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NASA TECH BRIEF

Two-Fluid, Impinging-Sheet Injector

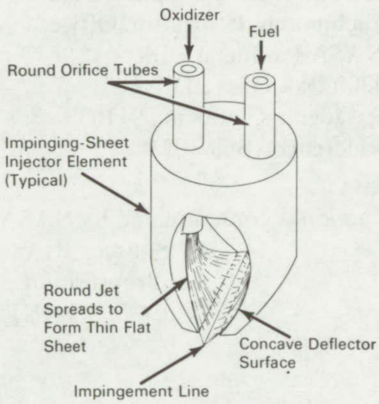

FIGURE 1

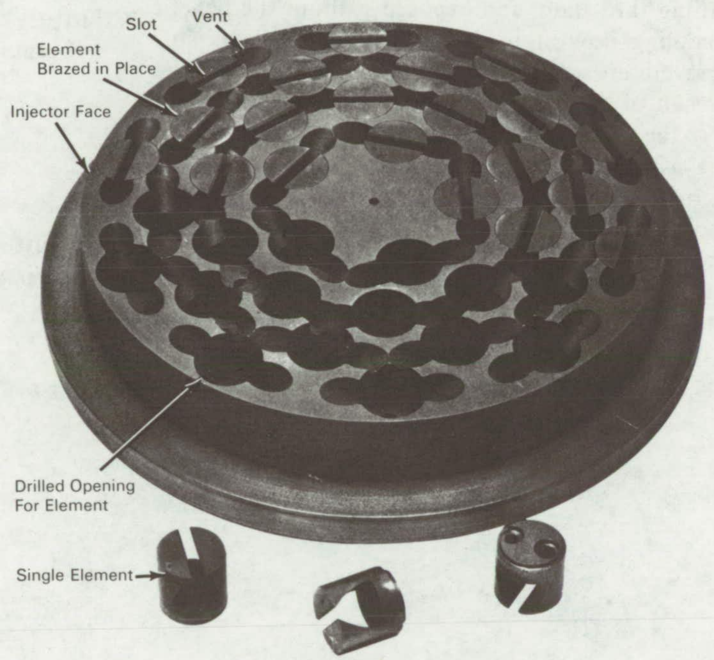

FIGURE 2

A two-fluid, impinging-sheet propellant injector of an earlier design (Figure 1) has been improved (Figure 2) by (a) burying the injector elements within the face of the injector to afford thermal protection to the elements and (b) venting the sides of the elements to allow escape of gases generated by backspray reaction. The new injector offers the following advantages: (a) It reduces the severe erosion found to occur when ejector elements are directly exposed during throttling without the benefits of a cooling flow of the propellant liquids (fuel and oxidizer). (b) It greatly improves combustion efficiency by venting the secondary stream of combustion gases resulting from reaction of a backspray of propellants within the injector elements themselves. In the older design the gaseous combustion products would tend to escape through the impingement region of the liquid sheets, disrupting the mixing and atomization of propellant and thereby reducing the combustion efficiency.

The design and principle of operation of a typical unmodified impinging-sheet injection element are shown schematically in Figure 1. A large surface subject to erosion and corrosion may be observed. Two sheets of propellant components (oxidizer and fuel) are formed individually on the deflector surfaces, and then caused to impinge along a common line

(continued overleaf)

(impingement line), where a mixed spray of atomized propellant is formed. In addition to the main portion of the spray, which is directed away from the element, there is a smaller but still significant amount of back-spray which is directed into the cavity within the element. Under normal flow operation, the erosion problem is minimal. A typical rocket engine is modified by controlled variation in the thrust of the rocket engine exercised by varying the flow rate of propellants through the injector. The most effective throttling techniques involve totally shutting off the flow of propellants to one or several of the injection elements at some time during the throttling cycle. However, in previous impinging-sheet injector models, the injector elements were mounted externally; that is, the elements protruded from the face of the injector into the combustion zone of the thrust chamber. When turned off during throttling, and exposed without the benefit of a cooling flow of propellants, such elements suffered severe erosion and were rendered unserviceable, as a result of the high-temperature oxidizing environment in the thrust chamber.

One aspect of the new injector design involves relocating the injection elements within the face of the injector to reduce erosion and also to reduce convective heat transfer and provide greater opportunity for conduction of heat away from shut-off elements and into the body of the injector. Another aspect of the new design involves a structure to provide for the escape of back-spray gases other than through the slot where impingement occurs. Figure 2 shows a 35-element injector of one of the new designs with some of the elements in place and others not yet installed. In this design, the buried, vented configuration is achieved by brazing the injector elements into vented receptacles in the face plate so that the slots from which the propellant sheets emerge are flush with the injector face.

Although developed primarily for mixing liquid propellants, this injector design could find use in any system where two liquids must be efficiently mixed prior to being subjected to chemical reaction. For example, this injector could be adapted for oil burners. In the chemical industries applications could be in spray-drying equipment, liquid extraction systems, and in processes involving formation of monofilament-type sheets of polymers (plastics).

Note:

Complete details may be obtained from:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
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No patent action is contemplated by NASA.

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