

## **IMPROVING THE EFFICIENCY OF HEATING SYSTEM IN AGRO-INDUSTRIAL COMPLEXES THROUGH OPTIMIZATION OF HEAT EXCHANGER DESIGN AND MATERIALS**

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*This paper explores the importance of heating systems in agro-industrial production, focusing on the role of heat exchangers in ensuring efficient temperature control. It reviews the materials used for heat exchangers, such as cast iron and copper, highlighting their advantages and limitations in agro-industrial environments. The study also discusses the potential benefits of alloying and coating technologies to improve the longevity and efficiency of heat exchangers, offering a pathway for energy savings and enhanced system performance.*

Heating systems are an essential component of agro-industrial production, as a stable temperature regime is crucial for the effective operation of greenhouses, poultry farms, and other production and storage facilities. A reliable heating system allows for controlling the internal environment parameters, which is particularly important for maintaining the optimal levels of humidity and temperature for growing crops and keeping livestock. The central component of any heating system is the boiler, which generates thermal energy. However, the efficiency of the boiler is largely determined by the performance of its heat exchanger — a key element that transfers thermal energy to heat the premises.

There are different types of materials used for manufacturing heat exchangers, with cast iron and copper being the most common. Cast iron heat exchangers have a high degree of corrosion resistance, making them very durable and suitable for use in harsh agro-industrial environments, where aggressive compounds may be present. However, the disadvantages of cast iron heat exchangers include their heavy weight and brittleness, which can complicate installation and maintenance, as well as limited heat transfer speed, which may be a drawback in situations where quick heating is required [1]. Despite these drawbacks, cast iron remains an economical choice that remains relevant for many enterprises.

Copper heat exchangers, on the other hand, stand out for their superior thermal conductivity and high heat transfer efficiency. They are lighter and much less prone to brittleness, which simplifies their installation and maintenance. Copper also tolerates rapid temperature changes well, making it more adaptable in conditions of intensive operation. However, the cost of copper is significantly higher than that of cast iron, which increases the production cost of copper heat exchangers. Additionally, copper may be susceptible to corrosion under certain conditions, which requires protection and constant monitoring in systems where aggressive chemical compounds may be present [2].

To increase the service life of heat exchangers and enhance their efficiency, materials with alloying additives or special coatings are increasingly being used.

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Alloying and coating applications significantly improve corrosion resistance, increase thermal conductivity, and provide long-term protection in aggressive environments. For example, aluminum coatings or nickel alloying can significantly improve the properties of heat exchangers. Aluminum is known for its high corrosion resistance and relative lightness, which allows for reducing the overall weight of the system and facilitating maintenance. Nickel provides additional protection against high temperatures and chemical influences, which is particularly relevant in agro-industrial systems where temperature and humidity levels fluctuate frequently [3].

Heat exchangers with special coatings and alloying additives are characterized by increased efficiency, which not only reduces energy costs but also significantly extends the operational life of the equipment. They are more cost-effective in the long run, as they reduce the frequency of repairs and equipment replacements. Furthermore, such modernization helps improve the system's coefficient of performance, which in turn reduces overall energy consumption.

Therefore, the engineering of agro-industrial heat technical systems, particularly the research into the properties and manufacturing technologies of heat exchangers, is an important direction for improving the efficiency and durability of equipment. Continuing research in this area will allow for the development of new materials and improved coatings for heat exchangers that better meet the operational conditions and energy-saving requirements of the agro-industrial sector.

### **Conclusion.**

The optimization of heating systems in agro-industrial production is critical for maintaining optimal environmental conditions in greenhouses, poultry farms, and other facilities. The selection of materials for heat exchangers, such as cast iron and copper, plays a crucial role in system efficiency and durability. However, advancements in alloying and coating technologies offer significant potential for enhancing the performance, corrosion resistance, and longevity of heat exchangers. These improvements contribute to more energy-efficient systems, reduce maintenance costs, and ultimately support sustainable energy use in agro-industrial operations. Continued research in this area will drive further innovations, ensuring better alignment with the evolving demands of the sector.

### **References**

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