1. Objective of the project

The overarching objective of the project is to perform experiments on and deepen the knowledge about enhanced flow boiling heat transfer for different fluids flowing in a single vertically-oriented rectangular minichannel, where the heated element varying in thickness has either a smooth or modified surface. The analysis focuses on determining the local values of the heat transfer coefficient and formulating one-dimensional (1D) and two-dimensional (2D) calculation methods for forced convection nucleate boiling, which will be able to describe the heat transfer from the heated surface to the fluid. In addition, two-phase flow will be analyzed and the local flow patterns will be identified. The investigations will be conducted for a single minichannel with the following dimensions: a depth of 1 - 2 mm, a width of 16 mm, and a length of 180 mm. The study will explore the effectiveness and limitations of the calculation methods; it will allow us to compare the results obtained with these methods and determine the possible effects of their modifications.

2. The research to be carried out

A new experimental studies will involve analyzing flow boiling heat transfer in a single vertically or different oriented rectangular minichannel for different working fluids, different surface modifications of the heated elementhas not tested for this configuration, and its different thickness.The investigations will be involve applying different methods of surface modification. The heated surface will be modified, for example, by spark erosionand new modified surface: vibration-assisted laser surface texturing andcapillary stainless steel fibrous structure will also be considered. The main element of the setup is the test section with a single vertically-oriented rectangular minichannel with a unilaterally modified heated surface. A contactless method − infrared thermography − is used to measure the temperature on one side of the module, i.e. the temperature on the smooth surface of the heated element. Simultaneously, two-phase flow structures are observed on the other side of the minichannel, where the modified heated surface is in direct contact with the working fluid flowing in the channel. The smooth heated surface, which is in direct contact with the surroundings, is covered with a layer of black paint whose emissivity is known. The temperature is measured on the smooth surface using an infrared camera placed opposite the central, axially symmetric part of the channel. From the data linear distributions of temperature along the minichannel length are determined. The temperature results obtained by means of infrared thermography for the heated surface and the working fluid will be approximated using an appropriate polynomial or a similar method. Two calculation methods, i.e. one-dimensional and two-dimensional, will be employed to determine the local values of the heat transfer coefficient for the surface-fluid interface from the boundary condition of the third kind. The one-dimensional calculation method takes into account one direction of heat flow along the fluid flow in the channel. The other, the two-dimensional calculation method is based on the Trefftz functions; it takes into account two directions of movement: along the fluid flow in the minichannel and perpendicular to it, both dependent on the thickness of the heated element, the thickness of the glass pane and the depth of the minichannel.

3. Reasons for choosing the research topic

There are some discrepancies in the literature regarding flow boiling heat transfer in a rectangular minichannel. It is noteworthy that there is no meticulous and conscientious research on the impact of the surface modification and thickness variation of the heated element on the local values of the heat transfer coefficients; the correlation between the thermal and flow parameters and the local structures of two-phase flow also needs investigating. It is vital to determine the effect of pressure on flow boiling for a working fluid flowing in a minichannel and the constraints associated with it. The influence of surface modification on the enhancement of flow boiling heat transfer has not been elucidated sufficiently, either. The problem should be considered with regard to optimal modification of the heated surface, when the heat transfer coefficient is higher than that reported for the smooth surface. In the project will be carried out the innovative research for a single minichannel (in previous projects, where I was a participant - studies were performed for different numbers of channels) and will be tested different innovative surface modification and optimum of them selected. Studies on flow boiling heat transfer will be performed for the various working fluids, heated element varying in thickness, different experimental parameters and the thermal properties, in configurations have not yet been tested. The research project will not be the sameas currently implemented project, because the research will be conducted only for a single channel and the study will carried out in configuration has not examined in the current project. In addition, the currently implemented project entitled "Effect of enhanced heating surfaces on flow boiling heat transfer in mini spaces", ID 215879, according to the schedule should end - 06/03/2017. According to information from the project manager, research tasks relating to research and analysis of the results obtained on the module with rectangular minichannels planned to be completed within the current calendar year, and the study will be realized for a mini annular space realized in next year. Thus, in this project, not occur realization of similar topics and tasks of both projects, in the case of a positive evaluation of the reviewers of this proposal.