STUDY ON MEASUREMENT THE TEMPERATURE OF A SKATING RING BY THERMOGRAPHY METHOD

Gelu COMAN, Krisztina UZUNEANU, Marcel DRĂGAN

"Dunărea de Jos” University of Galați, Romania

Rezumat. Lucrarea prezinta un studiu legat de masurarea temperaturii pe suprafața unei piste de patinoar prin metoda termografierei dar. Utilizarea programului ThermaCam Researcher Professional 2.8 permite înregistrarea și prelucrarea datelor, precum și fotografarea procesului de solidificare la diverse momente de timp. Cu ajutorul datelor înregistrate putem determina evolutia temperaturii în anumite zone ale pistei

Cuvinte cheie. Termografiere, pista de patinoar, gheata, solidificare

Abstract. This paper presents a study regarding measuring the temperature of a skating ring by thermography method. Using ThermaCam Researcher Professional 2.8 software it allows recording and processing of data and photographing the solidification process at various moment. Using the saved data we can show the temperature variations in certain zones of the ice rink pad.

Keywords Thermography method, artificial skating rink, ice, solidification

1. Introduction

The heat transfer in the skating rink track is nonstationary and phase changing. In case of skating rinks equipped with pipe registers, the temperature field during the ice formation process can’t be modeled by analytical methods. Also, the paper presents the experimental study for temperature distribution around the cooling pipes of an ice rink pad.

The experimental research was targeted on finding the temperatures in several points of the pad and also details on the ice shape and quality around the pipes. The experimental results were compared against the numerical modeling using finite elements.

2. Problem Formulation

The problem of melting and solidification of substances, from the point of finding the temperature distribution within solid and liquid phases and of the movement of the solid – liquid interface, is very interesting (both from theoretical and practical point of view), because heat transfer conduction accompanied by phase change occurs in many applications, such as ingots solidification, directional solidification of alloys in order to obtain a certain metallographic structure, freezing of foods, soil freezing and thawing, phase change thermal storage, etc.[1,2]

For the experimental study was used a thermography camera Flir A20 which belongs of the Department of Thermal Systems & Environmental Engineering (Figure 1).

For the experimental study of temperature distribution around the cooling pipes of the pad, an experimental test bench was built in the Refrigeration laboratory.

The experimental study was divided in two phases:

Phase I - study of temperature distribution around water immersed pipes;

Phase II - study of temperature distribution around sand buried pipes.

The main components of the experimental test bench are:

- Refrigeration system;
- Ice rink pad;
- Secondary cooling agent loop;
- Data (temperature) recording system

The layout of the experimental test bench is shown in Figure 1. The refrigeration system is a single stage vapour compression system using R134a. The pad is cooled using a secondary agent (ethylene-glycol) loop, which it is first cooled in a tank. [3,4]
To measure the temperatures on the skating ring surface using thermocouples is impossible due to the larger diameter of the thermocouple bulb compared with the air-water surfaces thickness. For this reason we used to measure the temperature by thermography method, thus reducing the errors (Figure 2).

Thermographic measurement technique is a modern method of temperature measurement and is used in many areas and is based on infrared radiation emitted differently by bodies [6].

To measure temperature accurately, it is necessary to compensate for the effects of a number of different radiation sources. The following object parameters must, however, be supplied for the camera:

- The emissivity of the object
- The reflected temperature
- The distance between the object and the camera
- The relative humidity.

**Fig.1 Experimental test bench**


**Fig.2 The thermography camera Flir A20**
One advantage of using the software ThermaCam Researcher Professional 2.8 (Figure 3) is that the temperature can be measured in specific points (SP1, SP2, ..., SP5), or a line which intersects several areas (LI 01).

The points and line were placed on the study area so that their positions correspond to points coordinates on the numerical simulation model geometry (Figure 4).

The time for measuring the temperature was set to 420 minutes.

Fig. 3 ThermaCam Researcher Professional 2.8 software

Fig. 4 Termografiea pistei patinoarului

Fig. 5 shows temperature variation vs. time for points SP1, SP2, SP3. One can notice that temperature variations at the pipe wall (SP1) and at half distance between the pipes (SP3) are different.

This leads to a fast formation of ice next to the pipe and a slower one between the pipes.

After 330 minutes, the temperatures in the points (SP1...SP5) are approximately equal.
3. Conclusion

One can notice that the largest deviations between experimental and numerically modeled temperatures are at the beginning of the process, when water is in liquid form and are due to the fact that the cooling load is maximal and the temperature of the secondary cooling fluid has small variations.

After complete solidification of water, temperature differences drop, showing a decreasing cooling load and a stable operation of the refrigeration system. Experimental results match numerical ones so the mathematical model used for numerical simulation is validated by the experimental study.

REFERENCES