REVIEW

of the dissertation of Master **Eng. Miroslav Dimitrov Simov on the topic:**

"INCREASING THE SERVICE LIFE OF PLASTIC INJECTION MOLDING TOOLS"

for the acquisition of an educational and scientific degree "Doctor" in the professional field 5.1. Mechanical Engineering, PhD Program "Methods for Control and Testing of Materials, Products and Equipment"

Reviewer : Nikolay Tonchev – tontchev@vtu.bg

1. Characteristics of the dissertation

Miroslav Simov has in-depth technical expertise in the field of machine tools and plastic tools, complemented by significant managerial and teaching experience. His professional activity is closely related to mechanical engineering, construction and management of production processes, with a special focus on injection molds and plastic parts.

The career of a magician. Ing. Simov started in 2002, and key positions in his professional path include:

- Design Engineer – design of injection molds for the production of sensors for pneumatic drives.
- Head of Injection Mold Maintenance and Repair Department, Arexim Engineering Ltd., Sofia. Smolyan – responsibility for maintenance and repair of tooling used in the production of plastic parts.
- Design Engineer (July 2006 – August 2007), ZMM Ltd., Sofia. Smolyan – preparation of design and technological documentation for products in the field of woodworking tools.
- Constructor (September 2003 – July 2006), Arexim EOOD.
- Teacher (February 2002 – September 2003), "Hristo Botev" Vocational High School, Sofia. Smolyan – teaching machine drawing and application of CAD/CAM systems.

Ing. Prof. Simov holds a Master's degree in Mechanical Engineering from the Technical University of Sofia, Plovdiv Branch (1997–2002) and is a full-time PhD student at the Plovdiv University "Paisii Hilendarski" (as of 2022).

2. Relevance and significance of the dissertation

In today's world, with the ever-increasing use of polymer materials in modern industry, especially in automotive, electronics and consumer goods manufacturing, the issue of the life of tools (injection molds) is very important both from a technological and economic point of view. It is precisely this circumstance that mostly determines the relevance of the presented problem.

The strengths of the dissertation are expressed in the integrated approach to the problem used, combining theoretical research, computer simulation and experimental verification. Especially valuable is the detailed analysis of the influence of modern additives in polymers, including combustion retardants based on phosphorus, bromine and chlorine, on the corrosion destruction of molding surfaces. This aspect is rarely considered with the necessary depth in the existing literature.

The practical orientation of the study represents another essential force. The dissertation is not limited to theoretical reasoning, but proposes specific technological solutions applicable in real production conditions. The use of computer simulation with Moldex 3D to predict critical wear zones and optimize the structure from the design stage is a modern and effective approach.

The experimental part is distinguished by precision and the use of modern research equipment. The application of atomic force microscopy to study the topography of coatings, nanoindentation to determine mechanical properties and a callotester to measure thickness demonstrates a high level of technical equipment and methodological maturity.

As for the weaknesses, the following points can be noted. While the research is extensive, it could be expanded to explore a wider range of coatings, including modern DLC coatings and multilayer nanostructured systems. There is also a lack of systematic research on the cost-effectiveness of the proposed solutions, which would be particularly valuable for industrial applications.

3. Evaluation of the exhibition

The structure of the dissertation is logical and consistent, following the classical scheme of scientific research. The literature review is comprehensive and demonstrates excellent knowledge of the current state of the problem. The dissertation successfully systematizes extensive information on the types of wear, modern tool materials, powder-metallurgical steels, metal-ceramic materials and surface coatings.

The presentation is clear and precise, with appropriate use of technical terminology. The text is richly illustrated with figures, tables and diagrams that effectively support the presentation and make it easier to understand the results presented. The results of the computer simulation are particularly well presented, where the visualization of temperature fields, melt pressure and orientation of glass fibers provides valuable information about the mechanisms of wear.

The experimental part is structured methodically, and each methodology is described in detail before the presentation of the results. This allows for reproducibility of research and facilitates the critical evaluation of the data obtained. The mathematical dependencies are clearly formulated, and the statistical processing of the experimental data is correct.

The conclusions in each chapter are specific and logically follow from the results presented. The author demonstrates the ability to critically analyze and synthesize

information. However, some sections could be shorter, avoiding repetition of information that has already been presented in previous chapters.

The language and style of presentation are at a good level. Technical terms are used correctly and consistently throughout the text.

4. Assessment of the dissertation's knowledge

Magus. Ing. Miroslav Simov demonstrated in-depth and systematic knowledge in the field of tool production, materials science and tribology. Its preparation covers both the fundamental aspects of material wear and the practical features of the design and operation of injection molds.

Knowledge in the field of polymer materials is at a high level. The dissertation precisely describes the influence of different fillers and additives on tool wear, demonstrating an understanding not only of mechanical but also of chemical processes in the processing of plastics.

In the field of modern methods of surface treatment and coating, the dissertation shows excellent orientation. Knowledge of PVD and CVD technologies, nanoindentation, atomic force microscopy and methods for assessing adhesion is up to date. The ability to work with complex measuring equipment and interpretation of the results obtained is at a very good level.

Proficiency in modern CAD/CAE systems for design and simulation of casting processes has been demonstrated convincingly. The results of the simulation with Moldex 3D have been professionally analyzed and interpreted, making valuable conclusions for optimizing the design and technology.

The overall assessment of the knowledge of the dissertation student is very good and fully satisfies the requirements for acquiring an educational and scientific degree "Doctor".

5. Assessment of contributions

The scientific contributions of the dissertation are clearly formulated and have both scientific-theoretical and applied nature.

The first contribution related to proving the feasibility of determining areas of intense wear by means of computer simulation is valuable from the point of view of a preventive approach to the problem. Establishing the relationship between local temperature exceedances and potential corrosion destruction is an important result that can be used in design optimization at the design stage.

The second scientifically applied contribution on reducing the specific wear intensity while increasing the load for the Ti/TiN/TiCN coating is an interesting result that defies intuitive expectations. Establishing this fact has practical implications for the selection of coatings for high-duty applications.

The third scientifically applied contribution to the influence of pre-mechanical and thermal treatment on the wear resistance of the Ti/TiN/TiCN coating confirms the importance of a comprehensive approach to surface preparation. The finding of a 130-

fold reduction in wear intensity on a hardened and polished underlay compared to an uncoated surface is an impressive result with clear application implications.

The fourth scientifically applied contribution on the topography of laser-welded surfaces is important for practice, as it demonstrates the possibility of restoring worn areas without deterioration of surface quality.

Applied contributions are particularly valuable from an industrial point of view. The proposed methods for laser welding of cracks in critical areas and restoration of worn areas are directly applicable in production practice. Proving that the hardness of laser-welded layers with SDLSTA alloy is comparable to that of the base material makes this method particularly attractive for repairing expensive injection molds.

The proposed technology for recovery by welding and sandblasting, successfully applied in real production conditions and extending the life of the tool from 300,000 to 1,100,000 cycles, demonstrated a significant economic effect.

In general, the contributions have a pronounced scientifically applied nature, with the emphasis placed on solving specific practical problems based on scientifically based approaches. They represent real added value to existing knowledge in the field.

6. Publishing

The following publications related to the dissertation are indicated in the work: The first publication in the journal "Machines" (MDPI) with an impact factor is in a prestigious international open access journal, indexed in Web of Science and Scopus. This publication examines the wear resistance of Ti/TiN/TiCN hard coating on Stavax ESR steel and presents key results from experimental studies.

The second publication in the Romanian Journal of Materials is also in a reputable international journal, indexed in authoritative databases. It is dedicated to the study of laser-welded layers and their properties.

The third publication in the International Journal of Advanced Research in Engineering and Technology is in an international journal with ISSN, which guarantees international visibility of the results.

The publications cover the main areas of dissertation research and demonstrate the ability of the dissertation student to present his results at an international level. The fact that two of the publications are in journals indexed in prestigious international databases is an indicator of the quality and significance of the research.

7. Bibliography evaluation

The bibliography of the dissertation includes 137 sources, which testifies to a thorough literature review. The cited sources cover a wide time range, including both classic works of the late twentieth century and state-of-the-art publications of recent years.

The structure of the cited sources is balanced, including scientific articles from reputable international journals, monographs, technical catalogs of manufacturers of materials and equipment, as well as standards. This demonstrates a comprehensive

approach to the study of the problem, combining fundamental scientific knowledge with practically applicable technical solutions.

As a note, it can be noted that it would be useful to include more publications related to the cost-effectiveness of different methods for increasing the resource, as well as comparative analyses of alternative technological solutions.

8. Conclusion

The presented dissertation of Mag. Ing. Miroslav Dimitrov Simov on the topic "Increasing the service life of plastic casting tools" is an in-depth and complex study of a current problem in the field of mechanical engineering. The work is distinguished by an excellent literary review, precise methodology of experimental research, modern technical equipment and valuable scientific and applied results.

The dissertation demonstrates in-depth knowledge in the field of tool production, materials science, tribology and modern surface treatment technologies. The combination of theoretical research, computer simulation and experimental verification makes the study comprehensive and convincing.

The presented scientific contributions have both scientific, theoretical and practical value. The proposed methods for increasing the life of injection molds by applying hard coatings and laser restoration of worn areas are applicable in industrial practice and can lead to a significant economic effect.

Publications in reputable international journals testify to the quality of the research and the ability of the dissertation to present its results at an international level.

Based on the above, I recommend with full conviction that the esteemed jury award a magus. Ing. Miroslav Dimitrov Simov, after successful defense, the educational and scientific degree of "Doctor" in the professional field 5.1. "Mechanical Engineering".

11.11.2025 /. . . . . /

Prof. Dr. Nikolay Tonchev