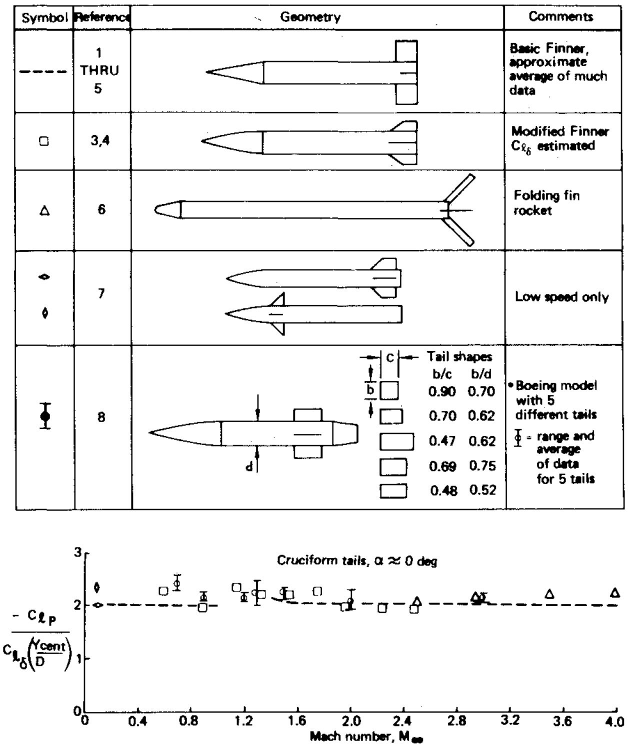

Fig. 1 Correlation of roll damping data for cruciform-tailed missiles.

configurations. This term is intended to account for differences in tail geometry and the ratio of body diameter to tail span. To obtain C_{ℓ_p} from Fig. 1, C_{ℓ_δ} must be known. Theoretial methods[10] and much experimental data are available for predicting this coefficient. Figure 1 is valid only for a missile with a single set of cruciform fins. If canards or wings are located ahead of a tail, large roll damping interference effects may occur between the forward and aft surfaces.[2]

Use of Eq. (1) to predict roll damping, within the limitations discussed above, should be adequate for most engineering purposes. Figure 1 should be updated as additional experimental data become available.

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A Calorimetric Bomb for Determining Heats of Combustion of Hypergolic Propellants

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Introduction

IN connection with our studies on hypergolic hybrid propellant systems,[1-3] it was found desirable to have an idea of the actual experimental values of their heats of combustion. A survey of the literature showed that, although a variety of bomb calorimeters[4,5] are available for measuring the heat of combustion values of solid fuels in gaseous oxygen, no suitable device exists so far for determining these values using a liquid oxidizer instead of oxygen. The apparatus described by Rastogi and Kishore[6] gives values very much lower than expected. Herein we report the design and operation of an improved bomb-calorimetric device for measuring the heats of combustion of hypergolic hybrid and biliquid propellant systems.

Experimental

Bomb Calorimetric Device

The usual pressure bomb assembly for the calorimetric measurements has been modified as shown in Fig. 1. The liquid oxidizer is placed in a specially designed duck-shaped glass vessel. The glass duck is supported by two loops of a stainless steel (SS) wire hanger around the pegs at the sides so that it is able to rotate freely. The hanger in turn is fixed by means of a screw to the lid of the bomb. The fuse wire usually meant for igniting the fuel is used for keeping the glass duck in the upright position, instead.

To start with, a known amount of the liquid oxidizer (HNO_3) is placed in the glass duck which is then fixed onto the hanger and supported by the fuse wire in the upright position. The fuel is placed in the SS cup. The bomb is then carefully closed and kept in an isothermal static-bomb calorimeter while connected to the firing unit. After the initial temperature has been noted, the firing switch is pressed, which results in the snapping of the fuse wire. The duck inverts and pours the entire oxidizer onto the fuel causing instantaneous ignition of the fuel. The rise in temperature is then noted and the heat of combustion is calculated[7] from the rise in temperature and water equivalent data. The water equivalent of the calorimeter was determined by the usual procedure in oxygen using AR-grade benzoic acid. The experiments were repeated for each fuel, varying the amount of the oxidizer close to

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