CURRENT ASPECTS OF BOILER EQUIPMENT IMPROVEMENT

Diaghileiv V.O., Kavertsev V.L.

National Technical University «Kharkiv Polytechnic Institute», Kharkiv

An analysis of current trends in boiler engineering shows that manufacturers are focusing on enhancing the efficiency of boiler equipment through the implementation of innovative design solutions. A key area of development is increasing the thermal efficiency (efficiency coefficient) of boilers by improving their structural configurations. Notably, there is a shift from fire-tube to water-tube boiler designs, which allows for a reduction in boiler water volume and improvement in heat exchange characteristics. The use of pre-chambers for preparing the air-fuel mixture is also becoming more widespread, contributing to more complete fuel combustion.

Modern boiler designs increasingly incorporate advanced materials such as aluminum, copper, and heat-resistant sandwich panels. These materials reduce the overall weight of the equipment and improve its thermal resistance. Modular heating systems based on sectional boilers are gaining popularity due to their adaptability to varying thermal loads. There is also growing interest in the use of alternative and renewable fuels, driven by both ecological and economic considerations.

Transitioning to low-temperature operating modes is seen as an effective method to increase fuel efficiency and reduce emissions. At the same time, the simplification of boiler construction and the integration of built-in components such as economizers contribute to lower production costs. The efficiency of a boiler, being a fundamental performance indicator, is largely determined by its structural features, which affect its ability to regulate thermal output across different load conditions [1].

Since boiler capacity is typically calculated for peak demand during extremely low ambient temperatures, for the majority of the heating season, boilers operate under medium or reduced loads. Under these conditions, low-temperature boiler designs prove to be the most energy-efficient. A significant drawback of many existing hot-water and steam boilers is the inefficient heat transfer in the combustion zone, resulting in high flue gas temperatures (up to 200–250 °C) and a reduced efficiency of around 85–87%.A promising direction in improving boiler performance is the intensification of heat transfer within the combustion chamber by optimizing its geometry and taking into account the distribution of temperature gradients, airflow dynamics, and the completeness of chemical reactions. The application of such methods can significantly enhance the efficiency of boiler systems under variable thermal loads.

References:

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