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summary of

Origination of the model of porous propellant that are based on the main problem of inner ballistics by numerical solution

(PhD) dissertation

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I. Summary and aim of research work

Although there have been organizational and technological changes in the Magyar Honvédség and in the different armies worldwide, the firearms have stayed the fundamental armament tools. Among the top technology products the significance of the propellants that have been used for centuries has not decreased. Despite the technical development and organizational changes in most armies in the world – including the Magyar Honvédség – the firearms still play a significant role. On the basis of the latest literature data it seems, that the artillery, and infantry based on the latest principles for instance fluid filler, electric accelerated shells, etc will not replace the traditional guns for a long time.

Although the principle of the acceleration of shells has remained unchanged for centuries, the requirements for the gunpowders have greatly changed. Along with the standard military aspects (greater mechanical power, smaller heating load of the weapon, increased chemical stableness etc.) the importance of economy and environmental protection of manufacturing have increased although the changed word politics situation has decreased the quantitative demand on gunpowder.

One of the most important expectation concerning the powders is the optimal or approximately optimal power. In the construction of an increased efficient gunpowder the development of the production technologies is of high importance among with the new methods that can be used for the modelling of the functioning of the gunpowder.

The porous powders offer a new possibility of the specific increase of productivity mainly by the shortly barrels short arms (pistols, revolvers) and the civilian arms (for instance shot shell) and also by the industrial cartridges and blank cartridges.

Analysing the domestic and worldwide literature of the past 50 years concerning this topic - and for today it has radically decreased – I have not found a model describing the porous powders burning.

Considering the above mentioned facts I have set the following scientific aims:

- The scientific analysis of a new gunpowder model method in my dissertation
- Elaboration of the porous grains burning model.

In order to achieve the scientific aims set in my PhD dissertation the following methods were applied:

- Study of the international and domestic literature and analysis of the scientific works connected to the research topic;
- The gunpowder burning flowchart inferential analysis;

- Searching connected to the research topic, creation of a model (modelling);
- The parallel examination of the tentative and model results;
- Publication of the intermediate results reached in the field of searching.

I elaborated the various gunpowder burning models using literature. I made the parallel analysis of the methods. I determined the burning characteristics of the porous powders using the method of inferential ways and set up the model of grain burning expository and its computer program. I made computer and laboratory tests then evaluated and analysed these results. I elaborated the requirement system for the application of this model. I made suggestions on the application of the elaborated model.

II. Short description of the research work and its conclusions:

In the **first chapter** I scanned the physical – chemical process of the burning of powder, the metamorphosis of power grain to powder exhaust gas, as well as the weapon placed continued unravel inner ballistic model. I have determined those fundamental mathematical interrelations with which the process in question can be described with approximation. During the analysis process I laid special emphasis on the research of the critical stages from the point of view of burning.

In the **second chapter** I analysed the mathematical methods that are essential in the creation of the model, and then sorted those processes that are reliable and precise, with which the mathematical task can be solved.

In the **third chapter** I summarized the mathematical-physical model of the grains burning expository. I indicated those points, where the generic model deviates from the porous grains burning expository model.

In the **fourth chapter** I described the experience of the computer research carried out for the checking of the model. I presented the ballistic laboratory trials that have been executed and I compared the results with the results of the mathematical model.

III. Summary of the scientific results and recommendations:

The activities of the defence industry have gained a new aspect since the accession of the Republic of Hungary to NATO. One of these is the powder – mill. In order to meet the new application requirements the development of new cartridges and new charges of powder are required. The aim of my dissertation was to elaborate such a scientific model that provides help to meet this requirement.

Considering the aims set up I have done the following my dissertation:

I analysed the physical – chemical flowchart of the burning of powder, the metamorphosis of powder grain to powder exhaust gas, as well as the inner ballistic model that unravels the process going on in the weapon.

I determined those fundamental mathematical interrelations and their physical aspects with which the process in question can be described with approximation.

I determined that the phenomenon which can be described with the help of the integrable model leaves several questions unanswered, because the modellers had a different aim or because the solvability and control through measuring is not solved.

I developed a numerical integrable model, which makes it possible to describe a wider spectrum of phenomenon and gives response to such important questions, which control can be solved with the modern measuring equipments.

I analysed the solution possibilities of the linears that make up the model, and observed the acceptability and degree of the closed format solution.

I scanned the processes that serve the numerical solution and the tasks that have to be solved during their applications.

I concluded that since the model developed by me is not a linear differential equation system, the closely-knit shaped solution can only be solved by considerable simplification. The numerical solution can be carried out. For the numerical solution the Runge-Kutta type uniform should be used and at least a quaternary methodology should be applied.

I analysed the necessity of porous powder application. I observed the schematic manufacturing technologies and I justified the feasibility of porous gunpowder manufacturing. I analysed the physical-chemical flowchart of the powder-mill.

I analysed in chronological order with the help of literature the technologies elaborated for the manufacturing of porous powder.

I developed the geometric and inner ballistic model of the porous gunpowder. I defined the notion of effectivity, and also the effective burning lay, the effective burning velocity, the effective density and the porosity factor.

I developed the computer program for the porous gunpowder model.

I made tests in order to check the mathematical model. I compared the testing results with the results of the model.

I determined that the measurement results can be reproduced with a comparatively wide assortment of powder types using the model. The powder burning phenomena can be well described with the assumptive values of the powder porosity factor introduced by me.

Summary:

- I have carried out the scientific analysis of one new gunpowder model
- I elaborated the modelling of the porous grains burning model and the computer programme representing this model

Scientific results:

1. Modelling the inner ballistic process serving differential equation system line-up.
2. Creation the porous powder inner ballistic flavour reflective geometric model.
3. Definition of the burning of porous powder with the classic model modelling possibility "factor of porosity" notion, which makes possible the application of normal powder model on porous powder.
4. Elaboration of the method for determining the factor of porosity dates of characteristic of materials by the measuring data

Recommendations:

On the basis of the facts mentioned in the PhD dissertation I suggest the following:

The elaboration of such scheming program based on the powder model elaborated by me, which makes it possible to design a trustworthy ballistic scheme also in such case when porous powders are applied.

The creation of a gunpowder making superintending program and measuring system based on the model, which makes possible a quick and accurate interference in the powder manufacturing process.

In my opinion this dissertation contributes to the success of the technological conversion by the Magyar Honvédség in the frame of NATO integration. The technological methods elaborated by me can be applied on both the development of new products and on the production of the current products in one of the defence industry applications in the manufacturing of the powder.

The results can be used in the education of this field and also in the postgraduate education.

I my point of view I have successfully applied in my dissertation the 30 years of technological developer experience and the knowledge I have gained during my PhD training, which contributes to the technical development of the domestic defence industry.

IV. Own publications that connect to the essay:

Publications:

1. Piroska György: Páncélozott szállító harcjármű + hajóágyú = kísérő jármű, Haditechnika 1980/1
2. Tanulmány a tábori tüzérségi lövedékek lőtávolságának növelési lehetőségéről, TD05113/HTI sz., 1980
3. Piroska György: A 122 mm-es önjáró tarack, Haditechnika 1981/3
4. Tanulmány az osztályparancsnoki figyelőműszer valamint az ET-78 távmérő és a PAB-2A tüzér tájoló műszer beépíthetőségéről, TD05393/HTI sz.,1982
5. Algoritmus leírás a passzív mozgású tüzérségi lövedék mozgását meghatározó programhoz, Nyt 4709/HTI sz., 1982
6. Piroska György: Az MT-12 szovjet páncéltörő ágyú, Haditechnika 1983/2
7. Tanulmány a MN Haditechnikai Intézet kísérleti osztály méréstechnológiájának modernizálásáról, 0319/1983/HTI sz., 1983
8. Tanulmány a lőszerek lőtávolságának meghatározásáról, TD006376/HTI sz., 1984
9. Ismertető az ÁRPÁD II. ballisztikai program eredményeiről, 0858/1989/HTI sz., 1989
10. Piroska György: Csöves lőfegyverek, Egyetemi jegyzet, Budapesti Műszaki Egyetem, www.manuf.bme.hu, Budapest, 1995
11. Piroska György: A lőpor geometriai méret változás hatásának sztohasztikus szimulációja a belballisztikai folyamatokban, ZMNE, 2000
12. Piroska György: A belső ballisztikai folyamatok modellezése, Haditechnika 2001/3
13. Lőpor porozitási jellemzők elemzése ballisztikai bomba mérések alapján, ZMNA Haditechnika 2002 szimpózium különkiadvány
14. Porózus éghető anyagok égéselméleti modellezésének néhány kérdése ZMNA Haditechnika 2002 szimpózium különkiadvány
15. Piroska György, Dr. Szabó Tibor: Az M139Y MOD-1 izraeli közelségi gyújtóval végrehajtott kísérleti-ellenőrző lövészet tapasztalatai, Haditechnika 2003/2 (50%)
16. Bevonatolt lőpor égéselméleti modellezésének néhány kérdése ZMNA Haditechnika 2004 szimpózium különkiadvány
17. Dr. Szabó Tibor, Dr. Erdélyi Sándor, Piroska György: Tüzérség, Haditechnikai Füzetek 2004/2 (40%)
18. Dr. Szabó Tibor, Petrovics Mihály, Piroska György: A NATO STANAG meteorológiai és ballisztikai jelentések átalakításának és számítógépes feldolgozásának lehetőségei a Magyar Honvédségben, ZMNE Tudományos Könyvtár, 2004 (20%)
19. Piroska György: Belső ballisztika, Egyetemi jegyzet, Budapesti Műszaki Egyetem, www.manuf.bme.hu, Budapest, 2004

20. Piroska György: Külső ballisztika, Egyetemi jegyzet, Budapesti Műszaki Egyetem, www.manuf.bme.hu, Budapest, 2004

Interpretations:

1. The concept of ordnance equipment's development and our achievmets in field during the period of Hungary's accession to NATO (Előadás, Varsó Fegyverzeti HTI 1999. Időtartam 20 perc)
2. Lőpor porozitási jellemzők elemzése ballisztikai bomba mérések alapján (Előadás, Budapest ZMNA Haditechnika 2002 szimpózium, Időtartam 20 perc)
3. Porózus éghető anyagok égéselméleti modellezésének néhány kérdése (Előadás, Budapest ZMNA Haditechnika 2002 szimpózium, Időtartam 20 perc)
4. Bevonatolt lőpor égéselméleti modellezésének néhány kérdése (Előadás, Budapest ZMNA Haditechnika 2004 szimpózium, Időtartam 20 perc)

Patents:

1. Eljárás és vezérlő berendezések tüzérségi tűzvezető rendszerek automatizálására (Szabadalom 1988, lajstrom szám: 195.715, 5%)
2. Megvezető szerkezet zárszerkezettel ellátott csőhátrasiklásos kézifegyverekhez (Szabadalom 1990, lajstrom szám: 207.156, 10%)

V. PROFESSIONAL, SCIENTIFIC AUTOBIOGRAPHY

Study:

On the Budapest Polytechnic Mechanical Engineer Department in 1974 I have received a degree as a Mechanical engineer

On the Eötvös Lóránd University of Science Natural Science Department in 1981 I have received a degree as a mathematician for applied mathematics

On the Zrínyi Miklós National Defence University in 1991 I have made an intermediate English military language exam

On the Zrínyi Miklós National Defence University in 1998 I have made an intermediate German military language exam.

Job site:

I have been working for the Mod Technology Agency since 1974 – as a civil servant – research-worker.

Professional knowledge:

My main field of work is the exterior - and interior ballistic design, models and the test ballistics within weapon and ammunition development. Apart from the main activities I work with cannonry instruments development and testing.

I had been involved in the development and testing of different standardized and applied military devices such as:

- 14,5 mm ‘Bodzabél’ range cartridge
- 82 mm automatic mortar
- KT -83 – ISZM-1 manual laser rangefinder and goniometer tool
- ÁRPÁD fire-control system

I participated in more development processes and testing with Nitrokémia Co., Bakony Művek, Mátravidéki Fémművek, DIGÉP, and MOM.

I participated on different conferences, where I made presentations.

During my development work I have made different studies and participated in the elaboration of more patents.

Tutoring:

Between 1982 - 1988 I have led the professional training of more Vietnamese undergraduates.

Between 1988- 1991 I participated in the engineer training systems as a visiting master at the BME National Defence Group.

Since 1997 I organize in the topic of exterior - and interior ballistician at the BME Machine Engineering Department training systems.

Other scientific activities:

I am one of the founders of the Hungarian Astronautically Association.

I am president and one of the founders of the Hungarian Ballistic Association.

Others :

ZRÍNYI DÍJ (Award) for the ÁRPÁD fire-control system.