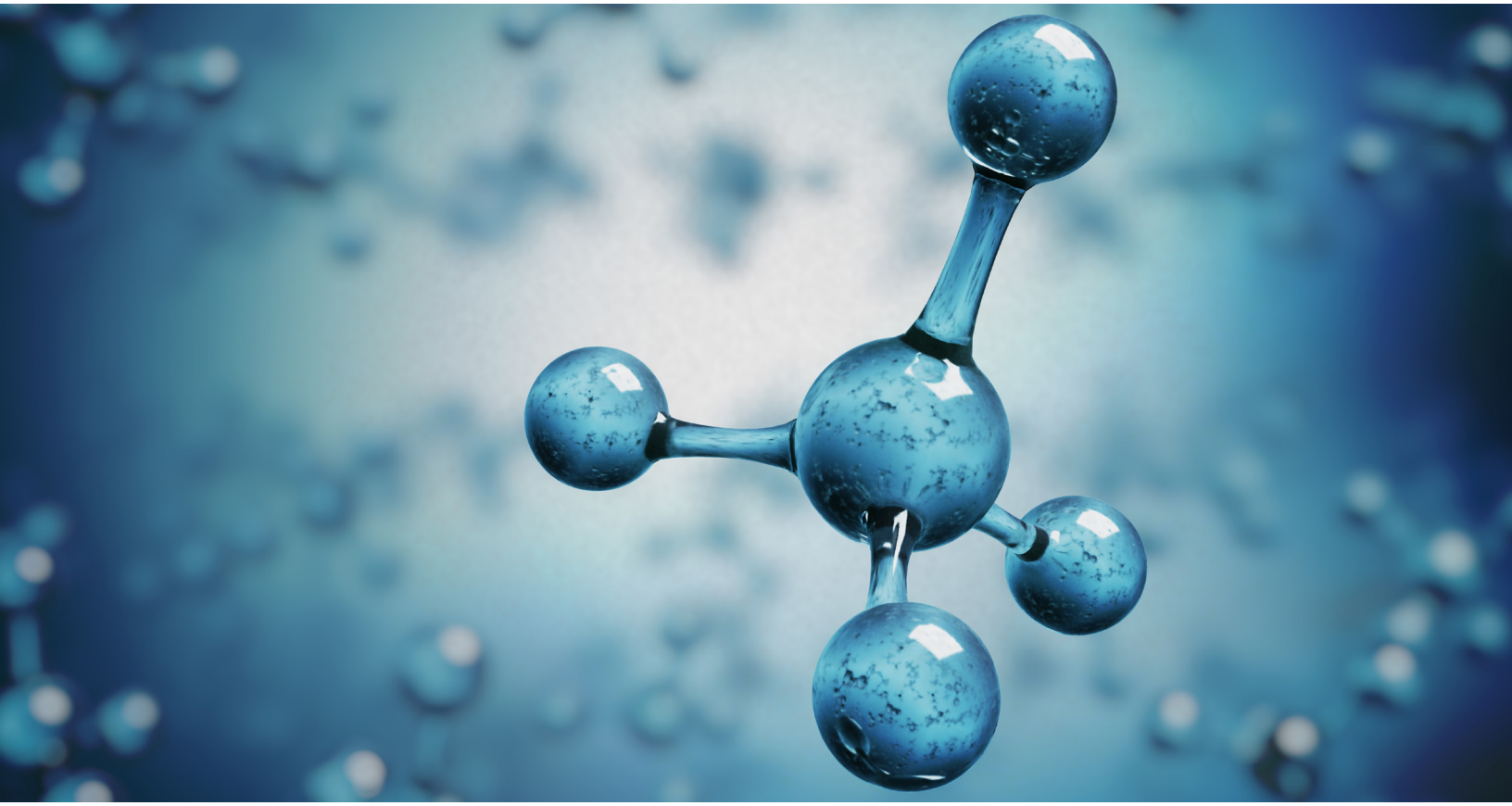

Introduction

The energy-water nexus (i.e., availability of potable water and clean energy) is among the most important problems currently facing society. Although alternative energy sources currently exist, environmentally friendly fuels are needed to bridge infrastructure gaps. Ammonia is one such fuel, but current technology for ammonia production is not carbon neutral. Wastewater is one potential source of ammonia. This research reports initial findings in using ammonia captured by wastewater treatment as an alternative fuel. This approach enables clean water to be produced during the same process as ammonia. The goal of the initial work is to 1) determine filtering process parameters influence on synthetic wastewater 2) identify how impurities present in the ammonia influence ignition of ammonia-air mixtures.

Study Methods

This study was broken into two sections: synthetic wastewater treatment and fuel ignition with expected wastewater treatment-based impurities. The former used membrane filtration methods and analytical measurements to quantify the ammonia recovery experimentally. Experiments used both nanofiltration and reverse osmosis to process feedstock at various feed pressures and flow velocities. The combustion study, conducted computationally, quantified the changes in the ignition delay of ammonia-air mixtures in a system relevant to Diesel engines. A modified chemical kinetic mechanism was introduced to incorporate reactions between impurities of CO, CO2, H2O, and HCl. These impurities are hypothesized to be present after the filtration process.

Findings

The experimental wastewater treatment study determined that reverse osmosis produced higher purity ammonia. The pressure difference across the membrane influenced the flow rate but did not alter the purity of the ammonia recovered for a given membrane.

Analysis of the combustion simulation results showed that CO, CO2, and H2O had minimal effects on the ignition delay with concentrations up to ~1%, by volume. Carbon monoxide and water impurities slightly decreased the ignition delay whereas CO2 slightly increased the delay. The most significant effect was HCl, which increased the delay for most conditions. These findings suggest that wastewater-derived ammonia will only need to have HCl filtered from the solution to avoid adverse ignition effects.

Wastewater treatment produces high purity ammonia that will serve as a sustainable, carbon-free alternative fuel.

Policy Recommendations

Future work needs to quantify the impurity levels for each filtration technique and flow conditions. These results will determine if any additional processing is required of the recovered ammonia solution. The presence of carbon oxides will introduce a small carbon footprint, however, it is possible that the use of wastewater-derived ammonia may still be carbon neutral or negative. Chlorine containing impurities will likely need to be filtered out to minimize adverse effects on the ignition process and related pollutants. Additional studies will need to be conducted to determine how these impurities will influence flame spread within a combustion engine.

About the Authors

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To Learn More

For more details about the study, download the full report at **transweb.sjsu.edu/research/2041**

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