

ASPECTS OF THERMODYNAMICS IN SPORTS FOOTWEAR

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Abstract: The paper presents experimental thermal analysis of sports footwear in order to identify areas that provide the best ventilation of the foot for comfort in running. For analysis, using thermographic cameras, infrared, five athletes have been tested, running shoes Nike, Killtec type and Lotto. Thermographic recordings were made at three different times, which after a workout, then two minutes after your workout, and 10 minutes after the workout. Using a specialized software, the images have been processed, the resulting temperature variations over the entire shoe. They were identified as the most comfortable pair of shoes, which have secured the release of heat in the feet the highest rate.

Was able to determine the extent of aeration provided by each type of footwear under review, as evidenced by the aeration temperature on flow shoes can lose over a period of time. Through such analysis experimental Thermodynamics can be personalized, elect the type of footwear the best an athlete, based on specific physiological parameters. In addition, aeration and încălzăminte thermal protection role when necessary. By using termography related can be determined types of footwear suitable for the purpose, in particular for heat a situation or another.

Key words: biomechanics, thermography, performance, material, pressure.

1. INTRODUCTION

Athletic footwear plays an important role in obtaining the performance, especially in athletics. It is well known that research in the field has led to the emergence of new materials used in sports shoes, with senior elasticity indices, optimum forms of footwear that provide aerodynamic taloneți of parsonalizați, for the best possible pressure distribution and planting attractive colours, to induce different emotional States, using knowledge of Chromotherapy.

Athletic footwear, used for training or competition, had acquired over the years aimed at increasing the performance values. Thus, if in ancient Greece athletes to run in bare feet, with the territorial expansion of the Roman Empire many athletes ran with sandals, to protect themselves from low temperatures. Once these athletes became winners, public opinion is shifting and wearing Sandals was seen with suspicion and associated with cheating. Once it has been recognised that the soles of sandals increase adhesion on the ground and spreads leg before with greater efficiency, many athletes have adopted wearing these sandals.

In England in the 18th century it was developed a method to reduce the weight of the shoe the athletes to "float" above the ground easier. For competitions, shoes made of leather, fit well, but due to the fact that they were not waterproof, folds appeared in the outsole by making them useless for running. In 1832 he patented a Webster Wait method of attaching the rubber soles of shoes and boots, making them more resistant and avoiding the appearance of creases. The 1860s-1870s they meant an evolution for special use of shoes bicclști shoes, using very light and with 8 or 10 rows of laces.

Joseph William Foster founded the first shoe company in Boulton, England, in 1890. His nephew took over the business and renamed the company Reebok. The popularity of the game of tennis in the 1920s led to wearing Reebok shoes in her spare time, intended for recreation.

The father of the modern running shoe was Adolf Dassler started manufacturing this type of footwear in the 1920s. In 1936 this footwear has been recognized as the best in this field and has become of favorite athletes of the calibre of Jesse Owens. Adolf Dassler is specialized in the design of the shoes sport, so in 1948 he founded the company Adidas, which, however, was divided into companies, Adidas and Puma. For better efficiency in running, Adolf Dassler has added three lateral bands on shoes, model first appeared in 1949.

In 1962 he introduced the first New Balance Shoes tested scientifically, these weighing 95 grams. It is known that between the State of comfort and performance footwear there is a direct dependency, so a shoe that provide optimum aeration of the leg can lead to performance. Testing the degree of aeration is achieved either by means of temperature, pressure or by filming in infrared. In the latter case, the temperature measured is of great precision, ranging from tenths up to thousandths of a degree and can be specified at any point on the surface.

The purpose of this paper is to present the termografic criterion to choose a sports footwear for optimizing thermal comfort and improving performance.

2. COMFORT AND PERFORMANCE IN SPORTS EQUIPMENT

A sports equipment has different items depending on the sport and the type of physical activity carried out (workout, walk or competition). Thus, for athletics, athlete training, are used in general: short, t-shirts, socks, athletic shoes. The comfort provided by these depends on the materials used and their construction, all together to provide more aeration and biomechanical parameters: thermal protection in an optimal rate, good adhesion to the ground for footwear, as well as less drag from the environment, good mobility of the body etc. Of the materials used, mainly, can be listed: polyamide and polyester, cotton, for clothing and natural rubber skin compact, translucent rubber, Microcellular rubber, microdur, crepul, vinilnice resins, etc., for footwear.

A sports footwear shall carry out depreciation of efficiency, flexibility, control and stability in the heel area, ease and traction. It can be hard to choose from the vast range of sports footwear available. There are differences in design and variety of materials and weight. These differences have been established to protect the areas of the foot that have the most stress in sports.

Thermal comfort footwear for track and field sports require that the outside to allow a good aeration in a relatively short time, so leg temperature may not be much greater than that of the body and the perspiration produced can be absorbed entirely by the socks. Moreover, sports footwear also has a custom character, with a different behavior from one person to another, depending on each person's metabolism, with multiple degrees of thermal comfort for the same type of footwear but used in different individuals.

Investigation of thermal comfort by means of infrared Thermographic recordings offers the best characterization, at the moment, they are a person who wants to achieve athletic performance.

Infrared thermography is a modern technology of remote sensing and surface temperature telemăsurare in State of rest or motion, based on the emission and absorption phenomena of infrared radiation. Remote-sensing instruments transforms images of objects invisible radiation spectrum visible images in black and white or color [1, 2, 3].

The main advantages of the termografic control are:

- do not require light sources whereas each object emits infrared radiation;
- temperature measurement objects can be done remotely, without direct contact and without disturbing the temperature;
- thermal, global information or detail is obtained in real time;
- measurement accuracy is high;
- allow the pairing with complex equipment for recording, storing and processing.

A thermal imaging system is composed of [4, 5]:






- sistem of thermal imaging-infrared camera;
- sistem thermal imaging-specialized program computer.

Operating parameters for the infrared camera used in the experimental records are: measured temperature range between -20°C to 500°C ; sensitivity $-0,1^{\circ}\text{C}$; the autonomy of operation-3 hours. Temperature determined by infrared thermography can be viewed on time, on specific areas of interest or that the variation between the minimum and maximum values of all measured surfaces.

3. EXPERIMENTAL RESULTS

Thermographic recordings were made on a group of five athletes shoes equipped with athletes for training, with the following brands of footwear: Nike, Killtec and Lotto. Are indicated in table 1, through images, the type of shoe worn by each athlete sports analyzed in part.

Table 1: Types of sports shoes review

Topic number	Footwear type	Footwear picture
1	Nike – 1	
2	Nike – 2	
3	Nike – 3	
4	Killtec	
5	Lotto	

Temperatures registered by the infrared camera were taken at three different times: immediately after a workout, after another two minutes and after 10 minutes after the first record. Thermographic images obtained in table 2 provides detailed information on the field of temperature and degree of aeration, in circumstances where the ambient temperature in the filming was 20 ° c. Temperature scale used for temperature field is given in Figure 1.

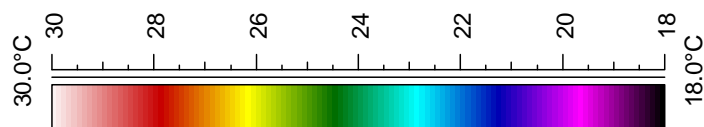
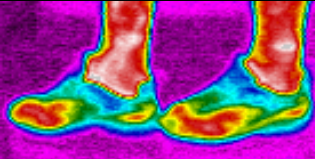
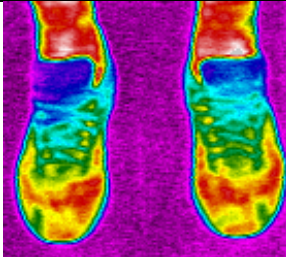
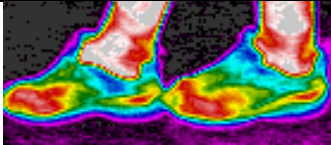
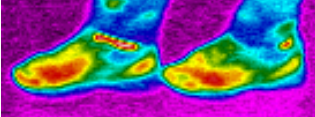
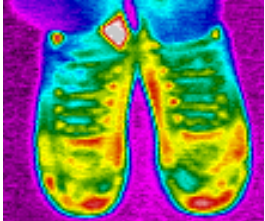
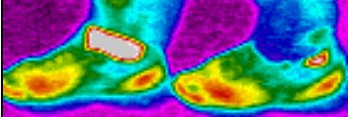
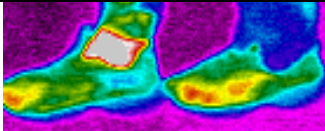
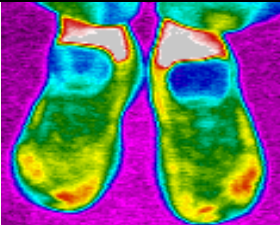
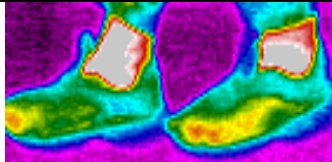
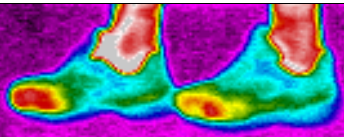
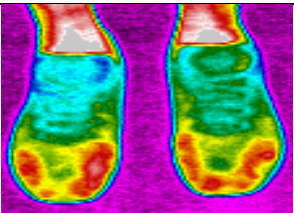
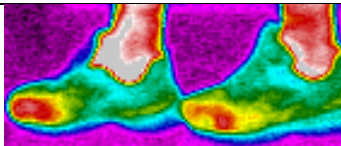
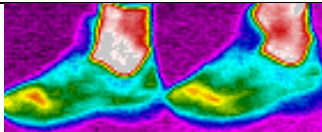
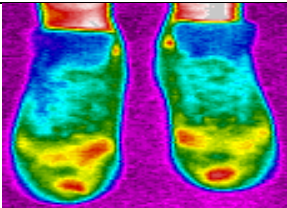
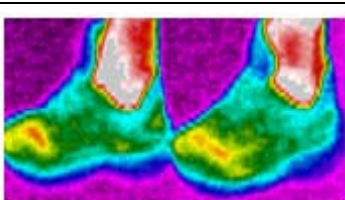


Fig. 1: Temperature Scale used in the Thermographic recordings.

Table 2: Thermographic Images experimental

Topic number	Time 1 (0 minute)	Time 2 (2 minutes)	Time 3 (10 minutes)
1			
2			
3			
4			
5			

Using a specialized software, Thermographic images were attached and the graphs of temperature variation on the entire surface of the footwear, both for his left foot and the right being numeric values highlighted extreme.

4. DISCUSSION

Using images in table 2, as well as graphs of temperature, as shown in figures 2 and 3, the following aspects can be identified from the thermodynamic point of view:

- heat in footwear builds generally towards the tip of the foot, other parties having a neighbourhood close to the environment, which creates a degree of aeration;
- the tip of the foot can be divided into three distinct zones with different temperatures: distal extremities of the big toe and second, and third fingers of the foot and the two distal sides, internal and external;
- of the three temperature zones highlighted, the less airy are the sides of the foot, where the flow of warm air can be discharged too quickly;

- of the five pairs of shoes, the best is the one with the number 3, which allows for efficient heat dissipation for the entire duration of registration;
- the most disadvantageous footwear is the number 5, which blocks the heat indoors, it can be used when you want the thermal protection of the foot

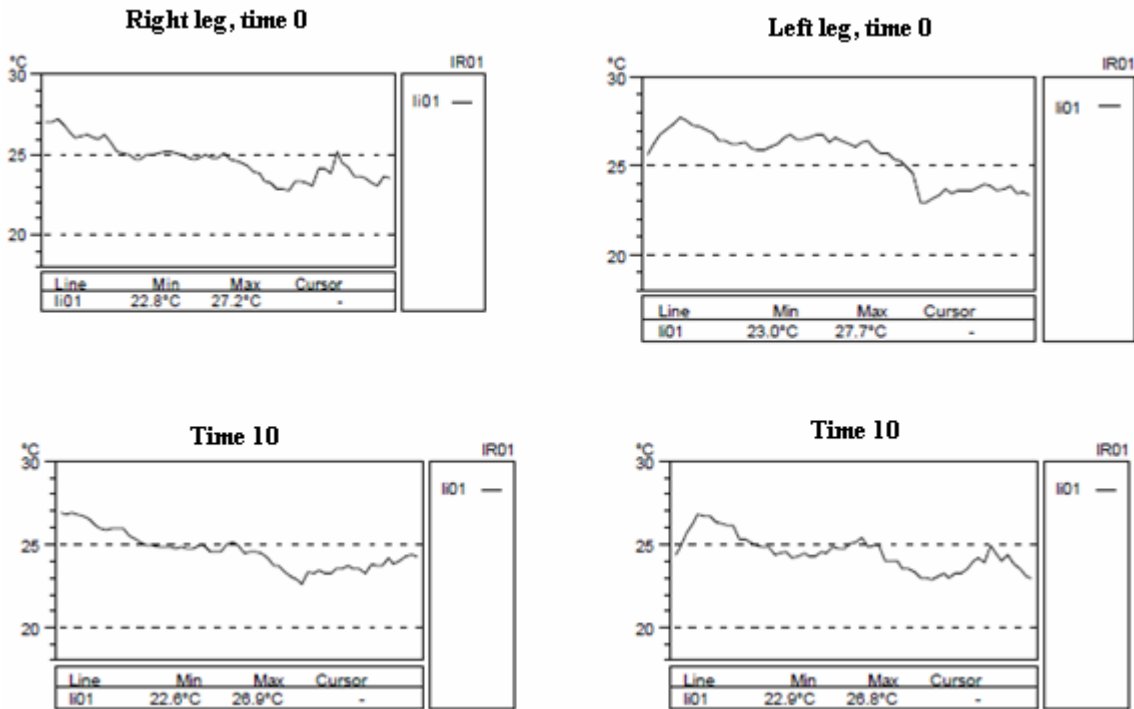


Fig. 2: Variation in temperature from 3 pair of shoes

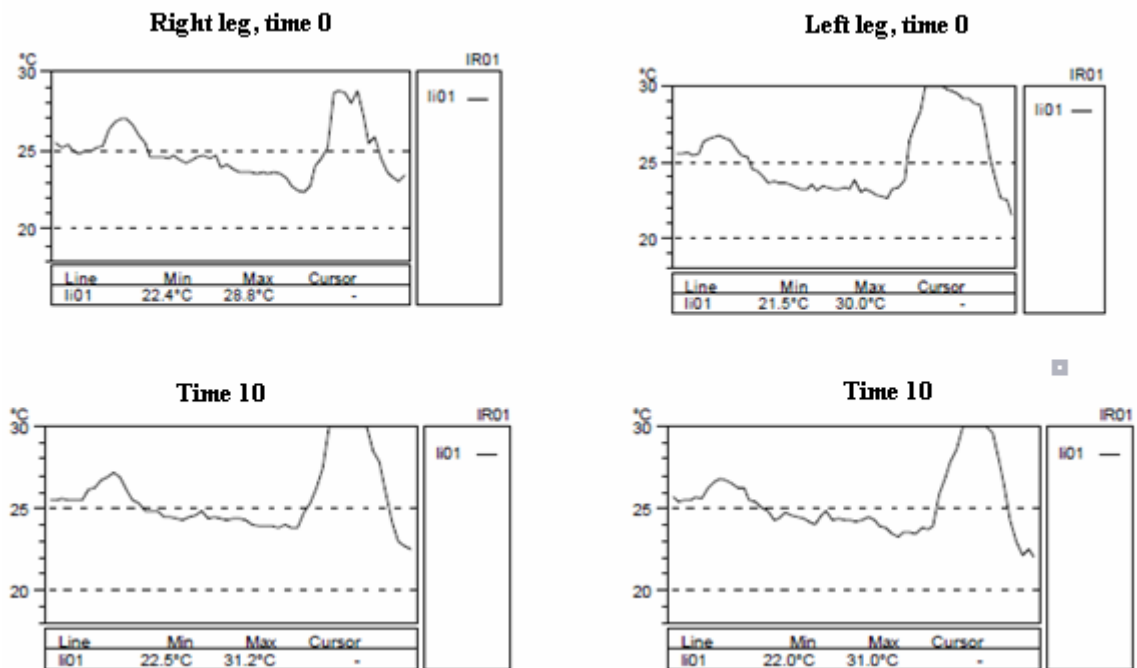


Fig. 3: Variation in temperature from 5 pair of shoes

In the charts it is observed that the amplitude of temperature variation is much smaller at the pair of shoes with the number 3 to the number 5.

5. CONCLUSIONS

Investigating shops allows the determination of the most appropriate footwear from the viewpoint of thermal protection, either for general use footwear or athletic shoes for aeration, specifically.

Investigated and analyzed data showed the possibility of sports footwear and personalization from the thermodynamic point of view, being highlighted the best footwear, among those tested, for test subjects.

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