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ETHANOL PRODUCTION

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ABSTRACT: *The study presents an analysis and description of the ethanol production system.*

KEY WORDS: *ETHANOL, RECTIFICATION, ENERGY EFFICIENCY, SEPARATION.*

ВИРОБНИЦТВО ЕТАНОЛУ

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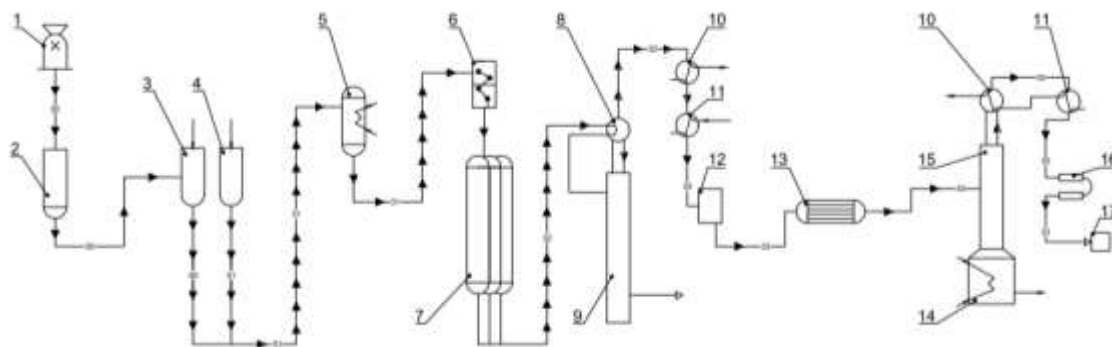
АНОТАЦІЯ: *У роботі проведено аналіз схеми виробництва етанолу та здійснено її опис.*

КЛЮЧОВІ СЛОВА: *ЕТАНОЛ, РЕКТИФІКАЦІЯ, ЕНЕРГОЕФЕКТИВНІСТЬ, РОЗДІЛЕННЯ.*

Modernization of the distillation column and heat exchanger is reasonable, as these units are among the most energy-intensive elements of the ethanol production process scheme. Their efficiency directly affects the quality of the final product, the plant's energy consumption, and the stability of the process. Therefore, their improvement has practical significance in terms of reducing costs and increasing production efficiency.

The technological scheme of ethanol production is shown in Figure 1.

The raw material is loaded into a mill 1, where it is crushed. It then enters a mixer 2 for purification and is pumped into a cooker 3, where it undergoes thermal treatment to dissolve starch. The mixture is then heated in a steam generator 4 and sent to a saccharification unit 5. After that, it is cooled in a cooler 6 before entering a fermentation unit 7, where maltose is fermented.



1 – mill; 2 – mixer; 3 – cooker; 4 – steam generator; 5 – saccharification unit;
6 – wort cooler; 7 – fermentation tank; 8 – preheater; 9 – fermentation column; 10 –
dephlegmator; 11 – condenser; 12 – storage tank; 13 – heat exchanger;
14 – still pot; 15 – distillation column; 16 – heat exchanger;
17 – final storage tank.

Figure 1 – Technological scheme of ethanol production

The resulting mash is preheated in a unit 8 and directed into the fermentation column 9, where alcohol is released along with steam. In the dephlegmator 10, partial condensation of the product occurs, after which it is collected in the condenser 11 and pumped into a raw alcohol storage tank 12. The product is then heated in a shell-and-tube heat exchanger 13 to the boiling point and fed into the distillation column 15, where further purification and concentration of ethanol to 96% by volume takes place. The obtained ethanol is condensed in the condenser 11, cooled in a heat exchanger 16, and directed to the storage tank 17.

With the development of technology and growing requirements for product quality and energy conservation, modernization of key elements of technological

schemes in the food and chemical industries is highly relevant. In ethanol production, such critical units include the distillation column and the shell-and-tube heat exchanger.

The distillation column performs the main function of separating the alcohol-containing mixture through multiple evaporation and condensation cycles. Its modernization may include replacing traditional contact elements (trays) with high-efficiency packing, implementing automated temperature and pressure control systems, and improving the dephlegmator to enhance separation selectivity. These improvements allow for higher ethanol purity, reduced energy consumption, and increased production capacity.

The shell-and-tube heat exchanger, used during mash preheating and ethanol cooling after distillation, is exposed to significant thermal loads in the range of 80–120 °C from both sides – the hot mash and the ethanol condensate. It operates with water-alcohol mixtures and steam, requiring high heat exchange efficiency to minimize thermal losses. As a key component in the overall energy efficiency of the process, its modernization may involve the use of materials with improved thermal conductivity, increased heat exchange surface area, and implementation of a multi-sectional counterflow design to ensure more efficient heat transfer.

Considering the importance of the distillation column and heat exchanger in the ethanol production process, their modernization is essential for improving energy efficiency, optimizing the technological process, and enhancing the quality of the final product. This approach will ensure stable operation of the system and compliance with modern production standards.

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