Chapter 12
Accelerated Aging Tests of HTPB-Based Propellants

Roberta Jachura Rocha
Aeronautics Institute of Technology, Brazil

ABSTRACT

In the late twentieth century, liquid and solid propulsion technologies have been integrated into hybrid engines currently applied in propulsion launch vehicles and missiles. The reaction of polyol (HTPB) and diisocyanate (IPDI) provides the most versatile of the binders in the production of solid propellants due to its ability to withstand high loads combined with low cost and ease of processing. A propellant based on HTPB obtained in this study was submitted to natural and accelerated aging tests, seeking to evaluate the modifications of mechanical properties as tensile strength, elongation and hardness up to 360 days. The mechanism considered in the aging process is the increase of crosslink density by breaking the double bond contained in the HTPB molecule, which causes the instability of the propellant, increasing its handling risk. Samples of these propellants subjected to aging presented variations in their properties that match the values available in the literature.

INTRODUCTION

Propulsion Systems Operation

Propulsion by rocket engines followed two distinct paths throughout the twentieth century. One, according to Tsiolkovsky’s view in Russia, Goddard’s in the United States, Esnault-Pelterie’s in France, and Oberth’s in Germany, understood that rocket propulsion was the key to accessing outer space, and for the consolidation of space travel, we opted for rocket propellant (MFPL) propulsion because of its superior performance when compared to solid propellant rocket propulsion (MFPS) propulsion. The other route in which it followed the propulsion by rocket motors was towards the development of the systems of armaments, in which the propulsion was adopted by motor rocket to solid propellant. It was decided to use the MFPS based on the need to combine good performance with the other characteristics provided by this propulsion model, such as the possibility of immediate use, its compact dimensions, lower cost.
and longer service life. At the end of the 20th century, liquid and solid propulsion technologies also found applications in an integrated form in launch vehicles and missiles, among others (Davenas, 2003).

**Solid Propellant Rocket Engines**

A rocket motor is the simplest form of chemical propulsion, capable of delivering high power in a relatively short period of time. Its main use is in the launching of satellites and probes used for space research.

Basically, the rocket motor consists of a metal cylinder, called a rocket motor tube, within which chemical reactions occur generating large amounts of gases at high temperature. In the rocket motor is the solid propellant, also called the propellant grain, which contains all the chemical elements necessary for a complete burning, since both the fuel and the oxidant are incorporated in a single solid. After ignition, the burning of the grain occurs without interruption on its surface at a predetermined speed, and the resulting gases from the burning are expelled back by a nozzle, which is an opening in the rear known as a nozzle (Vilar, 2005), as Illustrates Figure 1. Thus, the working principle of a rocket is based on Newton’s Third Law, the Law of Action and Reaction: the mass of gases expelled at high speeds at the rear of the rocket generates a force in the opposite direction Known as a thrust force that, together with the expulsion of gases, acts by propelling the rocket (Sutton & Biblarz, 2010), (Klager, 1984), (De Luca, et al., 2013), (Paubel, 2002).

A rocket motor is the simplest form of chemical propulsion, capable of delivering high power in a relatively short period of time. Its main use is in the launching of satellites and probes used for space research.

The solid propellant is the only material of the rocket motor with the function of being a source of propulsive energy if presenting simultaneously as a structural component. In order to provide a better understanding of the structural problems related to the rocket motor with solid propellant, a detailed analysis is required of all steps involved in the manufacture of the propellant, such as its formulation, the preparation of the motor envelope that will contain it, its healing process and of finishing of the grain,

*Figure 1. Solid propellant rocket engine*
*Paubel, 2002.*