Thermal Comfort Evaluation of Seam Types in Athletic Bodywear

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Different seams join pieces of fabrics and create garment structure through different ways of multi-layering of fabric, which change thickness of garment in the seam and create bulkiness. It is possible that the changes in bulkiness and thickness around the seams affect thermal properties of clothing by introducing changes in resistance of heat and moisture transport inside garment to environment. Seams also affect weight of entire garment and tactile comfort on the skin, which are important consideration for those who value functionality of sportswear for their improvement in athletic performance.

Two key factors for determining the thermal comfort of fabric and clothing are I_t, thermal insulation, and R_{et}, moisture vapor resistance:

Thermal insulation of clothing affects the heat transfer between the human body and environment. Higher thermal insulation is preferred during winter to delay body heat loss to the environment. On the other hand, during summer lower thermal insulation is preferred for quicker body cooling to avoid thermal discomfort or heat stress. Therefore, active bodywear for athletes needs to have low thermal insulation so the garment facilitate body heat release to the environment to avoid possible thermal discomfort or heat stress while working out with increased body temperature.

Evaporative resistance is resistance of garment to moisture transport between the body and environment through fabric or garment surface. Therefore, a low evaporative resistance indicates a high level of breathability resulting in dry skin with low relative humidity inside the clothing. On the other hand, a higher evaporative resistance indicates low capacity of the fabric or garment to transport moisture from the body to environment. Therefore it results in high relative humidity inside the clothing causing the wet feeling.

To objectively evaluate the thermal comfort properties of three typical seams used in sportswear construction (overlock seam, flatlock seam and adhesive seam), this study examined 1) physical properties of seams created by the three seaming methods in small-scale fabric samples, and 2) thermal properties of activewear bodysuit created by the three seaming methods through a series of thermal manikin test.

In order to investigate the impact of each seaming methods on thermal comfort of bodywear, three different test bodywear were constructed using different seaming methods. The garments used to test on the thermal manikin Walter® (Hong Kong Polytech University, Hong Kong) was used to evaluate thermal properties of each test garment constructed by overlock seams, flatlock seams and adhesive seams. Pattern for each garment was created by using Optitex patternmaking software, and sewn using the different seam types for different trials. This design incorporates more seam lines than usual to see clear results.

Results of the experiment testing were summarized in Table 1 below.

Table 1. Summarized results of physical and thermal properties of test seams

	Overlock	Adhesive	Flatlock
Thickness (mm)	75.75	42.00	73.5
Frazer Air Permeability (ft^3/min./ft^2)	185.30	183.20	157.00
Fabric Weight (g/m^2)	279.18	264.20	288.85
Thermal Insulation (°C·m^2/W)	.165	.163	.184
Evaporative Resistance (Pa·m^2/W)	25.537	26.010	25.490

Adhesive seams created a considerably thinner seam than overlock and flatseams, while flat seams show the greatest increase in the garment weight because of dense stitching (Table 1).

The thermal insulation data collected from thermal manikin test showed that the flatlock seamed garment had a noticeably higher thermal insulation value at .184 °C·m^2/W than the overlock and adhesive seamed garments (Table 1). This result may be related to the fact that the substantial amount of thread used in the stitching of a flatlock seams may create a dense and insulating localized seam that keeps warm air inside the clothing system, considering the lowest air permeability found in flatlock seam shown in Table 1.

The evaporative resistance data collected from thermal manikin test showed that the adhesive was found to have a slightly higher evaporative resistance at 26.010 Pa·m^2/W than overlock and flatlock seam. Although the adhesive was perforated, the thermoplastic material may not allow for evaporation as readily as a thicker seam of fabric and thread.

This study compared the physical and thermal properties of three typical sportswear seams in a controlled lab conditions to provide practical implications to technical designers' decision making in activewear design and production. Future study should include human performance test in a more thermally challenging environment with higher temperature, which will provide more practical information, as well as comfort perception in terms of heat dissipation and evaporative cooling.