EUROPEAN JOURNAL OF MATERIALS SCIENCE AND ENGINEERING
Volume 7, Issue 3, 2022: 153-156 | www.ejmse.ro | ISSN: 2537-4338

DOI: 10.36868/ejmse.2022.07.03.153

ASPECTS REGARDING THE CONCEPTION, DESIGN AND CONSTRUCTION OF RECUPERATIVE BURNERS

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Abstract

This article presents the main aspects of the conception, design and construction of self-designed recuperative burners. The starting point of the article is the operating principle of this specific type of combustion plant. This operating principle is based on the preheating of the combustor (combustion air) by taking over an important part of the enthalpy of its own combustion gases. Based on this principle, the recuperative burner of our own design has an energy efficiency that consists in reducing the specific consumption of fuel (natural gas) by about 25-35%. Also, the use of this specific type of combustion plant provides other functional advantages such as: a higher temperature in the hearth (due to a complete combustion), reduction of technological cycle times for the realization of various processes. The article also presents some functional parameters of a type-dimensional range of recuperative burners of our own design.

Keywords*:* *recuperative burner, conception, design, realization.*

Introduction

Recuperative burners (recuperative combustion plants) represent an important modernization of combustion systems. Due to their working principle, which will be described below, this specific type of burner has a special energy efficiency. This consists primarily of a fuel economy (natural gas) of about 25-35% under the conditions of ensuring superior functional and technological parameters. The operating principle of self-designed recuperative burners is based on preheating the combustion air right in the burner body (designed in the form of a heat recuperator), by taking part of the physical heat of its own hot burnt gases.

Figure 1 show the principle diagram of the recuperative burner.

The preheating of the combustion air in the recuperative burner body is done following a primary energy recovery process, which leads to an increase in the energy efficiency of the heating process of the steel casting pots or the heating and/or heat treatment furnaces. The materials from which recuperative burners are made, in the welded construction version, as is the case with the burners we refer to in this article, are of particular importance.

Thus, studies were carried out in the field [8,9] to optimize the properties of these metallic materials.

One of the first international firms to have concerns in the field of recuperative burners was Hotwork International [10].

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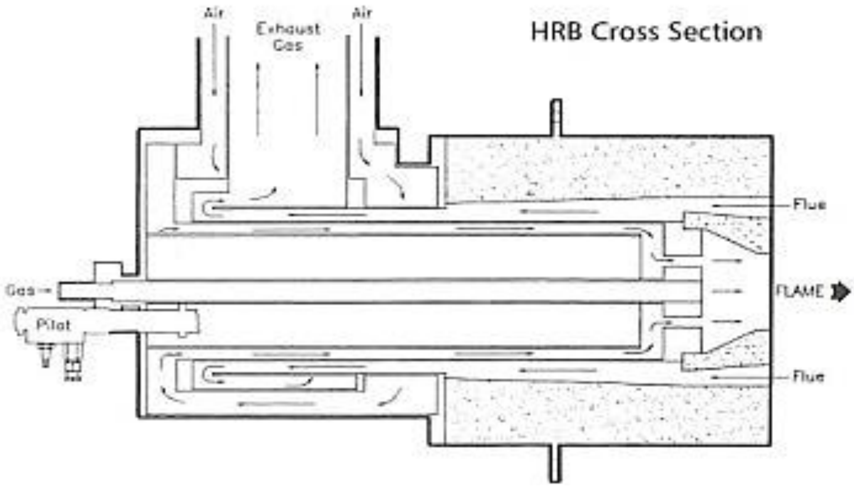

Fig. 1. Principle diagram of the recuperative burner

Ceramic recuperative burners were also made here, but the limitations appeared with the need to increase the nominal calorific power of the burners. They were becoming bulky. That is why the welded construction has advantages, including for the efficiency of heat exchange.

Table 1 present data about recuperative burners in operation in the country.

Table 1. Data about the recuperative burners in operation in the country

Nr. crt.	Nominal thermal power (kW)	Nominal natural gas flow rate (m^3_N/h)	Nominal natural gas pressure (Pa)	Casting pot capacity (t)	Combustion air temperature (°C)	Masonry pot temperature (°C)
1	100	10	6000	3.5	500	700-800
2	160	16	8000	7.5	500	800
3	250	25	2650	15	330	850-1100
4	400	40	7500	7.5	495	850

Conception, design and realization of recuperative burners of our own design

The recuperative burners, which were tested on the ICEM test stand, approved and tested in the industry in drying and preheating processes. A typo-dimensional range of such self-designed burners with nominal thermal power of: 63 kW, 100 kW, 160 kW, 250 kW and 400 kW was made.

Later, the areas of applicability of recuperative burners were expanded. In this sense, the conception, design and execution of the prototypes of recuperative burners for furnaces and other heating installations (for example preheating of the load in Electric Arc Furnaces - CAE) were approached and completed.

The two sizes of recuperative burners of our own design for furnaces whose prototypes were executed in the Atelier de Prototypes ICEM S.A. Bucharest within this stage of work have nominal thermal powers of 160 kW and 200 kW, respectively. Although the recuperative burner represents a unitary whole from a constructive and functional point of view, it is composed of three distinct main parts:

- the mixing area of the fuel with the combustion air formed by the flame stabilizers (central and annular) and the hot air pipe;

- the combustion air preheating area, where heat transfer takes place between the hot burnt gases and the combustion air (burner recuperator);
- combustion chamber (embrasure).

The two flame stabilizers and the hot air duct were designed in such a way as to ensure the combustion in several stages.

Thus, the natural gas is brought into the mixing zone through the body of the central stabilizer and the preheated combustion air both through the interior of the annular stabilizer (primary combustion air) and through its exterior (secondary and tertiary combustion air).

The ring stabilizer is arranged coaxially and outside the central stabilizer.

The central stabilizer is provided with a row of equidistant radial holes (nozzles) for the distribution of natural gas in the primary combustion air jet circulated through the annular section between the two stabilizers.

The annular stabilizer has a row of equidistant radial holes for the entry of primary combustion air and another row of equidistant axial holes through which the secondary combustion air circulates. The tertiary combustion air circulates through the outside of the ring stabilizer through the section defined by the part called the air nozzle. By means of the radial holes of the ring stabilizer, the rapid formation of a homogeneous mixture between the primary combustion air and the fuel gas is ensured.

Thus, at low fuel flows, conditions are created to maintain the flame front in the immediate vicinity downstream of these radial holes (first stage of combustion).

The secondary and tertiary combustion air mixes with the combustion gases produced in the first stage, thus reducing their temperature.

Under these conditions, at the exit from the burner, a mixture of burnt gases and dilution air corresponding to combustion at a very high excess air coefficient is created.

The combustion air preheating area has been designed in such a way as to ensure a large heat exchange surface between the combustion gases and the air required for combustion. In this sense, both transport routes of the combustion air have a helical shape, delimited by means of a rib placed in the space between the two cylindrical ferrules and having a helical shape.

Conclusions

The recuperative burner represents a specific type of combustion installation, with a special energy efficiency.

This efficiency is due to the operating principle and consists in a fuel economy (natural gas) of about 25-35%. The operating principle of the recuperative burner is based on the preheating of the combustion air by taking over the enthalpy of its own combustion gases.

Also, the recuperative burner has a good reliability ensured since conception, by reducing the number of components, but ensuring the entire functional role.

Thus, the energy recuperator through which the operating principle of the recuperative burner is ensured, is designed and made right in the body of the burner.

The construction of the recuperative burner is complex and requires a high level of technology and professional training.

The problem that must be solved through future research is the reduction of the overall dimensions of recuperative burners with high nominal thermal powers.

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Received: May 10, 2022
Accepted: June 15, 2022