

Review on doctoral dissertation

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The title of the Ph.D. dissertation: **Pool Boiling of Water-Glycerin Mixtures**

The dissertation

The doctoral dissertation, presented by Viktor Vajc, consists of 3 chapters and 10 subchapters (132 pages), a list of 227 references (14 pages), a list of authors publications (2 pages), a list of symbols and notations (4 pages), a list of 52 figures and 14 tables, an appendices (5 pages). The Annotation Sheet provides information about Author, Supervisors and Affiliation. The annotation and keywords are repeated in Czech before lists of figures, tables and the table of contents in the first few pages. The dissertation is written in English.

The main issue addressed in the dissertation is heat transfer during boiling of mixtures of water and glycerine on three different planar surfaces. In view of the significant production of glycerine as a by-product of biofuel production, it is appropriate to take up the topic of research on the boiling behaviour of glycerine-water mixtures.

State-of-the-art analysis

In the theoretical part of the dissertation, the author made a comprehensive review of the issues related to heat transfer during boiling of pure liquids and multicomponent mixtures, presented the considered models of heat transfer during boiling, the physicochemical properties of liquids, surfaces and parameters of the models taken into account in them. The author also presented the thermophysical properties of water and glycerine and the behaviour of their mixtures during boiling. The review of published works is very broad, focusing on the most recent reports, and also includes many important works from the last decades of the 20th century reaching back to classic older studies.

The theoretical part concludes by presenting the motivation for undertaking research on boiling of water-glycerol mixtures, identification of research gaps in the study of heat transfer during boiling, and definition of the scientific objectives of the work.

The review of published works on heat transfer during boiling is extensive. It includes important works from the first half of the 20thw to the latest. Each researcher proposed his own description of heat transfer mechanisms, introduced new quantities, the correlation equations presented are complex and difficult to compare directly. The first part of the work gives credit to the author's ability to organize the achievements of many researchers. The review is written very clearly, and despite the difficult subject matter, numerous complex correlative relations, it is comfortable to read and is itself of great value to the development of research on heat transfer during boiling.

Experimental and Results

The next part of the dissertation presents the results of experimental studies of heat transfer during saturated and subcooled nucleate boiling of water and glycerine mixtures over copper, nickel plated and titanium surfaces. The surfaces tested were a copper plate, a nickel-coated plate and a thin titanium foil. In each case, the author started the tests with pure water, treating it as a reference system that allowed comparison of the results obtained with experimental data and available correlations for pure liquids. In subsequent experiments, mixtures of water and glycerine were tested under both saturated boiling and subcooled boiling conditions.

It should be noted that the work used three different test stands, each of which was designed to work with a different heat transfer surface. Each stage of the research includes a presentation of the test stand, the methodology of measurements and conducting calculations, evaluation of uncertainty errors. Attention is drawn to the thoroughness of the error assessment and the scientific reliability of the description of the apparatus and methodology. Each section on boiling tests concludes with a presentation of the results with a discussion of them, along with a comparison with available data in the literature and correlations to predict measured values.

The author presented his own correlations linking the heat transfer coefficient during boiling with the heat flux rate and the water and glycerine content of the boiling mixture. The study of boiling on each surface concludes with a summary indicating the most important findings and observations made during the study. The experimental part of the dissertation ends with a summary of the results and findings of the study.

The last chapter of the work consists of conclusions summarizing the work done.

Novelty

The work is innovative in many respects. The heat transfer process during boiling is extremely complex and difficult to describe. Over the years, many attempts have been made to describe it. While for pure liquids the proposed models and correlations make it possible to predict heat transfer during boiling, none of the models is general. Attempts to use experimental results for pure liquids for predicting heat transfer during boiling of mixtures should be considered far from satisfactory. Hence the importance of undertaking research on boiling of mixtures of water and glycerine on various surfaces. The author has made important findings related to the dependence of heat transfer coefficients during boiling on the heat flux and composition of the mixtures.

An important achievement of the author is to propose his own correlations to predict the heat transfer coefficients during boiling for each of the tested surfaces. The proposed correlations do not require thermophysical properties or equilibrium data of the boiling liquid vapor of the system.

The development and experimental verification of a dynamic method for studying heat transfer in boiling is extremely valuable.

Of great interest are the results of a study of boiling of an subcooled liquid, which concluded by proposing a correlation that allows estimating the total heat transfer coefficient during boiling of an subcooled liquid.

Very interesting are the studies of boiling on the surface of titanium foil. The use of an IR camera allowed insight into the process of vapor bubbles formation, evaluation of their

diameters of the temperature footprint and measure nucleation frequency. This part of the work is particularly interesting and pioneering.

Comments

The work is carefully written, the reasoning is correct and interesting. I would appreciate your comments on the observations indicated below:

#1. page 100

Twice it appears that the "liquid was left to cool down to condense the remaining vapour nuclei until it reached a temperature below".

line 3 from the top "to 80°C".

line 22 from the top "to 90°C".

What is the reason for this difference?

#2. page 102

Fig. 8.4 for $\omega=1$ (pure water) HTC for the two highest heat fluxes are clearly outside the correlation trend. What can this discrepancy be attributed to?

At the same time, the Appendix C: Fig A.1 for $\omega=1$ for the same ΔT_{sat} marks three different values of heat flux q . How was this data interpreted, which flux value was used to determine the HTC ?

The above comments do not detract from the value of the dissertation.

Conclusions

The dissertation, through its content and structure, is an original and useful scientific work and, as such, is a significant and high-quality contribution to science. In the present dissertation, the author has thoroughly and methodically studied and critically evaluated the scientific body of work in the field of boiling heat transfer, models and mechanisms of the process, and has thus made an indisputable contribution to the field. The results of the author's research are extremely important and will undoubtedly contribute to the development of boiling heat transfer research.

The scientific contribution of this dissertation is multifaceted. The insightful and excellently written analysis of previous work in the field of heat transfer during boiling can stand alone as a valuable compendium of knowledge. The dissertation and the results presented can provide both methodological and analytical guidance for further research and make a valuable contribution to the development of research on the heat transfer process during boiling.

I recommend Viktor Vajc's dissertation, for public defence.

Reviewed by:

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