



HEAT LOSS ASSESSMENT AND REDUCTION METHODS IN GLASS PRODUCTION LINES: THE CASE OF THE “KVARTS” PLANT

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Abstract

Glass production is an energy-intensive industrial process in which a significant share of supplied thermal energy is lost at different stages of manufacturing. This study focuses on the assessment of heat losses in glass production lines at the “Kvarts” plant with the aim of identifying the main sources of thermal inefficiency and evaluating their impact on overall energy performance. The research is based on an energy audit of thermal-technological equipment, including glass melting furnaces, auxiliary heating systems, and heat transfer structures. Operational parameters, temperature distributions, and insulation conditions were analyzed to determine the dominant heat loss mechanisms. The results indicate that major heat losses occur through exhaust gases, furnace walls, and outdated thermal insulation, leading to increased fuel consumption and reduced thermal efficiency. Based on the findings, practical methods for reducing heat losses and improving energy efficiency are proposed. The outcomes of this study can be used to optimize energy use, reduce production costs, and support sustainable development in the glass manufacturing industry.

Keywords: Glass production, heat loss assessment, energy audit, thermal efficiency, waste heat utilization, energy saving technologies.

Introduction

The glass manufacturing industry is characterized by high levels of energy consumption due to the continuous operation of thermal-technological equipment at elevated temperatures. Glass melting, refining, and forming processes require stable heat supply, making energy efficiency a critical factor in the economic and environmental performance of glass production plants. As energy prices continue to rise and environmental regulations become more stringent, the need to minimize energy losses and improve thermal efficiency has become increasingly important. At the “Kvarts” plant, glass production lines operate under intensive thermal conditions, where a considerable portion of input energy is not effectively utilized and is dissipated as heat losses. These losses occur through various pathways,





including exhaust gases, furnace structures, and insufficiently insulated surfaces. As a result, the specific energy consumption per unit of glass product increases, negatively affecting production costs and sustainability indicators.

Heat loss assessment through systematic energy auditing provides a reliable approach for identifying inefficiencies in thermal processes and evaluating the performance of existing equipment. By analyzing operational data, temperature profiles, and heat transfer characteristics, it becomes possible to quantify heat losses and determine their contribution to overall energy inefficiency. In this regard, the assessment of heat losses in glass production lines at the “Kvarts” plant represents an important step toward the development of effective energy-saving strategies.

The purpose of this study is to analyze the mechanisms of heat loss in glass production processes and to propose practical methods for their reduction based on the results of an energy audit. The implementation of such measures can lead to reduced fuel consumption, improved thermal efficiency, and enhanced sustainability of glass manufacturing operations.

Main Part

The assessment of heat losses in the glass production lines at the “Kvarts” plant was carried out on the basis of operational data analysis and direct measurements obtained during the energy audit. The study covered glass melting furnaces, auxiliary heating units, exhaust gas channels, and structural elements responsible for heat retention. The analysis showed that a significant portion of the supplied thermal energy is lost before it can be effectively utilized in the technological process. These losses have a direct impact on fuel consumption and reduce the overall thermal efficiency of the production lines.

One of the dominant sources of heat loss was identified as high-temperature exhaust gases discharged into the atmosphere. Measurements revealed that the temperature of exhaust gases remains considerably higher than the ambient level, indicating insufficient recovery of waste heat. This situation suggests that the existing heat recovery systems are either technically outdated or operating below their optimal efficiency. As a result, valuable thermal energy that could be reused for preheating raw materials or combustion air is lost, leading to increased fuel demand.

Another major contributor to heat losses is heat transfer through furnace walls, roofs, and other structural components. The condition of thermal insulation materials plays a crucial role in determining the magnitude of these losses. At the “Kvarts” plant, partial degradation of insulation layers and the use of materials with limited thermal resistance were observed. This leads to excessive heat dissipation to the





surrounding environment and causes additional energy consumption to maintain the required process temperatures.

Technological interruptions and non-optimal operating regimes were also found to contribute to heat losses. During start-up, shutdown, and load variations, thermal stability of the process is disturbed, resulting in inefficient heat utilization. In addition, incomplete control of combustion parameters affects flame stability and heat distribution inside the furnaces, further reducing thermal efficiency.

Based on the results of the heat loss assessment, several methods for reducing energy losses were identified. Improving thermal insulation by replacing outdated materials with modern high-performance insulation can significantly decrease heat transfer through furnace structures. The implementation of waste heat recovery systems, such as recuperators or regenerators, can enable the reuse of exhaust gas heat and reduce overall fuel consumption. Furthermore, optimizing operating regimes and enhancing process automation can minimize heat losses associated with technological interruptions and ensure stable thermal conditions.

The analysis confirms that systematic heat loss assessment and targeted energy-saving measures can substantially improve the energy performance of glass production lines. Reducing unnecessary heat losses not only lowers production costs but also contributes to environmental sustainability by decreasing fuel usage and associated emissions. Therefore, the proposed approaches provide a practical framework for enhancing thermal efficiency in glass manufacturing processes, particularly in energy-intensive plants such as “Kvarts”.

Conclusion

The conducted study demonstrates that heat losses represent a major factor reducing the energy efficiency of glass production lines at the “Kvarts” plant. The results of the energy audit indicate that a substantial portion of supplied thermal energy is lost through exhaust gases, furnace structures, and insufficient thermal insulation. These losses lead to increased fuel consumption and higher specific energy use per unit of finished glass product, negatively affecting both economic performance and environmental sustainability.

The analysis confirms that outdated heat recovery systems and degraded insulation materials significantly contribute to inefficient heat utilization. In addition, non-optimal operating regimes and limited automation of thermal processes further intensify heat losses during production. Addressing these issues is essential for improving the overall thermal efficiency of glass manufacturing operations.





The findings of this study show that the implementation of targeted energy-saving measures, including modernization of insulation systems, optimization of combustion control, and utilization of waste heat recovery technologies, can considerably reduce heat losses in glass production lines. Such measures enable more rational use of energy resources, lower production costs, and reduce environmental emissions associated with fuel combustion.

Overall, the assessment of heat losses at the “Kvarts” plant provides a practical and scientific basis for enhancing energy efficiency in glass manufacturing. The proposed approaches can be applied not only at the studied plant but also at other energy-intensive industrial facilities seeking to improve thermal performance and achieve sustainable production goals.

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