August 1972 B72-10502

NASA TECH BRIEF

NASA Pasadena Office

Integrated Monopropellant Thruster

In the fluidics art, vortex devices are components (without moving parts) that perform as amplifiers, inertial sensors, variable restrictors, and diodes. They have the unique capability of completely shutting off the main stream flow. In a nonvented vortex device, the mainstream flow can be modulated between full output and about 10 percent of full output. If the nonvented vortex amplifier uses gas to control the flow, the throttling ratio of the amplifier can be as high as 50 to 1 on a mass flow rate basis.

These latter characteristics of the vortex amplifier (as shown in Figure 1) suggested the application of these principles to the problem of throttling monopropellant thrusters. The thrusters shown in Figures 2 and 3 incorporate these principles and have the capability of being operated in an ON/OFF mode or modulated continuously as a function of the control flow. Moreover, the design promotes a more efficient integration of flow control, catalyst bed, and thruster nozzle. This results in a considerable weight reduction. In addition, the close coupling of the control valve to the mainstream flow enhances the overall-system time response. Also, the vortex flow improves the gas generation efficiency in the catalyst bed. Since there are no moving parts in the thruster, subsystem reliability is significantly enhanced.

Figure 1 shows the relative positions of the supply, control, and outlet ports in a typical nonvented vortex amplifier. Without control, the fluid or gas from the supply port would flow unrestrained into the outlet port. However, if a gas or liquid from the control port impinges on the mainstream tangentially, it will deflect from its radial path to form a spiral pattern. The deflection of the mainstream and the subsequent formation of a vortex field lengthens the flow path of the main fluid stream. This increases the pressure drop. As the mainstream moves into the vortex, its tangential velocity increases. This causes a dissipation of energy and a reduction in the flow at the outlet port. The amount of reduction, therefore, is directly proportional to the strength of the control stream.

Figure 2 is a cross-section view of a thruster using the fluidic vortex amplifier principle. Control is obtained through two tangential ports that allow the uniform distribution of the control fluid. The propellant flow through the cylinder containing the spontaneous catalyst will be unconstrained or blocked, depending on the control desired. Thus, the decomposition of the propellant is controlled and, as a consequence, so is the thrust at the nozzle end of the engine. In this instance, the source of the control fluid can be an auxiliary gas supply or a higher pressure monopropellant supply.

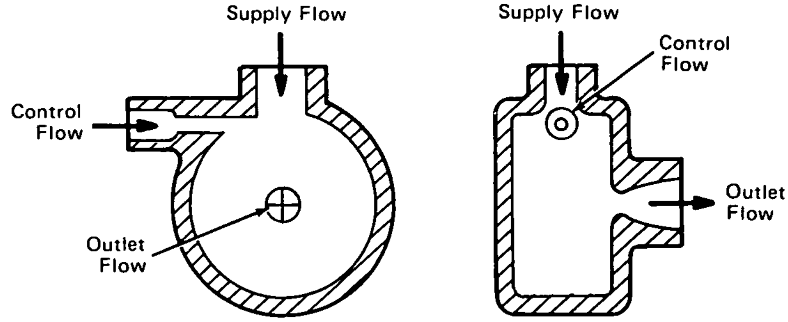

Figure 1.

(continued overleaf)

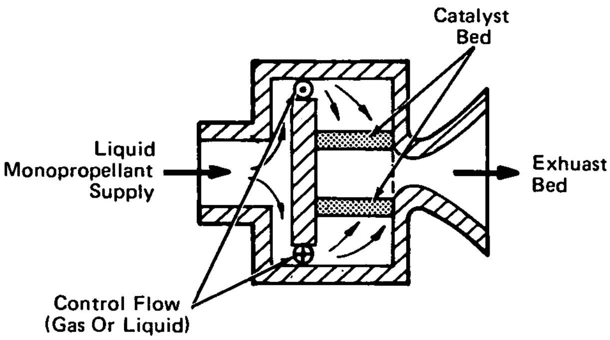

Figure 2.

Because of the larger exposed catalyst bed area, greater decomposition can be obtained by using the configuration shown in Figure 3. Here, the propellant would flow under normal pressure conditions through the catalyst bed. However, the control would be exer-

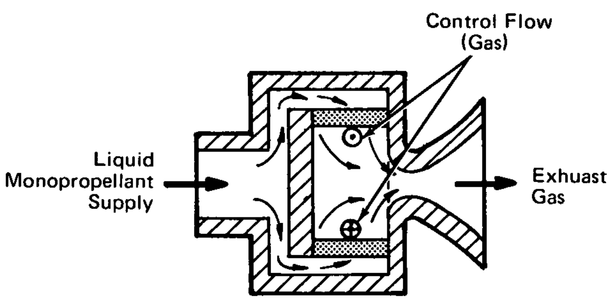

Figure 3.

cised at the exit from the bed. In this example, gas would be used as the control medium by introducing internal swirling or "vortexing" of the now gaseous propellant.

Aside from the increased reliability and decreased weight, the application of the fluidic vortex amplifier principle to a monopropellant thruster makes for better decomposition of the fuel. The principle can be applied to any size of monopropellant thruster and is specifically practical in the thrust range of 225 to 4500 N (50 to 1000 lbs force).

Note:

No further documentation is available. Specific questions, however, may be directed to:

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Patent status:

No patent action is contemplated by NASA.

Source: Charles Mangion of
TRW Systems Group
under contract to
NASA Pasadena Office
(NPO-12004)