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E.V. Gupalo, associate professor, c.t.s.
A.O. Eremin, chief of department, d.t.s.

RESEARCH OF РУФЕ WORK OF CIRCULAR FURNACS AT ENRICHING OF OF BURNING AIR BY TECHNOLOGICAL OXYGEN

National metallurgical academy of Ukraine, Dnepr

With the use of the worked out mathematical model there are researched thermal work of circular furnace at enriching of burning air by technological oxygen (from 21 to 37 %) for two variants of oxygen mixing with atmospheric air. It is set that organization of mixing does not render substantial influence on the factors of furnace thermal work. The maximal economy of fuel is arrived at maintenance of oxygen in air 37 % and makes 19,5 and 20,1 %, respectively, for the first and second variants. At a limit on the maximal expense of oxygen (2000 m^3/hour) its content in air is 33,6 %, and realization of measure provides the economy of natural gas 17,7 %.

Keywords: annular furnace, natural gas, industrial oxygen, enriched air, fuel economy

In works [3-6] the economy of fuel is investigated in the heat aggregates of metallurgical plants on content oxygen in air in a range 21-100 %. It is shown that the maximal economy of fuel in heater furnaces does not exceed 55-58 % and arrived by translation of furnace on «fuel-oxygen technology» of its incineration.

As a research object is chosen circular furnace for heating of skelp with diameter 0.57 and long a 1.90 m before a piercing press to the eventual temperature of surface 1270 °C with the difference of temperatures on the thickness of billet 30 °C. At a m maximum productivity 60 t/hours a furnace works on a two area temperature mode.

A furnace is heated by natural gas with means of 55 burners of type «pipe in a pipe», from what 35 is located in the walls of external ring and 20 – in the walls of internal ring.

The mathematical model of heat work of circular furnace is worked out, where it is possible to realize heating of metal on two-, three- or by multiarea temperature mode. During a mathematical modeling consistently it is execute next calculations:

– burning of fuel with determination of theoretical and actual expense of air, specific output of products of combustion, composition of smoke gases and them calorimetry temperature of burning, dependence of enthalpy of smoke from a temperature;

– parameters of external heat exchange with determination the relative coefficients over of radiation for the systems «gas-laying-metal», «furnace-laying-metal» and «laying-metal»;

– heating of metal, during which determine treason of characteristic temperatures of metal, smoke gases and laying furnace;

– thermal losses of furnace, charges of fuel on every area, general and zonal heat balances of furnace, technics-economy factors of its work;

– heating of air in a metallic recuperator, during which determine the

temperature of smoke gases after a recuperator and temperature of heating of air.

With the use of mathematical model, heating of metal is investigated in a circular furnace which works on atmospheric and oxygen-rich air at a maximum productivity 60 t/hours.

Two variants of mixing of atmospheric air by technological oxygen are also considered. According to the first variant atmospheric air, that it is heat up in a recuperator, mix up with technological oxygen before a furnace. On the second variant at first carry out mixing of atmospheric air and oxygen, and then the enriched air is warmed up in a recuperator. Calculations are executed for both variants at parts of oxygen in air burning 0.21-0.37.

Researches of heat work of circular furnace showed, during the use for incineration of fuel of atmospheric air heating of metal to eventual preset parameter place is taken at the charges of natural gas by 2360 m^3/hours (or 39.34 m^3/t metal); duration of heating folds 6.3 hours.

In connection with not high speed of smoke gases in the working chamber of circular furnace of increase of radiation coefficients for the system «gas-laying-metal» at enriching of air by oxygen stipulates intensification of heat exchange in the work volume of furnace which results in the necessity of insignificant correlation itsr temperature mode with the purpose of providing of the necessary productivity.

The cost expenses on a fuel expect on a formula:

$$\Delta C = Ö_{ph} \cdot b_{ph} - Ö_{O_2} \cdot b_{O_2} \ , \qquad (1)$$

where $Ö_{ph}$, $Ö_{O_2}$ – a cost of natural gas and technological oxygen, hrn/thousand m^3, respectively; b_{ph}, b_{O_2} – economy of natural gas and expense of technological oxygen is specific, m^3/t, respectively.

At conditions, when a cost of natural gas is high and has a tendency to the further increase, and technological oxygen is eigen energy recourse of plant, for stimulation it is consumptions of its surpluses, which appear due to treason of the productivity of basic metallurgical aggregates, it is expedient to determine the maximal cost of technological oxygen and set its vacation price, leaning on this factor and its production cost. For a furnace, that examine, the maximal cost of oxygen, at which its use is economic justified without the account of charges on introduction of measure, can be defined from equation (1) on condition that $\Delta C = 0$:

$$Ö_{O_{2\max}} = \frac{Ö_{ph} \cdot b_{ph}}{b_{O_2}} \ . \qquad (2)$$

Both considered variants of organization of mixing of technological oxygen with atmospheric air are economic justified. However, it is necessary to notice that during implementation of researches a metallic recuperator was accepted by gas proof. Practice of exploitation of heater devices testifies that so takes place not always, that is why insignificant advantage which is Variant 2 can depreciated by the losses of technological oxygen in a recuperator at presence of source of the enriched air during its heating.

Transfer of circular furnace on outside oxygen-rich work needs equipment of its by an additional pipeline for tricking into of oxygen and reconstruction of automatic control system by heat work of furnace. Except for that, it should be noted

that due to the substantial economy of fuel during introduction of measure substantially the range of adjusting of heat power of burner diminishes built on, what are equip a furnace. Not having regard to complications with the preliminary estimate of capital charges on the reconstruction of furnace, an economic effect is expected from introduction of measure at the level of 9.9-10.5 mil. hrn/year grounds to assert that the term of payback of measure will not exceed one year.

Conclusions. Heat work of circular furnace, which works on atmospheric and oxygen-rich air in the range of treason of concentration of oxygen in air burning from 21 to 37 %. Two variants of organization of atmospheric air mixing are considered with technological oxygen, is investigated. It is certainly, that organization of mixing substantially does not influence on the factors of heat work of furnace. The values of maximal economy of fuel arrive at maximal part oxygen in air (0.37), which presents 19.5 and 20.1 %, respectively, for variants 1 and 2. However, having regard to the features of the technical state and constructions of recuperators, which equip furnaces, expedient is mixing of warmed-up atmospheric air with cold oxygen after a recuperator. In the conditions when an expense of technological oxygen is limited (2000 m^3/year) and mixing of heat up atmospheric air with oxygen takes place after a recuperator, realization of measure provides the economy of fuel 17.7 % at content oxygen in the enriched air 33.56 %.

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