УДК 66.974.434:66.048.5-982:536.248.2

EXPERIMENTAL STUDIES OF BOILING HEAT TRANSFER OF FOOD SOLUTIONS

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ЭКСПЕРЕМЕНТАЛЬНІ ДОСЛІДЖЕННЯ ТЕПЛООБМІНУ ПРИ КИПІННІ ХАРЧОВИХ РОЗЧИНІВ

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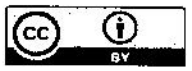

Abstract. *Vacuum evaporation is widely used in the food technologies. The equipment for this process is well known and methods of calculation and design of vacuum evaporators are described in literature as well. However, in some cases the accuracy of existing methods is not enough. The problem of designing the new, more efficient apparatuses those work in regimes, which are not usual, needs to clarify some dependencies. It concerns the problem of boiling heat transfer coefficient determination for such solutes as food products because of the high or sometimes extremely high viscosity of many food staffs is. To take into account properties of products many authors use the Prandtl number. However, determination of these properties exact values is not always possible especially it concerns the viscosity of Non-Newtonian fluids, which are the most of food staff. For experimental verification of heat transfer coefficient values, an apple juice was chosen. At first, the theoretical value was obtained with Tolubinskiy dependency using. The vapor bulbs grows rate and surface tension coefficient were solved as for water. The dependencies between the heat transfer coefficient and heat flux for apple juice with concentration from 15 to 50 Brix were obtained as result. There are several different equations to calculate the properties of apple juice depending on temperature and concentration and several resulting dependencies that differ from each other were obtained. The comparison with the experimental data that was obtained by authors made possible to choose the right equations for apple juice viscosity determination when the heat transfer calculation error did not exceed 20% that is standard error for used dependency and for many others. To reduce this error on the base of obtained experimental data the correction coefficient was calculated. Therefore, the equation to calculate the heat transfer coefficient for boiling apple juice where maximum error did not exceed 5% was obtained. The experimental research was conducted under atmospheric pressure. To obtain the value of heat transfer coefficient in vacuum condition the Tolubinskiy dependency can be used or addition experiments should be conducted. It depends of required accuracy level.*

Анотація. *У статті розглянута проблема визначення коефіцієнтів тепловіддачі при кипінні концентрованих розчинів харчових продуктів. Проаналізовано можливості використання для цього відомих залежностей, що доступні у літературі та проведено порівняння отриманих результатів з результатами експериментальних досліджень при кипінні концентрованого яблучного соку, що були проведені авторами.*

Ключові слова: кипіння, теплообмін, випарювання, концентрування, вакуум.

Keywords: boiling, heat exchange, evaporation, concentration, vacuum.

Introduction. One of the energy-intensive sectors of the food industry of Ukraine is the heat treatment of food liquids and food concentrates. In Ukraine the production of concentrates annually evaporated about of 1-1.5 mln. ton of water, which in monetary equivalent is 300-400 mln. UAH. There are two typical problems of concentration processes: it is a high energy costs and loss of thermally labile component materials.

One of the methods in food production is the organization of evaporation of the initial solutions in a vacuum. The main problem is to disinfect the initial mass as much as possible and to preserve its organoleptic and sanitary-hygienic qualities. These conflicting requirements can be solved by organizing processes of concentration in a vacuum with short-term exposure to high temperatures and rapid cooling. Such technology requirements significantly complicate the engineering implementation, but are successfully solved using evaporation in vacuum evaporators and rapid cooling by natural means (ice water or cooled gases). This means that traditional technologies that implement such conflicting demands are burdened by a significant increase in energy use. Therefore, the study of effective ways to reduce energy costs, their optimization and practical application look like actual research areas in the field of food technology improving. A possible way of this can be an introduction of a heat pump to the traditional technology.