TSF012

An Investigation of the Ignition of Surface-to-Surface Missiles

Chirachaya Srikhao[1,2,*], and Lerkiat Vongsarnpigoon [2]

[1] Research and Development, Defence Technology Institute (Public Organization),
Ministry of Defense Changwattana Road, Pakkred, Nonthaburi 11120, Thailand
[2] Master Program in Engineering Technology, Faculty of Engineering, Thai-Nichi Institue of Technology
Pattanakarn Road, Suanluang, Bangkok 10250, Thailand
[*] Corresponding Author: chirachaya.s@dti.or.th, Telephone Number 087-4976459

Abstract

A type of Surface-to-surface missiles used by the Thai military mainly used solid propellant in a relatively simple propulsion system. Ignition of the propellant is initiated by hot gases passing through holes drilled at an angle along the surface of an embedded ignition case. This paper considers the effect of the angle of these holes on the flow and pressure of hot gases impacting on the solid propellant. Both cases of constant angle of the holes and varying angle are considered. The investigation has been carried out by the finite volume method using the program ANSYS FLUENT.

Keywords: solid propellants, ignition, pressure, velocity, finite volume

1. Introduction

Missiles of various types, e.g. surface-to-air missiles (SAM), surface-to-surface missiles (SSM), are used by practically all military forces in the world. They are actually an ancient weapon dated back at least a thousand year to ancient China [1]. Modern missiles are of course much more sophisticated but still basically rely on the same propulsion concept. The missile moves as a result of hot gas escaping from its exhaust end pushing it forward as a consequent of the conservation of linear momentum.

One type of surface-to-surface missiles used by the Thai military has a relatively simple propulsion system that lends itself to investigation and modification. On this missile, the propulsion system relied on an ignition of solid propellant which forms a hollow cylinder inside the body behind the missile head. Within the hollow cylinder sits an igniter which consists of an igniter case and igniter propellant. The igniter case is a solid composite cylinder with holes drilled at an angle along the surface to allow hot air to escape out and ignite the solid propellant. The igniter propellant is usually a cylindrical sack of solid propellant pellets with a primer inserted [2]. A schematic diagram of an SSM is shown in Fig. 1.

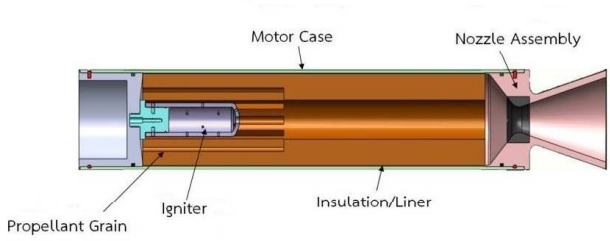

Fig.1 A schematic diagram of an SSM

To operate the SSM, the primer in the igniter is lit usually by electricity causing the igniter propellant to burn. This creates a rush of hot air out through the holes of the igniter case. The hot air in turn creates high pressure and temperature at the inner surface of the solid propellant cylinder leading to ignition. Clearly, it is desirable that the solid propellant is evenly ignited and burns uniformly along its length to create high thrust and stability. Hence, burning of the igniter propellant should lead to uniform high pressure and temperature along the surface of solid propellant.

Many studies have been made on the burning and ignition of solid propellants [3,4,5]. It was found that the ignition of the propellant depended very much on the surface temperature and pressure. There is a critical temperature and also a critical pressure which must be reached for ignition. However, the role of the igniter case has not been looked into much. This paper considers the effects of variation of the holes on the igniter case.

2. Investigation of the igniter case

As mentioned above, an igniter case is a small composite cylinder with regular holes through its length and a small amount of propellant packed inside. Hence the ignite case is modeled as a hollow cylinder inside another larger hollow cylinder with small space separating the two. One end of the nested cylinder is closed; this is the end next to the missile head. For simplicity, the nozzle assembly is ignored and the outer cylinder is assumed to be open to air at atmospheric pressure. Upon ignition, the propellant in the igniter turns into hot gas which escapes out through the holes in the case. Since hot gas is actually created. For calculation purpose, the burning propellant inside the igniter case is therefore modeled as a row of velocity inlet in the middle of the igniter case. Velocity and temperature of the gas coming out of the inlet are specified arbitrarily to be 100 m/s and 1000° K, respectively. The flow of the hot gas from the inside of the igniter case out through the holes in the case into the space inside the solid propellant can be calculated using the program ANSYS (FLUENT).