Optimization of Production Processes on the Rotary Regenerative Air Preheater

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Abstract: *The recovery of residual heat from the flue gases is significant for improving the efficiency of the unit in power plants. In order to achieve good efficiency, an innovative design for preheating the combustion air for power plants has been proposed. The fundamental aim of the research was to present the benefits modernizing equipment to the existing power plants and to investigate the burning process that have a considerable impact on optimizing the production processes of energy environments. Unlike the conventional air preheating system that uses a rotary regenerative air preheater, the new configuration adopts a cascade heating concept, in which the air obtains heat from the feed water, circulating water and flue gases in several exchangers, tubular heat, which significantly decreases the air, leaks and destruction of exergy. The research has definition technological solutions for accommodation structures that have a considerable the impact on improving the efficiency of the technological process in thermal power plants and energy fuel. This action can be beneficial for improving the air preheating system and in order to advance energy production*.

Keywords: *optimization, modernizing equipment, air preheating system, combustion, coal, energy production.*

1. INTRODUCTION

In the heating industry, a boiler system is called a whole set of devices that is used to convert the chemical energy contained in solid fuel into thermal energy in the form of water or steam, it is used for the purpose of technological processes to drive steam turbines, or hot water supply. [1,2]. With the rapid development of the world economy and population growth, the demand for energy sources is increasing. Interpreting the expression steam boiler, we will define a system by which the process of transforming water liquid into saturated steam.

In the activity of the fuel combustion process, the boilers are divided into granular dust, coal burnt as lignite, use predominates in power plants, the size and production capacity. The second and most popular type of energy device is the grill boiler, the coal is burn on different types of grills, they are used for heating, steam generation in different types of power lines. The study examines the importance of optimizing coal burning in terms of grate heating boilers [3]. Modernization for industry thermal is comprehensive, all activity is concentrated for the main parameters of the process [4].

Complicated optimization changes will occur, and the solution is to allow the selection of the most advantageous option of modernization and optimization. The situation of optimizing coal combustion is associated with repair activities that increase the energy efficiency of existing electrical units [5]. Significantly prolongs the life of radiators. Regardless of any interference in the structure of existing power lines, such as pipes, drums, steam valves and boiler pipes are associated with shutdowns of up to several months for a plant [6]. A more correct optimization of the combustion system and the steam system means that the investments planned in a very short time result in an investment productivity [7,8].

The aim of the research is to establish the benefits of modernizing the existing boiler equipment and to investigate the process of burning different types of coal that have a significant impact on optimizing the production processes of energy environments [9]. The proposed organization and modernization solutions aim at significantly improving the operation of existing thermal power plants. The research included the following: analysis of basic terminology in the field of thermal energy, analysis of thermal problems, characteristics of grill boilers (Fig. 1) and their parameters, storage, research of coal properties, transport and combustion, calorific calculations, fuel value, optimization concept of the coal burning process, analysis of the impact of burning different types of coal on the operation of boiler equipment, analysis of boiler design and modernization principles, principles of energy balancing of heating equipment and environmental aspects in the energy industry [10].

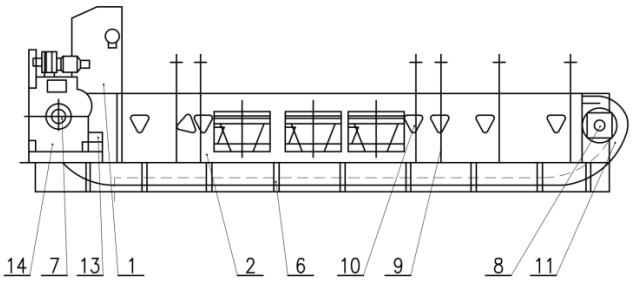

Fig 1. Grill boiler of the steam boiler [11], 1.coal bunker, 2.left side of the boiler, 3.front wall of the boiler, 4.space of air, 5.main path, 6.support, 7 .shaft motor, 8.gear axle, 9.and 10.air flaps, 11.description grille, 12.wall, 13.blocks and 14.transmission.

1.1. Improved boiler device to reduce heat loss through the chimney

There are many outdated devices in the energy sector, which generate huge production losses during the production of energy utilities. One of the most damaging losses economically is the so-called basket loss [12]. The process by which the appliance loses large amounts of unprocessed heat coming out of the chimneys together with the flue gases. The exhaust temperature often exceeds 200ºC, where the optimum value is 140ºC. In

order to reduce the discharge temperature and reduce chimney leaks, the following modernization works need to be carried out [13]:

- Rebuilding pressure-convection elements;
- Restoring the air preheater;
- Using soot steam blowers, cleaning the inside of the oven;
- Design of an external water exchanger for the utility needs of the plant.

Due to the optimization of the boiler end elements, it is possible to increase the heated surface. The restoration work must be preceded by a detailed investigation of the distribution of the additional surface of the pipe, of the technical condition of the modernized device. The designer usually has limited options for extending existing water and air heating elements, it is advisable to completely replace them with new elements. In fig. 2 shows you the classic solution of used tubular boiler beams, where you will see the exhaust gas flow, which does not meet any resistance. This process will likely encounter typical structural errors that need to be eliminated through use, such as denser pipes and reduced stack losses.

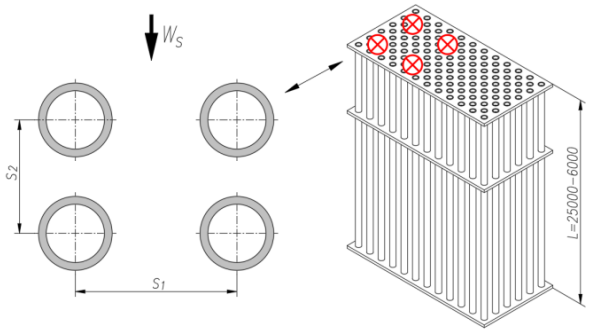

Fig 2. Diagram of a type of ribbed system for water and air heaters, S1 and S2 - distances between tubular type air heaters and WS flue gas transmission direction.

In order to reduce the loss of the chimney, a dense distribution of the pipe beams of the end elements of the boiler will be used (Fig. 3). A resource for placing the pipes on the heating surfaces of the boiler will reduce the temperature of the flue gases.

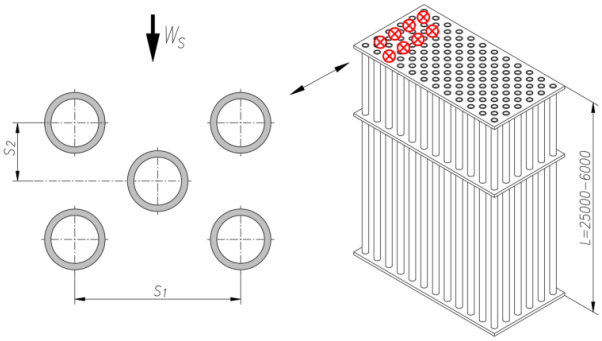

Fig 3. Schematic of a new type of rib system for water and air heaters. S1 and S2 - distances between tubular air heaters, WS-flue gas direction.

Based on the expansion of the water heater and the use of denser fins, the exhaust gases meet the resistance caused by the additional structural elements. In this situation, the temperature of the flue gases coming out of the chimneys is limited. The optimization works are related to the increase of the central efficiency. Often, the intention of modernization is to switch to better quality coal, whose combustion temperature is higher than the types of fuel previously used.

Based on the achievements of the modern metallurgical industry, it was possible to use new steel, much more resistant to high requirements and high temperatures. Newly manufactured boiler components are often much lighter and more efficient than those used previously. The impact of new metallurgical technologies is particularly visible in the modernization of boilers, which are relatively easy to replace by repair teams [14].

1.2. Optimization in relation to the design and modernization of the boiler equipment of coal burning.

Drastic increases in solid fuels have become the reason for huge changes in the energy economy. Modernization measures have a measurable benefit in the form of rapid return on investment costs and time savings in connection with the construction of new boilers. The design and construction of a new power line from scratch takes about three years, while the modernization of the existing energy system will not take more than nine months [15].

The optimization of the works produces significant economic benefits related to the boiler production processes. From a technical point of view, the type of investment is associated with renovation works, which are related to the following [16]:

- Energy efficiency optimization;
- Reduction of emissions of harmful gases and dust into the atmosphere;
- Adapting the appliance to work with selected coals;
- Reduction of thermal element failures; increasing the areas heated by the flame; increase performance;
- Optimizing the device's operation at higher energy pressure;
- Reducing coal burning, while increasing efficiency.

The preheater optimization works aim to eliminate the structural errors that occur during the operation of the device. Problems in the field of modernization and optimization of energy processes bring many measurable benefits to producers.

Designers whose job is to renovate the boilers to the new operating conditions, they avoid the renovation works consisting only of the reconstruction of the existing elements. These treatments lead to an extension of the life of the renovated elements, but do not increase the production capacity of the devices therefore they do not eliminate the problem of structural errors that result in reduced energy efficiency, which was revealed during operation.

As a result of using the optimization and repair processes performed on the functional devices, a unit with

its parameters can be created to meet any of the requirements compared to modern heating devices.

Modernized boilers are extremely flexible, adapted to burn different types of coal. Modified boiler equipment becomes less complicated for inexperienced employees [17].

Dust and smoke emissions return to the levels accepted by modern energy legislation, so power plants will not be required to pay fines for excessive harmful emissions [18, 19].

Principles of design and modernization specify the maintenance of the original dimensions of the device, making unnecessary interventions on the structures of the plant building.

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