Development of “Clothing Pressure Simulation Technology”
That Calculates Clothing Pressure from Fabric Tensile-Strength Test Results

Toyobo has developed “clothing pressure simulation technology” that calculates the pressure on the human body while it is wearing clothing—in other words, the clothing pressure. This technology allows us to predict and calculate clothing pressure based on fabric tensile-strength test results without the need for sewing. It also enables detailed calculation of the clothing pressure distribution. The Company will use this technology to engage in product development and contract research.

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1. Background Information on Developing the Clothing Pressure Simulation Technology

(1) Development of various “sensory measurement technologies” that evaluate cutaneous sensations using instruments

Utilizing measuring instrument-based technologies to evaluate “stuffiness,” which is only a vague sensation, Toyobo developed “microclimate-within-clothing” materials (yarns and fabrics) in 1982.

Since then, we have built sensory measurement technologies for evaluating various cutaneous sensations and utilized and applied them to product development. To evaluate sensations by means of instruments, we have also developed and utilized our unique measurement instruments including sweating thermal mannequins TOM III and SAM and a leg-shaped wearing-pressure apparatus.

(2) Development and significance of clothing pressure simulation technology

As described above, Toyobo has proceeded efficiently and effectively with product development using its unique sensory measuring technologies. To measure the clothing pressures of pantyhoses and spats, we also developed a leg-shaped wearing-pressure apparatus and evaluated the tightness of wearing clothing using clothing pressure measurement instruments.

These evaluations pose various issues, however, in that they cannot measure or evaluate unsewed products and cannot make detailed measurement of the clothing pressure distribution. Consequently, there was a strong need to seek technologies that calculate clothing pressures without the need for sewing.
To address such issues, we developed the new method, clothing pressure simulation technology, which calculates clothing pressure based on fabric tensile-strength test results. By combining this new calculation technology with conventional sensory measurement technology, we can evaluate multi-dimensionally the comfort related to clothing pressures.

2. Overview of Toyobo’s Clothing Pressure Simulation Technology

Clothing pressure simulation technology refers to a technology that predicts and calculates clothing pressure on the human body while wearing clothing based on fabric tensile-strength test results.

Conventionally, clothing pressure was calculated from the tensile length (displacement) of fabric tensile-strength test results and the initial gradient of the force (load) that was being applied, and it was impossible to calculate the clothing pressure of tight-fit clothing or clothing worn at a high extension ratio. Moreover, there was no technology for calculating form-fitted clothing worn tightly. Toyobo, however, has recently achieved technology that very accurately calculates clothing pressure. This technology has two main characteristics:

(1) It predicts and calculates the clothing pressure of a fabric without the need for sewing and enables detailed calculation of the clothing pressure distribution.
(2) It selects the optimum fabric and pattern in relation to the designed clothing pressure without the need for sewing.

The mechanism of the clothing pressure simulation technology is shown below:

(1) Creation of knitted material model

Two characteristics of the elongation deformation of knitted materials, as shown below:

[1] There is no proportional relationship between the tensile length (displacement) and the force that is being exerted (load) nonlinear.
[2] Elongation deformation behaviors are different in vertical, horizontal and diagonal directions (anisotropy).

We created a knitted material model that represents these characteristics.

(2) Construction of dressing calculation technology

In the calculation process of mapping the pattern data onto the human body data, due to the curvature in human body data, direct calculation causes wrinkles in the dress pattern data, resulting in the halt of the calculation. As a solution, we placed a cylindrical intermediary between the pattern data and human body data and stabilized the calculation.

The above-mentioned knitted material model and dressing calculation technology obtain a calculation value that corresponds well to the actual measurement value as shown in the diagram below.
3. Future Deployment

(1) We will utilize the clothing pressure simulation technology in the product development of sportswear and underwear.

(2) We will undertake contract research of clothing pressure calculation using clothing pressure simulation technology.

(3) In addition to clothing, we will deploy this technology to other applications that indicate “anisotropy” and “nonlinear” deformation behaviors.

(4) We will further improve this technology and proceed with the following development:
   [1] Improvement of the fabric elongation deformation model.
   [3] Calculation of the clothing pressure when the human body model has been changed from a rigid body to an elastic body.

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