

SOFTWARE PREDICTION OF NON-STATIONARY HEATING OF SHELL MOULDS FOR MANUFACTURE OF ARTIFICIAL LEATHERS

M. Hušek*, A. Potěšil**

Abstract: *In the design of non-stationary heating of shell moulds for the production of artificial leathers for vehicle interiors using infrared emitters, virtual simulations are of great importance. Virtual heating was used in a number of practically solved problems and has become irreplaceable in the complex process of technical preparation of the artificial leathers manufacture. It is based on combination of suitable informatics tools complemented by specific functions. Optimal temperature distribution on the styling mould surface is achieved only by suitable positioning of infra-red emitters, correct identification of positions of control thermocouples on the heated mould surface and setup of corresponding parameters of the regulation system. Development of the technology of virtual heating has been supported by the project MPO TIP 2009 under the registration number FR-TI1/266.*

Keywords: *Artificial leather, shell mould, non-stationary heating, radiation heating, finite element method.*

1. Introduction

In the last few years, the company Magna Exteriors & Interiors Bohemia, s.r.o (hereafter Magna) along with its expert partners (LENAM, s.r.o and Technical University of Liberec) have been dealing with an innovation project "Technology innovation of artificial leathers production". The artificial leathers are major styling elements of softened interior components in vehicles. An example of such a product is a dashboard, which represents a complicated part in terms of design, complexity of styling shapes, dimensions and process energy.

Preparation of heating of mould is divided into two basic stages, as illustrated in fig. 1.

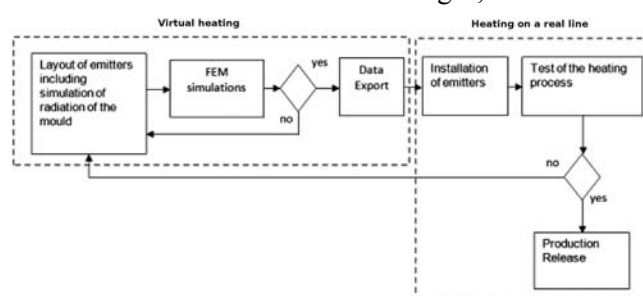


Fig. 1: Flowchart of the procedure of heating layout

The issue of virtual heating in the final stages of the above-mentioned project is mainly implementation of software application IREviewBlender in the preparatory stages of the artificial leather manufacture.

The main tasks of the sw IREviewBlender are:

- 1) Building a virtual model of a real module of heating of a shell galvano- mould, consisting of relevant components of a production line (frames for shell mould fixation, frame for emitters clamping and other special constructions).
- 2) Application of various types of infrared emitters as needed and within the technical limitations (emitters of various shapes, numbers, layout and power properties).

* Ing. Martin Hušek, Technická univerzita v Liberci, Studentská 2, Liberec 1, CZ, e-mail: martin.husek@tul.cz

** Doc. Ing. Antonín Potěšil, CSc.: LENAM, s.r.o., Klostermannova 690/15; 460 01, Liberec; CZ, e-mail: antonin.potesil@lenam.cz

- 3) Simulation of the heat flux distribution on the surface of a shell mould and optimization of the position of infrared emitters above the mould and their control thermocouples on the surface of the shell mould. This is necessary for successful control of non-stationary temperature field, see fig. 2.
- 4) Export of the results into a suitable format for the needs of control temperature-structural FEM analyses in CAE systems, see fig. 3.
- 5) Export of the topological data (coordinates) for emitters and thermocouples for safe and non-collision placement of emitters in the real supporting structure and placement of corresponding thermocouples on the mould (output image files or files with transformation matrixes for placement by a robotic arm).

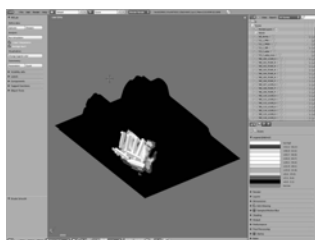


Fig. 2: Heat flux

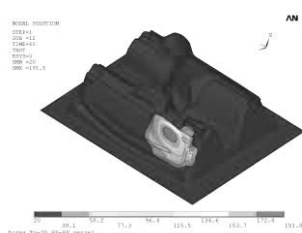


Fig. 3: Temperature calculation in sw ANSYS

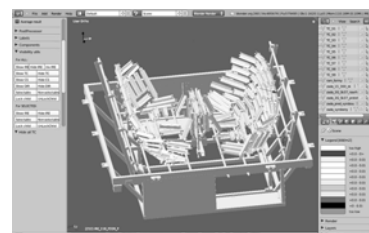


Fig. 4: Fixation of emitters

2. Implementation into Manufacture

It turned out, for example, that besides the satisfactory determination of positions and types of the used emitters, it is often necessary to make design changes of surrounding structures, such as fixing elements for special emitters, braces, etc. The result of such a situation is illustrated in fig. 4.

Another requirement of the operators of technical preparation of artificial leather production, which was successfully resolved, had been a design of a so called test shell mould and its heating. Before introducing a new product based on PVC or PU into production it is essential to perform a number of experiments with the powder mixture on test moulds without any abridgement of prototype or series production of leathers. These moulds are equipped with dividing grooves with various shapes and areas with several styling reliefs. For this purpose, a test mould has been designed for the test line. Its undulated shape serves for testing the functionalities of virtual heating and for searching of important criteria for optimal distribution of emitters in IREviewBlender. Another application of this mould is in testing genetic algorithms for optimization of the emitters distribution, which is dealt with by experts of the Technical University of Liberec.

The operation experience on prototype flow lines in the past showed that every mould has to be cleaned up after repeated usage in the production cycle and its surface must be covered with special separation and protection preparations at precisely defined temperature condition, which is again ensured by infra-red heaters. At the same time the whole procedure has to proceed ideally unmanned, i.e. automatically, and must be universal for various mould types and shapes. This situation required again application of the sw ReviewBlender, which allowed to divide the emitters into groups, while each group can be moved with defined displacements so that the positions of the groups of emitters could be adapted to various types and shapes of the moulds. Fig. 5 shows three configurations of emitters distribution. For better lucidity only their fixing elements – holders are illustrated.

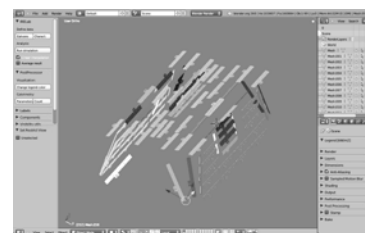
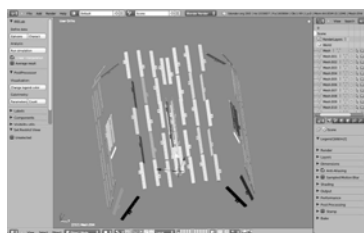
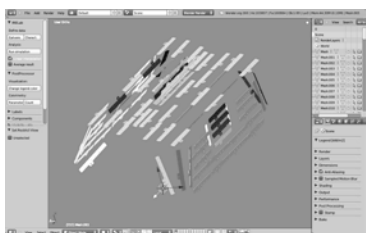


Fig. 5: Three group positions of the emitters