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C1Po1D-01 [25]: Cryogenic Flux Capacitor for Advanced Molecular and Energy Storage Applications

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Effective storage and transfer of fluid commodities such as oxygen, hydrogen, natural gas, nitrogen, argon, and others is a necessity in many industries and for hosts of different applications. Molecules are typically contained as low pressure, cryogenic liquids; or as high-pressure gases. Liquefied gasses afford high energy and volume densities, but require complex storage systems to limit boil-off losses, need constant settling in zero-gravity, and are not well suited for overly dynamic situations where the tank orientation can change suddenly. Most cryogenic liquid tanks are complex, nested configurations to increase thermal performance, making them large, massive, and difficult to be made into conformal shapes. Conversely, high pressure gas storage bottles are unaffected by orientation, and can be kept at room temperature; however, these vessels are heavy-walled to contain the high pressures, and the energy densities associated with gas storage are dramatically lower. These two options are typically traded depending on the system requirements, but few practical options exist that provide the benefits while limiting the downfalls. Alternatively, the Cryogenic Flux Capacitor (CFC) technology employs nano-porous aerogel composites to store, by physisorption processes, large quantities of fluid molecules in a molecular solid-state condition, at moderate pressures and cryogenic temperatures. By virtue of its design architecture, a CFC device can be "charged"and "discharged"quickly and on-demand according to operational requirements. Three CFC application areas are introduced: CFC-Fuel, CFC-Cool, and CFC-Life, corresponding to designs utilizing fuels such as hydrogen and methane; inert fluids such as nitrogen and argon for cooling power; and oxygen or breathing air for life support. Data for physisorption within different aerogel composites are presented in terms of both mass and volumetric parameters. For several prototype CFC modules, the charging and discharging performance test data using nitrogen at 77 K are described.

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