

TECHNOLOGICAL COMPLEX OF AUTOMATED CONTROL AND MANAGEMENT OF WATER PURIFICATION AND BREAD PRODUCTION WITH ROBOTIC TECHNOLOGIC INTENSIFIERS

Valentyn Khorolskyi¹, Svitlana Yermak^{2*}, Oleksandr Bavyko², Yuriy Korenets³,
Nataliia Riabkina⁴

¹Department of General Engineering Disciplines and Equipment, Educational and Scientific Institute of Restaurant and Hotel Business, Donetsk National University of Economics and Trade named after Mykhailo Tuhan-Baranovskyi, Tramvaynaya Street 16, 50005 Kryvyi Rih City, Ukraine

²Department of Entrepreneurship and Trade, Institute of Business, Economics and IT, Odessa National Polytechnic University, Shevchenko avenue 1, 65044 Odessa, Ukraine

³Department of Technology in the Restaurant Industry and Hotel and Restaurant Business, Educational and Scientific Institute of Restaurant and Hotel Business, Donetsk National University of Economics and Trade named after Mykhailo Tuhan-Baranovskyi, Tramvaynaya Street 16, 50005 Kryvyi Rih City, Ukraine

⁴Department of Economics, Organization and Management of Enterprises, Faculty of Economics and Business Management, State institution of higher education «Kryvyi Rih National University», Vitalyy Matusevych Street 11, 50027 Kryvyi Rih City, Ukraine

*e-mail: kaf.econ.kr@gmail.com

Abstract

The purpose of this article is to explore the possibilities of the integrated use of ultrasonic technology to improve the quality and intensification of recipe components and on this basis to develop design solutions to create a multilevel robotic technologic complex with a high level of intellectualisation, communication and informatization of technological operations of bread production with embedded into the process robots intensifiers.

For water purification, acceleration of the sourdough-dough production, cooking brine and ingredients there has been used an ultrasonic cavitation disintegration. There has been used the theory of mutual penetration of substances, which is based on Fick's law to determine the relationship between concentration gradient and flux of the raw material molecules diffusing. In a multilevel system of controlling the robotic technologic complex there were used optimization algorithms making sourdough, dough and bread, which are based on fuzzy information of indirect measurement of moisture, density, strength of flour, dough temperature and its smell.

The study has found that ultrasonic treatment of water in the mode: frequency 30 kHz, power 200 W, exposure 3.2 min. allows us to achieve the most clear effect on the quality indicators, namely: the water hardness is reduced by 15 - 20% from previous values; the pH is reduced on average by 0.28 - 0.35; iron content decreases on average by 25 - 28%. Also, the effectiveness of the use of ultrasonic cavitation for water disinfection, its influence on the water regimes has been established in the mode: 22 kHz, power 200 W, exposure 3 min. leads to the reduction of heavy metal pollution by 30 - 40%. There has been developed an intelligent system of automated control of technological process of bread production, the architecture of which differs from the existing built-in to the process robotic technologic cavitation intensifiers with the ultrasonic devices of water purification, disintegration, mixing and intensification of microbiological, biological, colloidal, chemical and hydrodynamic processes and systems for controlling parameters of the sponge-dough with a dedicated frequency of ultrasonic vibrations and a three-channel analysers to measure density, mass capacity, mass transporting and lifting force of sourdough.

There has been grounded the technological paradigm for the bread production with intelligent control and robotic technologic complex to prepare flour, water, yeast, sourdough and dough, proofing and baking bread for people living in areas which are characterized with some industrial pollution of the environment.

Key words: *Robotic technologic complex, Intensifier, Ultrasonic cavitation, Water purification, Bread production.*