HYDROGEN/NATURAL GAS SOLID-STATE STORAGE INTO NEW ADSORBENTS

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ABSTRACT

A zero-carbon emission future, to address the global warming and climate change crucial problem, demands the use of sustainable and clean energy sources. In this context, hydrogen and natural gas are increasingly gaining attention particularly as promising alternative vehicle fuels. In order to achieve a truly sustainable transportation however, these gases should not only be produced but also stored before their final consumption. Nevertheless, both hydrogen (H_2) and natural gas (mainly CH_4) possess volumetric energy densities much lower than that of gasoline, which arises a significant challenge regarding the storage of compressed gas into alternative vehicle fuel cells. For overcoming this barrier, an increased onboard gas storage capacity is needed, to attain a driving range equivalent with that of conventional vehicles. One option for increasing the energy density is the gas storage onto a solid surface by physical adsorption through weak van der Waals interactions.

Metal-organic frameworks (MOFs) are solid materials being considered for that purpose in the last years, because of their favorable adsorption properties especially due to their high specific surface, pore volume and gas affinity adsorption sites, as well as their appropriately tunable chemical composition and microstructure. Indeed, numerous MOFs, being composed of a network of metal cations and clusters bridged via organic ligands, and synthesized by different methods ranging from conventional solvothermal synthesis to alternative processing techniques with reduced organic solvent utilization, are reported in literature. Many of them are actually being considered for increasing the hydrogen/natural gas storage capacities, either in relatively moderate-pressure onboard adsorbent-based fuel tanks or in high-pressure compressors at fuel delivery station infrastructures. In this work, recent relevant research papers are studied, significant factors including MOF chemistry, crystalline structure and design, production process simplicity and yield optimization along with gas adsorption-delivery mechanisms and performance are discussed, and the potential for an increased applicability is analyzed in view of a broader implementation of this class of materials as efficient new adsorbents for hydrogen and natural gas storage.

KEYWORDS: Hydrogen, Natural Gas, Storage, Physisorption, Metal Organic Frameworks (MOFs)

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