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Author: Ms. Anagha Udupa
R V College of Engineering, Bengaluru, India, anaghaudupa.ae21@rvce.edu.in

Ms. R Tharunikaa
R V College of Engineering, Bengaluru, India, rtharunikaa.ae20@rvce.edu.in
Mr. Akash Prasanna
R V College of Engineering, Bengaluru, India, akashprasanna348@gmail.com
Mr. Syed Muzzammil
R V College of Engineering, Bengaluru, India, syedmuzzammil.ae20@rvce.edu.in
Mr. RONIT SINGH
R V College of Engineering, Bengaluru, India, rnt.prof21@gmail.com
Ms. Shaifali Arora
R V College of Engineering, Bengaluru, India, shaifaliarora2003@gmail.com

EMPLOYING CARBON-SPLIT PORE TUBES AS ADSORBENTS TO CONTROL THE LEAKAGE OF METHANE IN TRANSPORT VALVES

Abstract

This paper ponders the employment of methane as a cryogenic fuel for rocket engines and how few intrinsic properties of methane relative to adsorbents can be exploited to improve the storage and transportation of the system passively. Methane propulsion is a field that is being widely experimented on to be used in future rocket engines for space travel. The two liquids are transported through pumps from storage tanks to the combustion chamber and ignited, which generates high-temperature and high-pressure gases, which expand rapidly, creating a high-velocity exhaust stream. It has many advantages to liquid hydrogen fuel, like the capability of the fuel and oxidizer to be stored at similar temperatures, higher specific impulse, non-toxicity, in-situ production capabilities, and the absence of coking. Nevertheless, there are a few challenges faced, like: Design of low-leakage, long-duration cryogenic valves, Pump-fed LOX/LCH4 engines with deep throttle capability, Leak detection, Reaction control thruster design maturation, etc.

This paper aims to design a low-leakage cryogenic valve that uses adsorptive material like carbon slit pores where temperature plays important role in adsorption. On increasing the temperature beyond 180K the adsorption becomes low. Hence maintaining a low temperature (similar to that of storage tank of about 80K to 100K) in the valves lined with this adsorptive material will highly reduce the leakage of methane(which will be a passive mechanism due to the presence of throttling effect). This would allow the adsorption of methane molecules that reach the outer circumference of the valves. To release the adsorbed molecules a slight rise in temperature would be sufficient. The pore size also defines the number of molecule layers that can be absorbed, hence designing a smaller pore size towards the flow and increasing the size of pores radially will allow methane molecules to be trapped at the outer circumference. A complete design of the valve is provided in this research paper. Thermal analysis using ANSYS software of methane transportation from storage tanks through the valves was done to check the validity of the design and is included in the paper.