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Enhancing the Comfort Properties of Headscarf Fabrics for Chemotherapy Patients Using Phase Change Materials

Hafez S. Hawas
Spinning and Weaving Dept., Faculty of Applied Arts, Helwan University, Giza, Egypt
Faculty of Energy and Industrial Technology, October Technological University, Giza, Egypt
Eman Zaher Goda
Spinning and Weaving Dept., Faculty of Applied Arts, Helwan University, Giza, Egypt

Abstract:

Technical textiles encompass textile-based products with performance and functional characteristics rather than decorative or aesthetic purposes. Medtech or medical textiles -also known as healthcare textiles- are one of the more continual expanding sectors within the market of technical textiles. A substantial class of the intelligent materials of medical or healthcare textiles are PCMs or phase changing materials; as their morphology (such as molecular structure, shape, solubility, porosity, state) is changed as a response to predetermined stimuli (such as chemical, thermal). PCMs possess several outstanding characteristics; they are nontoxic, highly chemically stabile, noncorrosive, biocompatible, and nonexplosive. PCMs can be embedded into textiles to create a material that combines both the benefits of PCM with the advantages of textile materials. When in contact with the human body, clothing should be comfortable for extended wear and free from issues like blood flow restriction, skin irritation, or other health problems. PCMs are ideal compounds for achieving this, as they help maintain the body in a comfortable and normal temperature range. There are countless applications of PCMs in the medical field, for example, heat and cold therapy. One of the most significant areas of medical concern is cancer. The three major clinical therapies for cancer are chemotherapy, radiation therapy, and surgery. Chemotherapy, in particular, aims to eradicate cancer cells by targeting rapidly dividing cells. One frequent and upsetting side effect of chemotherapy is alopecia (or hair loss). Alopecia, brought on by chemotherapy, is commonly cited as the most upsetting side effect of the cancer treatment. In addition to alopecia, chemotherapy patients often experience disruptions in their body's natural temperature regulation. Extreme hot or cold feelings result from this, and periods of shivering or perspiration make the physical pain worse. The scalp is more susceptible to these temperature changes since it is more exposed as a result of hair loss. By preserving a constant and comfortable temperature around the scalp, PCM-based textiles can aid in dealing with these issues. PCM materials can relieve sudden changes in temperature by absorbing, storing, and releasing heat as needed, which help in improving chemotherapy patients' comfort and general well-being.

Research Problem: Hair loss (Alopecia) caused by chemotherapy is a prevalent and distressing side effect that many cancer patients experience. It can cause psychological problems including poor self-esteem and social withdrawal. Chemotherapy can also interfere with the body's natural ability to regulate its temperature, leading to uncomfortable physical sensations of extreme heat or cold.

Research Importance: Using PCM materials can relieve the sudden changes in temperature by absorbing, storing, and releasing heat as needed, which help in improving chemotherapy patients' comfort and general well-being.

Research Objectives: Creating head covering materials that use Phase Change Materials (PCMs) to reduce the symptoms of cancer. These PCM-based textiles are designed to improve patient comfort and well-being during chemotherapy by preserving an even and comfortable temperature around the scalp.

Research Methodology: This experimental work focuses on studying the effect of different weave structures and weft materials on the comfort properties of produced headscarves fabrics as air permeability, Moisture Vapor Transport Rate (MVTR), stiffness, horizontal wicking, and latent heat. Four samples were produced, using ITEMA dobby weaving machine. Two weave structure (Matt Rib 2/2 and Piqué) were used for producing the samples. Five comfort testing were carried on samples to evaluate its performance according to standard test methods and end use. Air permeability, Stiffness, Horizontal wicking, Water vapour permeability and Differential scanning calorimetry (DSC) were all conducted to research samples. The porosity percentage of the fabrics was assessed using a digital image analysis technique. Images were captured with a mobile magnifier application. These fabric images were initially saved in grayscale and then converted to black-and-white monochromatic images using Adobe Photoshop. Following this, the

Nedgraphics program was used to analyze the images and determine the porosity percentage by calculating the ratio of each color pixel.

Results: The main objective of this work was manufacturing a blended woven headscarf fabrics using three weft materials and blended as following ratio (50 % viscose PCM: 50 % Lyocell & 50 % viscose PCM: 50 % Bamboo) with two weave structures (Matt Rib 2/2 & Piqué) and examining the effect of this parameters on comfort and heat capacity properties. From the results, statistical analysis and discussion concerning the comfort properties of produced fabrics evidently showed that: Air permeability property of produced headscarf fabrics have been increased by using Piqué weave. Whilst the Bamboo as weft materials have achieved the highest rate of air flow through both side of fabric. Piqué Weave has recorded higher rates of Moisture Vapour Transport Rate (MVTR). However, Lyocell has recorded the highest rates of (MVTR). Piqué weave has recorded lowest rates of fabric stiffness. Whilst the Bamboo as weft material has scored the smaller rates of fabric stiffness. Horizontal wicking property of produced headscarf fabrics have been increased by using Matt Rib 2/2 as weave structure. However, the Lyocell has been achieved the highest rates of horizontal wicking. Matt Rib weave has recorded higher rates of fabric latent heat compared to Piqué weave. Whilst the Lyocell has recorded the highest rates of latent heat. There is a direct relationship between fabric's weight and the heat capacity of produced headscarf fabrics.

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Chemotherapy, Alopecia (hair loss), Medical textile, Comfort properties, phase change materials (PCMs), Latent heat.

References:

1- C. Byrne, "Technical textiles market – an overview," Handb. Tech. Text., pp. 1–23, 2000, doi: 10.1533/9781855738966.1.

2- S. Zhezhova, S. Jordeva, S. Golomeova-Longurova, and S. Jovanov, "Application of technical textile in medicine," Tekst. Ind., vol. 69, no. 2, pp. 21–29, 2021, doi: 10.5937/tekstind2102021z.

3- A. R. H. and S. C. Anand, Handbook of Technical Textiles, 1st ed. Woodhead Publishing Limited in association with The Textile Institute, 2000. doi: 10.1533/9781855738966.372.

4- I. I. of T. Delhi, "Industry in India Technical Textiles Industry in India, Opportunities and Challenges, Baseline Study," 2020.

5- National Composites Network, "Best Practice Guide: Technical Textiles and Composite Manufacturing".

6- Z. Ahmad, M. S. Naeem, A. Jabbar, and M. Irfan, "Fibers for Other Technical Textiles Applications," Top. Mining, Metall. Mater. Eng., no. August, pp. 201–220, 2020, doi: 10.1007/978-3-030-49224-3_10.

7- S. Marwaha, V. Satyam, and A. Kulkarni, "Emerging Opportunity in Technical Textiles," Asian Textile Journal, vol. 15, no. 6. pp. 81–86, 2006.

8- R. Guru, A. Kumar, D. Grewal, and R. Kumar, "Study of the ImplanTable and Non-ImplanTable Application in Medical Textile," Next-Generation Text., pp. 1–14, 2023, doi: 10.5772/intechopen.103122.

9- Selim Molla, Md Minhajul Abedin, and Iqtiar Md Siddique, "Exploring the versatility of medical textiles: Applications in implanTable and non-implanTable medical textiles," World J. Adv. Res. Rev., vol. 21, no. 1, pp. 603–615, 2024, doi: 10.30574/wjarr.2024.21.1.0058.

10- S. Akter, A. Y. M. A. Azim, and M. A. Al Faruque, "Medical textiles: significance and future prospect in Bangladesh," Eur. Sci. Journal, ESJ, vol. 10, no. 12, pp. 1857–7881, 2014, [Online]. Available: https://eujournal.org/index.php/esj/article/view/3196

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