Microwave-Induced Flash Vaporization of Volatile Media: A Preliminary Thrust Generation Study for the Waveguide Pellet Acceleration Concept

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Abstract. This paper presents two intermediate-scale experiments designed to test basic principles of Waveguide Pellet Acceleration, a novel method of using microwave power to generate propulsive thrust from flash vaporization of a "pusher" medium in order to accelerate a frozen DT fuel pellet. Results from a low-power Stage I experiment using a surrogate pusher consisting of an inert medium with volume-distributed metallic particle absorbers, are in good agreement with Parks' wave attenuation theory. In Stage II a high-powered short pulsed gyrotron source will be used to vaporize a surrogate pusher in a closed system (waveguide/test cell) without an accelerating projectile (pellet) in order to create a thrust-generating gas of interesting pressures ~ 60-100 bars and temperatures ~ 600-1000 K. To compare theory and experiment the vaporization of various volatile organic compounds with suspended metallic particle absorbers must be examined from a detailed thermodynamic perspective, given that large deviations from ideal gas behavior arise from the intermolecular forces when these solvents transition from ambient to a dense, warm, supercritical fluid. Using the Peng-Robinson real gas equation of state a closed form expression for the specific internal energy $U(V,T)$ was found that self-consistently includes the *intra*molecular rotational-vibrational energies, of relevance when measurements of the expanded gas state are taken on time scales faster than the molecular decomposition time. Other thermodynamically significant properties, such as the Joule-Thomson inversion curve, were calculated from this treatment that are in excellent agreement with reported experimental data. This lends further support to the use of surrogate pusher media in place of deuterium.