Toyobo Develops Vehicle Seat Comfort Evaluation Method Using Sweating Thermal Mannequin

Toyobo Co., Ltd., has developed a method to evaluate the comfort of vehicle seats, using a sweating thermal mannequin. The evaluation was conducted by reproducing the environment inside cars and human conditions when they get in and sit down during summer. The method measures the temperature and humidity between skin and clothing, using a sweating thermal mannequin to evaluate the sensation “hot and humid.”

The survey on automobile usage conditions was conducted in cooperation with Professor Yukie Tsuji of the Otemon Gakuin University Faculty of Management.

1. Development Background

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. Evaluation Method Outline

During summer, automobiles that are parked outside become extremely hot because car interiors are small, closed spaces which have large areas of glass compared with buildings. For that reason, even if the air conditioner is turned on immediately after entering the car, those inside continue to sweat and to feel hot, humid and uncomfortable for some time.

To efficiently and effectively develop vehicle seats that feel comfortable as soon as one sits down, we needed a measurement and evaluation method that would reproduce the environment inside cars and human conditions, and utilized apparatus to numerically measure sensations. We devised the approach of evaluating vehicle seat comfort using the sweating thermal mannequin SAM® under summer automobile usage conditions.
3. Evaluation Method Characteristics
(1) The method set evaluation conditions in accordance with actual usage by conducting a survey on automobile usage conditions and measuring temperature and humidity inside cars and car seat surface temperatures during summer.
(2) Arrangements were made so the sweating thermal mannequin could be moved back and forth between two rooms, with one reproducing conditions outside automobiles during summer and the other reproducing conditions inside automobiles during summer.

4. Evaluation Method Details
(1) Evaluation Method
We conducted an automobile usage conditions survey to grasp automobile usage conditions during summer. To grasp the environment inside automobiles, we measured temperature and humidity inside cars and vehicle seat surface temperatures during summer. For evaluations under sudden changes in environmental conditions, we made arrangements for movement between two rooms with constant temperature and constant humidity.

Under conditions set based on the automobile usage survey, we conducted experiments using human subjects and experiments using sweating thermal mannequin on three kinds of seats. Specifically, the subjects and mannequin were moved from a room at 32°C 70%RH to a room at 50°C 20%RH, where the conditions were then changed to 18°C 50%RH. This sequence reproduces the conditions, during summer, of moving from outside an automobile to inside the automobile and then using the air conditioner.

(2) Results
The following figures present the results for humidity between back and clothing on subjects, humidity between back and clothing on the mannequin, and subjective evaluations of the sensation of “hot and humid” by subjects. In clothing absolute humidity, both subjects and the mannequin show the same trend whereby the humidity inside clothing rises suddenly right after sitting down and then begins to decline after about ten minutes. The seat evaluation order results also confirm this same trend (with no statistically significant differences between seat 1 and seat 3). Thus the experiment results using subjects were reproduced using the sweating thermal mannequin with a high degree of accuracy, and it was possible to evaluate the sensation of “hot and humid” by measuring the humidity between clothing and the backs using the mannequin. We confirmed that this method can be used to evaluate vehicle seats employing different designs and various materials.
5. Future Plans
Toyobo will continue to develop this method not only for vehicle seats but for wide-ranging applications of evaluating comfort inside cars.

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