PhD THESIS ABSTRACT

” CONTRIBUTIONS REGARDING THE INTEGRATION OF THERMOBARIC CHARGES IN BALLISTIC SYSTEMS”

Author: Eng. George-Ovidiu IORGA
email: ovidiu.iorga@nbce.ro, tel.: +40721 346 196
PhD supervisor: Colonel Tudor-Viorel ȚIGĂNESCU, PhD Professor

The purpose of this PhD thesis is to contribute to the present state of knowledge in the vast domain of thermobaric explosives, through original contributions regarding the characterization of the explosive transformation of thermobaric mixtures and their ingredients physico-chemical properties and stability as well as through theoretical and experimental study on the integration of thermobaric charges in ballistic systems. In order to achieve the thesis purpose, the scientific research activity implemented throughout the PhD studies program and presented herein was structured to meet the following objectives:

- Presentation of present state of development in the domain of thermobaric ammunitions, in order to identify the technical solutions for the integration of thermobaric charges in ballistic systems;
- Definition of thermobaric explosives, their main characteristics and particularities that individualize this class of explosives in the domain of energetic materials;
- Identification, by scientific literature review, of the appropriate materials and methods for the preparation of thermobaric mixtures and for the evaluation and characterization of their chemical and physical stability;
- A comprehensive presentation of the events that take place in the explosive transformation of thermobaric mixtures, aiming to gain a deeper knowledge of the post combustion phenomena and the way that it contributes to the destructive effect obtained through the thermobaric explosion;
- The study of the optimal configurations and the adequate ballistics systems for the integration of thermobaric warheads, in order to maximize the related destructive effect;
- Characterization, through numerical simulation and experimentation, of the characteristics, the chemical and physical stability of thermobaric mixtures consisting of liquid explosive and metallic powder;
- Characterization, trough numerical simulation and experimentation, of the detonation phenomena of thermobaric charges in confined spaces and in planar configuration;
- Determination, through numerical simulation and experimental firings of the interior, exterior and terminal ballistics parameters for a armament system consisting of a recoilless gun and a thermobaric with piercing capability ammunition;
- Testing and evaluation, trough real firings, of the overall behavior of the developed ballistic system with thermobaric ammunition and the obtained destructive effect on buildings and armored vehicle targets.

In order to achieve the thesis objectives a scientific review was implemented in the domain of ammunitions and explosives and also in related domains like analytical and physical chemistry, instrumental analysis methods, electronic acquisition systems, sensors and transducers, materials science, materials strength and numerical methods.

In the thesis, analytical methods, accelerated aging procedures, testing and evaluation methods for the particular case of thermobaric charges integrated in ballistic systems have been developed and implemented within the experimental laboratory work and field determinations.

The present work contributes to the present state of the art in the general knowledge, use and testing of thermobaric explosives and creates the premises for the development of new research directions in the studied domain.

The thesis is structured in 5 chapters, the first one being dedicated to the review of the present state of the art, while the scientific research part is presented in the following 3 chapters. The last chapter focuses the conclusions and original contributions of the thesis.

In the **first chapter** the present state of the art is reviewed for the field of thermobaric ammunition and explosives. The main thermobaric explosives and armament systems are presented and also the physical and chemical stability of thermobaric materials is discussed. Some aspects of ballistics for the particular problem of recoilless guns are presented.

The **second chapter** is dedicated to the study of the physical, chemical and stability characteristics of thermobaric mixtures. The energetic materials and the combustible metallic powders used in the mixtures are investigated and also their physical and chemical stability are studied.

The **third chapter** of the thesis presents the performance characteristics of the thermobaric explosives. By mathematical modeling, numerical simulation and experimentation the main detonation parameters of some thermobaric mixtures, less studied previously, are presented and the main advantages, in terms of performances, are highlighted.

The **fourth chapter** summarizes the scientific work conducted in order to study the integration of thermobaric charges in ballistic systems. The interior, exterior and terminal ballistics for a recoilless gun – thermobaric with piercing capability ammunition are presented.

The **fifth chapter** presents the conclusions of the thesis and the original contributions brought by the author to the current state of knowledge on the matter, among which most important ones are as follows:

- Development and validation of a new model and a function for the calculus and characterization of dynamic viscosity and the physical stability of thermobaric mixtures;
- New methodology of accelerated aging and chemical analysis for the characterization of the chemical stability of thermobaric mixtures;
- New model and method for the estimation of detonation and shockwave performance of the thermobaric mixtures;
- New thermobaric mixture formulation, physically and chemically stable, with proven superior explosive performance, compared to reference explosive (TNT);
- Experimental model for a new ammunition with combined piercing and thermobaric effect, for recoilless gun systems;
- Innovative method for the calculus of the exterior ballistics parameters for the developed ammunition.