

Opponent's opinion of the doctoral dissertation

Doctoral student: **Amany Ahmed Salama Khalil, M.Eng.**

Name of dissertation thesis: **Effect of elastic knitted fabric construction parameters on thermo-physiological properties**

Opponent: **CAPT. Ing. Jana Švecová, Ph.D.**

Topicality and significance of the topic

Dissertation thesis addresses an important and very beneficial topic. Problematics of investigation of the effect of construction parameters of elastic single jersey knitted fabric on the geometrical and thermo-physiological properties is very topical for several reasons:

- The thermo-physiological properties of the fabric are one of the most important properties that affect on the comfort and psyche of human and it is very important for the wearing of clothing, whether for sports, professional soldiers or the other application.
- The spandex incorporating in the weft knitting machine had a good impact on the geometrical and thermo-physiological properties.
- This study presented an innovated 3D geometrical models and it was noticed that the overlapping structure had the smallest pore volume, followed by the maximum set, followed by the open structure.
- It was marked that new derive model is prepare to be used for prediction of thermal properties of SJKF.

Therefore, I believe that the chosen topic of the dissertation is beneficial and promising.

The aim of the dissertation

Based on the literature review, were identification aims of the thesis in chapters three:

1. To investigate the effect of construction parameters of elastic SJKF (yarn count, loop length, spandex weight percent and plaiting technique) on the geometrical and thermo-physiological properties.
2. To analyse the effect of spandex percent on fabric growth and fabric stretch of SJKF.

3. To present a theoretical 3D model of stitch overlapping, maximum set, and open structures by using AutoCAD software to investigate the pore size and distribution for different SJKF structures.
4. To apply three simple mathematical models (Maxwell–Eucken 2, Schuhmeister, Militky) of thermal conductivity to investigate if these models can be used to predict the thermal conductivity of elastic SJKF.
5. To derive a new equation that describes the thermal conductivity of the elastic SJKF based on the loop geometry and the yarn and fibres inclination on the direction of heat flow.
6. To assist the manufacturers and designers to predict the thermo-physiological properties of elastic SJKF produced from cotton yarns.

Selected methods and solution procedure

The solution procedure has a logical structure, the appropriate graphic and language level. The work can be divided into theoretical and practical part. From the review of literature followed to need investigation the effect of spandex weight percent on the thermo-physiological comfort properties of elastic SJKF. First, the influence of the design parameters of the elastic SJKF, namely yarn count, loop length and spandex weight percentage, on the geometric and thermophysiological comfort properties was estimated. Second, a mathematical model for predicting the thermal conductivity of elastic SJKF was presented. Third, a new approach was proposed to investigate the pore size and pore distribution inside the SJKF structure. The chosen solution methods are suitable for this area of scientific work.

Evaluation of achieved results

Two different numbers of worsted yarns were made from Giza 86 Egyptian cotton fibers. Full and half knit SJKFs were then produced with two yarn counts and five levels of spandex weight percent and five levels of loop length. The spandex yarns were incorporated using a braiding technique where the spandex yarns have a separate feed system, a braiding roller and a guide eye. The percent spandex treatment was obtained by adjusting and optimizing the speed of the spandex feed system. The results of investigating the effect of design parameters, namely yarn count, loop length, spandex weight percentage and knitting technique on the geometric and thermophysiological comfort properties of fully and half knitted SJKF, were found by measuring the thickness, weight, stitch density, bulk density of the fabric, thermal conductivity and absorbency, water vapor resistance and air permeability. Using a flexi frame, the growth and stretch fp of the knitted samples were measured and the thermal properties were measured at two stretch levels of 15

and 30%. The new model can be used to investigate the thermal conductivity of elastic SJKF and vice versa, where an attempt has been made to determine the structural parameters to obtain the desired thermal conductivity. These and other findings are important for designing and preparing different types of knitwear from elastic materials intended for the first layer of clothing and other applications.

Significance for the practice or development of a scientific field

The dissertation sought to present findings that could be useful in defining future direction and provide researchers with insider references. All of the above findings of research experiments should be taken into account with great importance in the design and preparation of knitted fabric production. The work opens up further space for continuing the investigation of the influence of design parameters on the thermophysiological properties of elastic knitwear with a change in raw material, fabric structure and an increase in the number of yarns. I see another benefit in the presented an innovated 3D modelling, the possibility of using a new geometric model to investigate the thermal conductivity of elastic SJKF and to propose an attempt to determine the structural parameters to obtain the desired thermal conductivity. The results can also be used for the patterning and innovation phase of functional clothing components of the armed and safety forces of the Czech Republic.

Publication activity

The publishing activity of the doctoral student is adequate and relates to the topic of the submitted dissertation. The doctoral student published 8 articles in professional Journals and 7 articles in professional Conferences.

Questions and comments on the dissertation:

In my opinion, the introduction to the thesis lacks the theoretical basis of selected thermophysiological and geometric properties in relation to clothing comfort, together with the introduction to the topic.

Other comments are more of a formal nature, resulting from the inconsistency of the structure of dissertations at various universities in the Czech Republic. ČSN ISO 7144 (010161) Documentation - Formal arrangement of dissertations and similar documents: states that the formal arrangement, style and arrangement of the bibliography of dissertations must be in accordance with the special rules of the university to which the dissertation is submitted. According to the extract from the TUL Study and Examination Regulations, Article 20, Point 3, the requirements for the content of the thesis are met. In Article 20 point 5) it is further stated that the

indicative scope of the dissertation and other comments may be further modified by the relevant directive of the dean. I did not have this document. However, I would like to make a few comments, rather recommendations for a better overview and coherence of the text in the future:

- After each chapter, it would be appropriate to have another subchapter in the form of a partial conclusion, which summarizes the most important and key things that happened in the chapter, the most important findings.
- Unification of bullet points, sizes and placement of images, tables throughout the work.
- Cite the source for each figure and table, especially in the theoretical part, even if it is your own source.

My questions:


1. It is clear from your results that the addition of spandex to SJKF had a good effect on the geometric and physiological properties as well as on the elastic recovery. How much would the cost of the garment and its production differ by adding spandex to the fabric?
2. What next direction will you take in your research?

Final evaluation

The submitted dissertation fulfilled the subject and goals set in the introduction. It meets the requirements on dissertation thesis, including verification of authenticity, publication activities and therefore **I recommends work for defense.**

July 7, 2023 Brno

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Review Report on Doctoral Dissertation

of Amany Ahmed Salama Khalil, M.Eng.

entitled: **“Effect of elastic knitted fabric construction parameters on the thermo-physiological properties”**

prepared based on invitation letter delivered on 6th June 2023

from Dean of Faculty of Textile Engineering doc. Ing. Vladimír Bajzik, Ph.D.

Supervisor:

Ing. Pavla Těšínová, Ph.D. Department of
Textile Evaluation Department
Faculty of Textile Engineering
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General description

The review has been performed on the basis of the Doctoral Dissertation in English.

The doctoral dissertation consists of 10 chapters, including an introduction, an overview of the current state of the problem, description of experimental parts, evaluation of results and new findings, list of references, and appendices. Additionally, a list of papers published by the author and a short Curriculum Vitae are included.

The material of the doctoral dissertation contains 109 pages, including 54 figures and 34 tables. The content of the dissertation is presented and divided into ten individual chapters. In the beginning, the list of abbreviations and nomenclature used in the dissertation is presented.

The first chapter was an introduction and overview of the current state of the problem. The second chapter was a review of the scientific literature. The third chapter describes the aim of the thesis.

The fourth chapter is focused on the studied material and used method. In this chapter, the characterization of yarns used in the fabric production, the materials description, experimental techniques, and research methodology are included.

Chapter five is the longest chapter focused on summary of the achieved results and studied the effect of construction parameters on the geometrical and thermo-physiological properties of elastic knitted fabrics. Chapter six proposed a 3D geometrical model of stitch overlapping. Chapter seven presented a prediction of thermal conductivity of elastic *SJKF*.

The summary of research work, evaluation of results, new findings, and recommendations

are presented in chapter eight. Chapter nine included 94 scientific references. Finally, in the last chapter of the dissertation, some of the appendices are included.

■ The topicality of the thesis

The main goals of the presented scientific work were:

- Firstly, to study the effect of construction parameters of elastic single Jersey knitted fabric (*SJKF*) on the thermo-physiological properties.
- Secondly, to propose a 3D geometrical model to investigate the pores volume through three different structures of knitted single jersey.
- Thirdly, to present a model of the thermal conductivity that could use to predict the thermal conductivity of elastic knitted fabric based on the fabric construction parameters and fibers inclination to the heat flow direction.

To achieve these goals, 120 *SJKF* samples were produced with different levels of construction parameters. The author tries to assist the manufacturers and designers of knitted fabric by her attempt to predict the construction parameters of elastic knitted single jersey fabric, when the requested thermal conductivity is known, as illustrated in chapter 7.

In accordance with the topic of research, the aim has been achieved. The aim of the dissertation is actual, very interesting and important from the practical point of view in industry.

Taking the above into consideration, I can state that the dissertation topic is current and relevant in the context of up-to-date research in textile material engineering.

■ Methodology

PhD candidate has produced two combed yarn count, then produced full plaited and half plaited *SJKF* with five levels of loop length and spandex weight percent. Also, 100% cotton samples were produced at the same yarn counts and loop length. The geometrical and thermo-physiological properties were measured according to standard test methods, yarns diameter and its bending rigidity were also measured. The fabric growth and stretch were measured by designed flexi-frame.

AutoCAD software was used to draw the 3D model of stitch overlapping, maximum set, and open structures.

Chapters 5, 6, and 7 present many experiments and results with comments and analysis. All applied experimental methods have been described clearly and in detail. In my opinion, the methodology is adequate to the problem which the author undertook to solve.

■ Results and discussion

All experimental results have been presented clearly and in detail. The figures, schemes, and tables are correct and supported to analyze the findings. Results have been commented on deeply, but in some parts, they do not present why the results were observed.

■ Conclusions

In this chapter, evaluation of results and new findings were presented with conclusions of the work. Conclusions are based on results. The conclusions take into consideration all findings of performed experiments.

The dissertation showed some suggested and recommended solutions for the optimum selection of elastic *SJKF* based on the thermo-physiological properties.

Experiment and simulation confirmed that proposed theoretical model could represent the structure of elastic *SJKF* in different conditions.

■ Bibliography

The bibliography in the dissertation is wide and actual. The references include 94 items. They are mostly the scientific articles published in world-renowned scientific journals and conference papers. The selection of references is adequate to the topic of the thesis.

Referee remarks, questions, and conclusions

Remarks

The candidate thesis is interested in the thermo-physiological properties of knitted fabric and tried to find the optimum parameters that affect consumer comfort.

The author presented a theoretical 3D model of stitch overlapping, maximum set, and open structures using AutoCAD software to investigate the pore size and its distribution for different *SJKF* structures.

The author applied three simple mathematical models (Maxwell–Eucken 2, Schuhmeister, Militky) then derived a new equation that describes the thermal conductivity of the elastic *SJKF*.

Questions

Generally speaking, the whole work is interesting. However, there are few comments summarized below.

- 1- Finishing methods details applied on the fabrics before and after dyeing “mentioned in Chapter 4” need more elaboration.
- 2- The author is advised to cite some relevant references in CHAPTER 5: SUMMARY OF THE ACHIEVED RESULT everywhere. So, this part would be more objective.

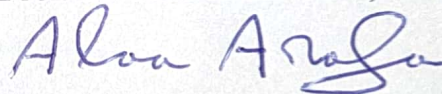
Conclusions

The author of the dissertation has high scientific achievements. The results of the research have been presented in 8 scientific publications, at 7 conferences and workshops.

At the conclusion of my review, I would state that the presented dissertation fulfils all formal requirements and the thesis conforms to principles and requests to the structure of scientific research.

Therefore, I recommend the dissertation submitted by Amany Ahmed Salama Khalil, M. Eng, for the next procedure at the Faculty of Textile Engineering of the TUL. In case of positive results of the dissertation defense, I recommend awarding the title of Ph.D.

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