Directions of Saving Energy Resources in the Technology of Orethermical Processes

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ABSTRACT

The basic costs of energy resources in orethermal production and ways to use the deadweight costs of heat and chemical energy of ferroalloy production by-products are covered.

1. INTRODUCTION

Orethermical processes are among the most energy-intensive among metallurgical production processes. The issue of saving electricity in the ferroalloy industry has been vital for many years. Finding of radical solutions is a rather complicated and complex task due to several factors:

- Reduction processes occur at high temperatures;
- 30% of the electricity used is lost with chemical energy of the exhaust gases;
- Products of smelting (metal, slag) withdraw a significant share of heat (15-20%);
- A significant amount of heat is lost in transit and also further processing of melting products.

2. BALANCE OF POWER FLOWS

For example, let's consider the heat balance of orethermal furnace in ferromanganese smelting using flux-free process [1], see Table 1.

Table 1. Thermal balance of ore-smelting furnace

	Profit heat	кДж/ кг	%		Energy expenditures	kilojoule / kg	%
1	2	3	4	5	6	7	8
1	The heat of electric arc	12550	50.92	1	Chemical energy of oxides recovery	8963	36.36
2	Chemical energy of coke and electrodes	11435	46.39	2	Chemical energy of blast furnace gas	6716	27.25
3.	Chemical energy of slag formation reactions	627	2.55	3	Physical heat of dumping slag	3050	12.38-
4	Physical heat of charge materials	35	0.14	4	Chemical energy of carbon that went into metall	2201	8.93
				5	Physical heat of ferromanganese	1390	5.64
				6	The heat of elements evaporation (Mn, Si, P)	837	3.39
				7	The loss of heat through the lining	416	1.69
				8	Physical heat of blast furnace gas, including water vapor (t = 425 ° C)	394	1.60
				9	The heat of melting slag and metal	284	1.15
				10	Chemical energy of water vapor decomposition	208	0.85
				11	Heat of evaporation of moisture in charge	188	0.76
	Total	24647	100,0		Total	24647	100.0

Generalization of costs is reported in Figure 1. The values of costs are given in % in the chart.

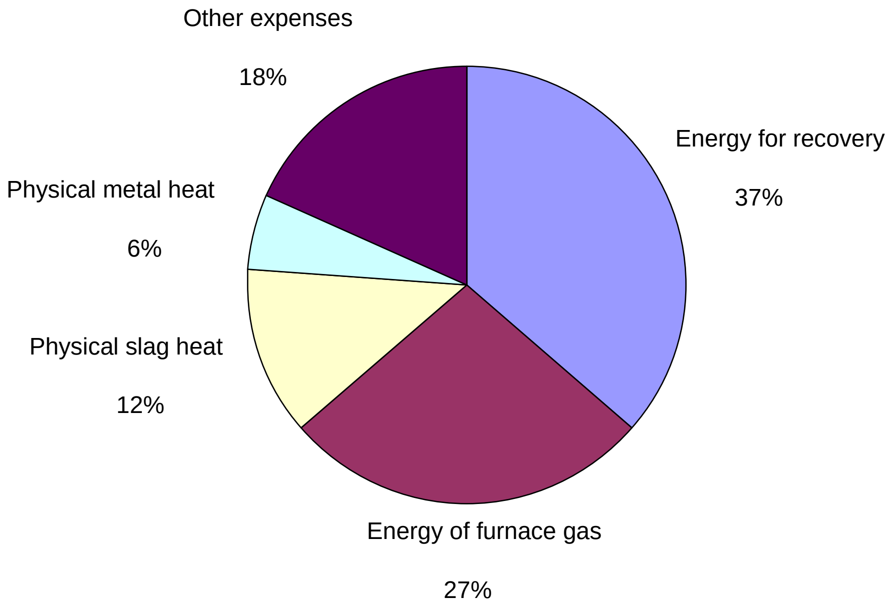

Fig.1. Diagram summarizing energy expenditures of furnace technology, %

3. ANALYSIS OF ENERGY LOSSES AND SAVING METHODS

As the table and the chart summarizing costs state, more than 27% is lost with furnace gas only.

Physical heat of melting products, metal and slag are almost 18% (5.64% and 12.38%, respectively) of the total losses. Due to lack of design solutions in construction of enterprises that are mostly focused on getting the basic product, or lack of technical solutions by-product heat utilization significant energy resource is lost.

Heat of melting products is almost not used thus heating the atmosphere. For example, the heat being radiated by slag carriage, filling machines, heat from cooling electric furnaces is still of little use. Heat of slag buckets may be used to reduce the moisture in the raw materials defrosting them in winter, or for domestic purposes. Off-gases is an important secondary source of energy (chemical energy of blast furnace gas is more than 27% in the thermal balance of the furnace) and are used only partially. This is prevented by outdated standard designs which almost did not provide technical solutions to reuse heat and energy of melting products.

Calculations show that the chemical energy of blast furnace gas accounts for almost 60% of chemical energy of coke and electrodes. Partly off-gases are directed to domestic needs to heat the factory facilities, but in the warmer months such a resource is just lost. Effective use of off- gases is prevented by high sulfur content which in a moist environment creates damaging acids. A solution of such problems may be the use of modern methods of treating gas and its use in steam turbine power generators. The electricity produced by using the utilized gas may be transported over long distances (unlike the awkward heating mains) or used in factories thus saving up to 10% of electricity consumed.

At the same time, operation experience of large capacity ore-smelting furnaces which structural elements are made of ferromagnetic materials (structural steel) necessitates taking into account losses due to magnetic fields and finding ways to reduce them. The authors performed calculations of electromagnetic losses in the construction of the arches of RPZ-63I1 and RKG-75 furnaces based on measurements of magnetic field intensity on the surface of arches and heat losses from the surface of the furnace mantle.

The results obtained are shown in Table 2.

Table 2. Heat and electromagnetic losses of RPZ-63I1 and RKG-75 furnaces

	Indicators and types of furnaces	RPZ-63I1	RKG-75
1	Installed capacity of furnace transformers, MVA	63.0	81.0
2	The total surface of furnace mantle heat emission, m^2	471.55	343.83
3	Heat loss from the furnace mantle surface, kW	1327.72	1774.83
4	Specific heat from the furnace mantle surf, W/m^2	1362	2546
5	Typical losses as % of installed capacity	2.1	2.21
6	Electromagnetic losses in the structures of furnace arch, kW:		
	- of structural steel	660.35	-
	- of non-magnetic steel	8943	96.3
7	Electromagnetic losses in % of installed capacity:		
	- in furnace arch of structural steel	1.05	-
	- in furnace arch of non-magnetic steel	0.127	0.119
8	Total losses of the furnace, kW	1988.0	1871.0
9	Total loss of the furnace in % of installed capacity:	3.15	2.31

Analysis of the data obtained shows that the electromagnetic losses in the arch of RPZ-63I1 furnace exceed by six times those in RKG-75. Manufacturing of furnace arch design element for RPZ-63I1 furnace of non-magnetic steel will reduce energy costs in the operation of the furnace by 30-35% and reduce unit costs of electricity during the production of silicomanganese by 50-60 kW h/ton.

In view of the above it should be noted that utilization of blast furnace gases as an energy source, heat of ferroalloy melting products, improving of technical and design solutions and construction materials of furnaces will significantly increase energy efficiency in ferroalloy production.

4. CONCLUSIONS:

1. The problem of energy efficiency and the use of secondary resources are particularly relevant these days for energy-intensive industries, including ferroalloy industry. It is shown that the share of irrevocably lost energy is about 45%. 27% of chemical and thermal energy is lost with the most affordable component (off-gases) only.

2. One of the main directions in addressing energy efficiency issue should be an integrated approach in designing electric furnace units using non-magnetic materials and auxiliary furnace equipment for efficient use of secondary resources in ferroalloy production.

5. REFERENCES

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