TECHNOLOGY OF OBTAINING IRON POWDERS BY THERMAL TREATMENT OF IRON OXIDE-CONTAINING METALLURGICAL WASTE USING HYDROGEN

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Abstract. *In this work, sources of iron-containing waste in Uzbekistan, their current processing technologies, iron oxide recovery methods and analysis of the main parameters of the process, areas of application of iron powder, requirements, brands, classifications of iron powder, working conditions of the experiment, CM using hydrogen gas 1.6 The parameters of thermal treatment in a 5-zone furnace, the results of X-ray fluorescent analyzer analysis of experimentally obtained samples, and the discussion of the analysis result are given. In the study, comparing the duration of the main parameters reduction and oxidation, it was found that both conversion rates at low temperatures are lower than at high temperatures for several cycles. At 800 °C cycle-to-cycle reduction times increased by about 2.2% and oxidation times by about 11%, while at 850 °C, reduction times increased by about 3% and oxidation times by about 4.5% per cycle. At 900 °C, however, the loss of reactivity in the cycle was only 1% for reduction and less than 1% for oxidation.*

Keywords: *iron oxide, iron powder, " Almalyk MMC"JC, CO_2 gas, "Clean Circles", hydrogen gas.*

Introduction: Until now, there are several methods of reduction of iron oxides to elemental iron, examples of which are reduction with carbon, reduction with strong reducing agents, and reduction to iron with gaseous hydrogen. Despite the fact that the base of iron-containing raw materials is sufficient in our country, at the moment, the production of ferrous metal and cookies is one of the lagging areas. As raw materials, it is possible to specify large production enterprises: iron-containing waste (khvost) of "Almaliq KMK" JSC, slag of Issyklik power stations, iron oxide waste of Tashkent Metallurgical Plant. Sources [1-3] show that the share of steel industry waste in the total (%) amount of man-made solid waste is 9%.

Compared to carbon recovery, using natural gas significantly reduces CO2 emissions. However, as a result of research, it has been proven that the formation of carbon dioxide can be reduced by 95% by reducing iron oxides with hydrogen gas [4-7]. As a reactive metal, iron has great potential to accelerate energy metabolism.

The Clean Circles project brings together scientists from different disciplines to study how metals and their oxides can be recycled as carbon-free chemical energy carriers for wind and solar energy storage [8-15]. Despite extensive research on iron oxide reduction in the literature [16–20], there are no clear indications of high purity micron-sized iron oxide powders on the most accurate reduction kinetics.

Methods: Samples were analyzed on a High Performance Energy Dispersive X-ray Fluorescence Spectrometer - Japan, Rigaku NEX CG EDXRF Analyzer Kit Polarized - 9022 19

000 0 and hydrogen recovery was carried out in a furnace CM 1.6 5-zone furnace. The following chemical processes take place in the experiment: (Gas-solid phase heterogeneous reactions) These processes are shown in Table 1 as follows

Table 1.

$3Fe_2O_3 + H_2 =$	from hematite
$2Fe_3O_4 + H_2O$	to magnetite
$1.202Fe_3O_4 + H_2 =$	from magnetite
$3.807Fe_{0,947} + H_2O$	to wustite
$Fe_{0.947}O + H_2=$	from wustite
$0.947Fe + H_2O$	to iron

Experiments were conducted at average temperatures of 800 °C, 850 °C and 900 °C for about 2.5-3 hours. Because the reduction and oxidation reactions slow down near conversion to 100% magnetite and wustite, we chose a specific area closer to magnetite than to the magnetite boundary. Thus, we used 40-60% of the total redox potential of the contact mass between wustite and magnetite. To define the reactive zone, the limits of 100% magnetite and wustite were determined at the beginning of each experiment by complete reduction and oxidation in the first cycle.

Results and Discussion. Comparing the duration of reduction and oxidation, it was found that both conversion rates at low temperatures were lower than at high temperatures for several cycles. At 800°C, cycle-to-cycle reduction times increased by about 2.2% and oxidation times by about 11%, while at 850°C, reduction times increased by about 3% and oxidation times by about 4.5% per cycle. At 900 °C, however, the loss of reactivity in the cycle was only 1% for reduction and less than 1% for oxidation.

Initially, it was assumed that cycle stability would deteriorate with higher operating temperatures. However, current experimental results suggest the opposite. The recovery process of iron oxides in a hydrogen environment was found to be optimal based on the following parameters:

Temperature in the oven zones:

1) zone 750 °C 2) 860 °C 3) 900 °C 4) 810 °C 5) 750 °C

2. Duration in the oven zone: 30 min.

3. Amount of loading in one crucible: 2-1.7 kg

4. H_2 consumption: $6m^3$/hour

5. Productivity:

Fe_2O_3 ----------- Fe

438 gr ----------- 288 gr

X-ray fluorescence analysis of iron trioxide waste from metallurgical plants is presented in Figure 1

The result of the analysis showed that Fe_2O_3 was the main component (95.6% mass) of the solid phase produced in the "acid regeneration shop" of the Tashkent Metallurgical Plant.

Based on the above technical indicators, the sample was analyzed and it was shown that the chemical composition of the elements in Figure 2 was formed.

Analyzed result(FP method, Scatter)

No.	Component	Result	Unit	Stat. Err.	LLD	LLQ
1	Cl	0.162	mass%	0.0005	0.0002	0.0007
2	MgO	0.131	mass%	0.0103	0.0233	0.0699
3	SiO2	0.0822	mass%	0.0018	0.0014	0.0043
4	SO3	0.133	mass%	0.0011	0.0014	0.0042
5	Cr2O3	0.0626	mass%	0.0021	0.0044	0.0133
6	MnO	0.362	mass%	0.0046	0.0065	0.0195
7	Fe2O3	95.6	mass%	0.0449	0.0024	0.0071
8	Co2O3	0.179	mass%	0.0110	0.0355	0.107
9	NiO	0.0163	mass%	0.0016	0.0033	0.0100
10	CuO	0.0630	mass%	0.0020	0.0015	0.0044
11	Ga2O3	0.0030	mass%	0.0004	0.0008	0.0024

Spectrum

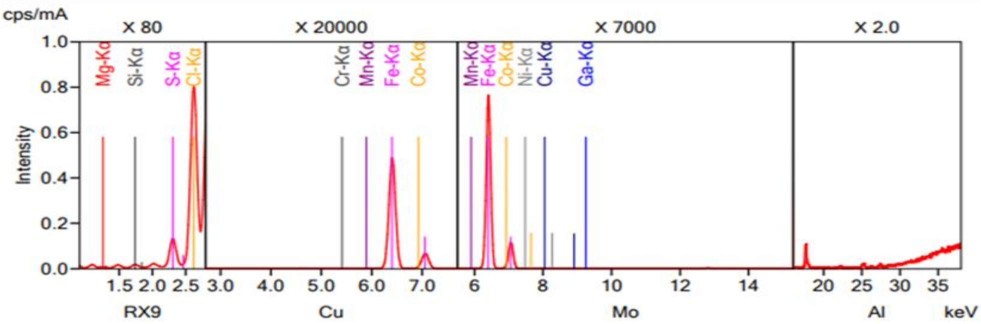

Fig 1. The result of the analysis of waste containing iron

Analyzed result(FP method)

No.	Component	Result	Unit	Stat. Err.	LLD	LLQ
1	Cl	0.0115	mass%	0.0002	0.0001	0.0004
2	Al	0.204	mass%	0.0044	0.0038	0.0114
3	Si	0.0949	mass%	0.0017	0.0012	0.0035
4	S	0.154	mass%	0.0009	0.0006	0.0017
5	V	0.0184	mass%	0.0018	0.0046	0.0137
6	Cr	0.0722	mass%	0.0020	0.0039	0.0117
7	Mn	0.406	mass%	0.0055	0.0077	0.0230
8	Fe	98.5	mass%	0.0435	0.0020	0.0061
9	Co	0.119	mass%	0.0113	0.0333	0.100
10	Ni	(0.0146)	mass%	0.0022	0.0050	0.0150
11	Cu	0.103	mass%	0.0030	0.0025	0.0074
12	Zr	0.227	mass%	0.0040	0.0013	0.0039
13	Mo	0.0144	mass%	0.0029	0.0043	0.0129
14	Sn	0.0098	mass%	0.0008	0.0009	0.0027
15	Au	(0.0043)	mass%	0.0011	0.0018	0.0054
16	Yb	(0.0377)	mass%	0.0057	0.0135	0.0404

Spectrum

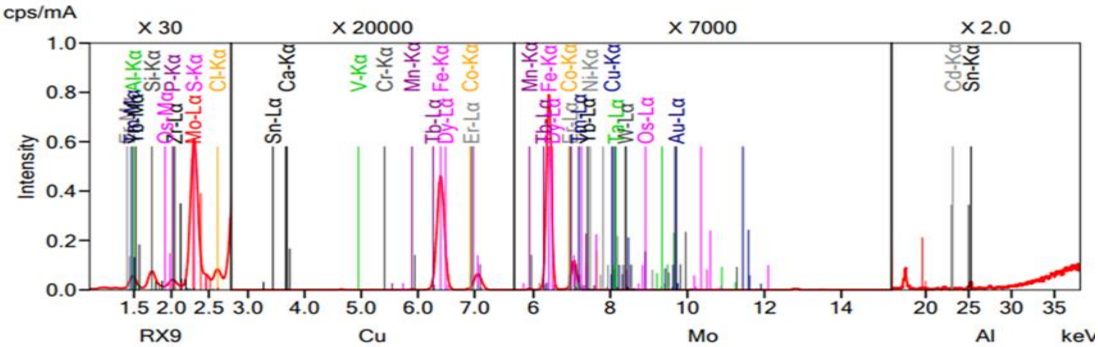

Fig 2. The result of elemental chemical analysis of the obtained iron powder.

It can be seen from the X-ray fluorescence analysis of the iron powder obtained in the process that the main part of the sample (98.5% mass) contains elemental iron and partial oxidation.

Conclusion

The creation of waste-free technologies for the processing of secondary raw materials is one of the current topics. In the technology of production of iron powder from waste containing iron oxide, almost no harmful waste is released into the environment. This technology is considered an economically efficient technology. In addition, in recent years, hydrogen gas recovery has aroused great interest among world scientists, and great work is being done in this regard. Based on the experiments, it was possible to obtain iron powder with a purity of 98.5%.

This iron powder can be used in the preparation of electrodes, in the production of various iron-based alloys, in a 3D printer based on metal powders, and in metallurgy, instead of cementing gold with zinc powders, it can be used as a cost-effective powder in the process.

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