Feasibility of Metal-Organic Framework for Vehicular Storage of Natural Gas

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Natural gas has the least carbon emissions of all fossil fuels when used as vehicular fuel. However, due to its low volumetric density, natural gas is costly and inefficient when used on-board vehicles through LNG or CNG systems. Adsorbed Natural Gas (ANG) systems, which store natural gas in adsorbents, are potentially low cost and safer alternatives to other systems. Metal-Organic Frameworks (MOFs) have extremely high surface area and have high potential for use in ANG systems on-board vehicles. However, MOFs as-produced are loose powders and must be pressed into pellets, potentially changing the MOF's natural gas storage capacity and transfer properties. Additionally, MOF have very poor heat transfer properties that can be increased with the addition of substances with high conductivity such as expanded natural graphite (ENG). I made MOF pellets and studied them at various densities, both with and without ENG, to show the Darcy permeability, diffusivities, and thermal diffusivities and conductivities. The results show that natural gas storage capacities and mass transfer properties of MOF-5 and HKUST-1 pellets are acceptable for vehicular storage of natural gas below certain pellet densities. Additionally, the thermal conductivity of the MOFs were significantly improved by addition of 5wt.% ENG. The MOF pellets with 5 wt.% ENG show small loss (<5%) of natural gas storage capacities and mass transfer properties while significantly improving the thermal conductivities of MOF. Results show that certain MOF pellets can be used in ANG at room temperature with less than 50 bar pressure to reach a natural gas volumetric density equivalent to that of CNG.

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