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ANALYSIS OF THE STAGES OF THE FORMATION OF FLAKES (WEALZ OXIDE) IN THE PROCESS OF WAELZ

Ro‘ziqulov Qodirbek Musurmanovich
Ministry of Mining and Geology, “Uzbek Overseas Geology Company” LLC
Utanov Farrux Djabbarovich
“Almalyk MMC” JSC zinc plant

Abstract. At “Almalyk MMC” JSC, zinc in zinc cakes is transformed into rough waelz oxide (RWO) by means of a rolling process. There are several types of RWO collected along the process gas pipeline, including return RWO, hot and cold collector RWO, cooler RWO, and light filter RWO. When RWO is calcined, calcined (CWO) and secondary welts oxide (SWO) are formed. Samples of these products distributed along the gas tract were chemically and microscopically analyzed.

Key words: Welding process, technological gas tract, RWO, CWO, SWO, chlorine, fluorine, zinc, reducer.

Аннотация. “Олмалиқ КМК” АЖда рух кекларидаги рух вельцлаш жаарёни ёрдамида хомаки вельц оксиди (ХВО) кўринишига ўтказилади. Технологик газ тракти бўйлаб йиғиладиган ХВО бир неча хил бўлади, жумладан: қайтарма ХВО, иссиқ ва совуқ коллекторлар ХВО, кулер ХВО ҳамда енгли фильтр ХВО кабилар. ХВО тоблангач, тобланган (ТВО) ҳамда иккиламчи вельц оксиди (ИВО) ҳосил бўлади. Газ тракти бўйича тақсимланган ушбу маҳсулотлар намуналари кимёвий ва микроскопик таҳлил қилинган.

Калит сўзлар: Вельцлаш жараёни, технологик газ тракти, ХВО, ТВО, ИВО, хлор, фтор, рух, қайтарувчи.

Аннотация. В АО «Алмалыкский ГМК» цинк, содержащийся в цинковых кеках, в результате процесса вельцевания переводится в форму чернового вельц-оксида (ЧВО). ЧВО, собираемый вдоль технологического газового тракта, подразделяется на несколько видов, в том числе: возвратный ЧВО, ЧВО горячих и холодных коллекторов, ЧВО кулера, а также ЧВО рукавного фильтра. После прокаливания ЧВО образуются прокалённый вельц-оксид (ПВО) и вторичный вельц-оксид (ВВО). Образцы этих продуктов, распределённых по газовому тракту, были подвергнуты химическому и микроскопическому анализу.

Ключевые слова: Процесс вельцевание, технологический газовый тракт, ЧВО, ПВО, ВВО, хлор, фтор, цинк, восстановитель.

INTRODUCTION.

As a result of the increasing demand for non-ferrous metals in industry, including spirit, there is a worldwide decrease in primary raw materials. Typically,

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when sulfide concentrates of spirit are processed using a hydrometallurgical method, spirit cake is formed, and to separate the main components from the spirit cake, jarosite (hydrometallurgy) or welchization (pyrometallurgy) processes are used. The possibility of processing spirit cake, secondary raw materials and wastes also preserves the importance of the welchization process. Secondary raw materials and wastes containing spirit (usually Zn – 18-35%) are loaded into the welch furnace together with carbon-containing reducing agents (usually the amount of reducing agent in the charge is 31-33%). The technological gas path devices of the smelting complex are a dust chamber, a hot collector, a cooler, a cold collector, a sleeve filter and an air extractor (smoke extractor). During the smelting process, certain components of the charge, under the influence of boiling temperatures, oxidation-reduction processes and positive and negative pressures of the gas path, pass into the exhaust and accumulate in certain devices. In order to separate lead, cadmium and lead from these products (RWO), they cannot be directly selectively dissolved in a solution of sulfuric acid. In order to produce high-quality spirit metal from secondary raw materials and waste, it is necessary to purify the RWO, which is a smelting product, from elements such as halogens, reducing agents, antimony and manganese.

LITERATURE REVIEW. The dusts (RWO) emitted from the furnace together with the technological gases of the welding process can be divided into two groups. These are condensation and mineral-like dusts.

Condensation dust (RWO) is formed as a result of oxidation and condensation of metal vapors. Mineral-looking dust consists of fine particles of slag, coal dust, and ash and slag from coke products [1].

Mineral dust contains a large amount of unwanted elements and causes RWO pollution. The amount of this product produced depends on the flow rate of process gases, the density and particle size distribution of the feedstock fed into the sintering process.

The gas transport system consists of process gas pipelines, a dust chamber, a gas cooler, a high-level filtration device, and gas extractors. Dust accumulation in horizontal gas transport pipelines is undesirable, and therefore it is necessary to maintain a gas velocity sufficient to carry away even large dust particles [2].

The main components in RWO are usually as follows, %: Zn – 55-57; Pb – 12,5-14,5; As – 0,04-0,05; Sb – 0,04-0,06; SiO_2 – 1,1-2,0; Cl – 0,4-0,6; F – 0,1-0,18; In – 0,0085-0,0110 [1].

During the production of one ton of steel, an average of 25-30 kg of dust containing spirit is produced. Today, 5.6 billion tons of dust are accumulated in steelmaking plants with high production capacity. In the Russian Federation, an

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average of 0.7 million tons of this type of dust is produced annually [3]. The simplest and most effective method for separating spirit metal from this type of dust is the welching process.

When zinc cakes are processed by the pyrometallurgical method, the volume of gasses from pipe furnaces (welts) is equal to 5-10 thousand m^{3} /hour. These gases contain SO_2 – 15-21% and sulfur gases – less than 0.1%. Gases exit from the rolling furnace to the gas tract at 500-700 °C. Dusts have an average diameter of 1.5 μm. Velts-casts contain up to 70.0% zinc, and the dust level of gases is equal to 100-110 g/m^{3} [4].

In addition to sulfide concentrates, oxidized spirit-containing materials (welz oxides and slag tailings) containing harmful elements (As, Sb, Cl, F, etc.) (1-2 times more than sulfide concentrates) are also processed at spirit plants [5].

The specific surface area of RWO has been confirmed to be 9 500-10 800 cm^2/g. Chlorine and fluorine in RWO are found in the form of compounds such as NaCl, $PbCl_2$, KCl, $ZnCl_2$, CaCl , $FeCl_2$, NaF, PbF_2, KF , ZnF_2 , CaF_2 , FeF_2 [6].

Usually, zinc in welts oxide is found mainly in the form of zinc oxide, partially zinc ferrite and zinc sulfide [7].

RESEARCH METHODOLOGY. In the process of spirit cake refining, spirit, lead, cadmium and indium in the charge are reduced to their elemental state under the influence of high temperature and carbon-containing reducing particles. These elements in the elemental state are oxidized by oxygen in the process air supplied in the opposite direction to the charge loaded into the refining furnace. The oxygen, consisting mainly of non-ferrous metal oxides, moves together with the process gases of the refining furnace to the bag filter using an air suction device located at the end of the gas path.

For analytical work, samples were taken from the main points along the process gas path of the welzlash complex, including the dust chamber return product, hot and cold collector bunkers, gas cooler bunker, and sleeve filter (URFM III at the “Almalyk MMC” JSC zinc plant) bunkers and prepared for laboratory analysis in accordance with the requirements of GOST 14180 “Non-ferrous metal ores and concentrates. Methods of sampling and preparation of samples for chemical analysis and moisture determination”.

Zinc, which is the main component of RWO, was determined based on the “Volume complexometric method”, and chlorine and fluorine were determined using the “Potentiometric method”. Measurements to determine the mass fraction and mass concentration of fluorine in the samples were carried out under normal conditions based on the requirements of GOST 8.395.

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As a second step in the analysis, the RWO and CWO samples were microscopically analyzed. The samples, which were cut into special briquettes, were used to examine the optical properties of the minerals based on the reflection of light using an ADF U300P polarizing microscope.

DISCUSSION AND RESULTS. As research objects of the experimental work, samples taken from zinc cake welding complex, technological gases, dust chamber, hot and cold collectors, coolers, filter RWO and blast furnace slag, blasted and secondary weld oxides were analyzed. The results of the analysis are presented in Figures 1 and 2.

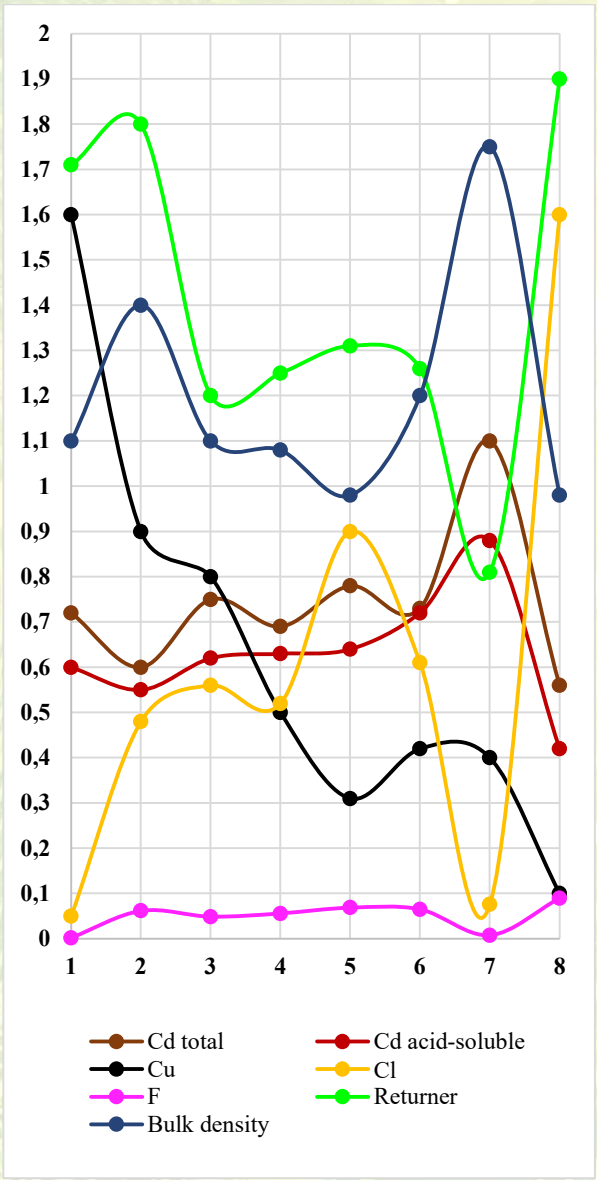


Figure 1 .

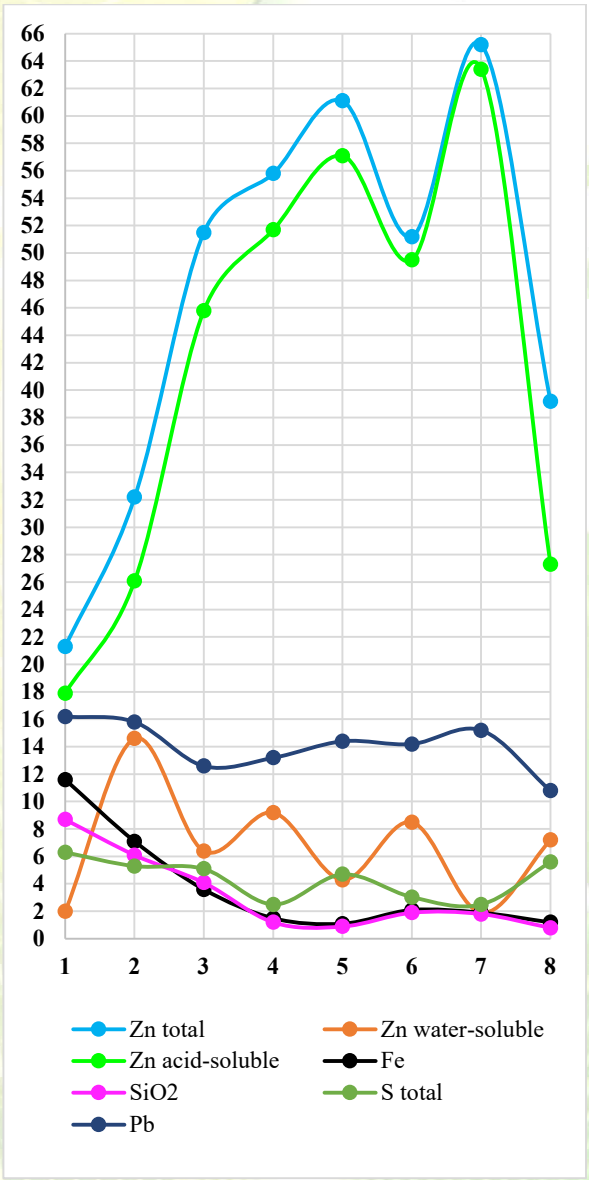


Figure 2.

1 and 2 are the samples taken from the order numbers (horizontal axis): 1-return welts oxide (dust chamber), 2-hot collector RWO, 3-cooler RWO, 4-cold collector RWO, 5-broad filter RWO, 6-receiving RWO, 7-CWO, 8-SWO.

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According to the results, the cadmium content in the dust chamber sample (0.72%) is higher than in the collectors (0.60% and 0.69%). The higher cadmium content in the CWO compared to the RWO can be explained by the leaching of elements. The higher copper content in this sample (1.6%) than in the other samples (0.31-0.9%) also confirms the high copper evaporation temperature and mechanical flight of the charge components.

The amounts of halogens and reducing agents in the RWO samples taken from all points (Cl – 0.48-0.9%; F – 0.049-0.069%) were higher than in the CWO (Cl – 0.076%; F – 0.008%), but were highest in the IVO (Cl – 1.6%; F – 0.09%). This is a result of the accumulation of these types of elements in the SWO as a result of the heating of the RWO. The fact that the bulk density of the samples reached the highest in the TVO – 1.75 g/cm^3 , can lead to a reduction in the utilization of equipment on an industrial scale, i.e., a reduction in production costs.

The fact that the amount of sulfur in the dust chamber sample is close to that of the sulfur in the gas path (21.3%) also confirms the mechanical flight of charge particles from the furnace. In the gas path samples, it was confirmed that the amount of sulfur increases up to the sleeve filter. As a result of the heating of the RWO, not only the elements (Cl, F, C, Fe, SiO_2, S) decrease, but also the amounts of sulfur (65.2%) and cadmium (1.1%). Sulfur was observed to be high in the dust chamber sample (6.3%), while its decrease in other samples (up to 2.5%) was observed. Since sulfur is relatively easy to fly, it reached a high amount in the SWO (5.6%).

The results of the RWO sample magnified 900 times on an ADF U300P microscope are presented in Figures 3 and 4.



Figure 3. CdO and Fe $_2$O $_3$ complex



Figure 4. Association of ZnS and PbS

Microscopic observations show that the RWO sample contains very small amounts of sphalerite, galena, and complex associations of these two minerals. In addition, complexes of iron and cadmium oxides can be observed. These types of compounds are present in the RWO sample in the amount of about 3-5%.

Of the CWO sample the images under the ADF U 300 P microscope are shown in Figures 5 and 6.

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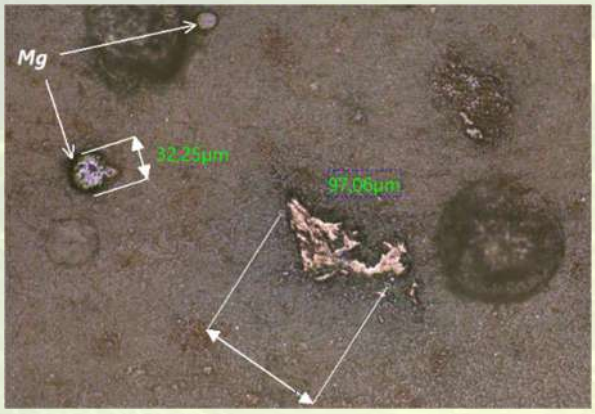


Figure 5. Mg and Anisotropic derivative

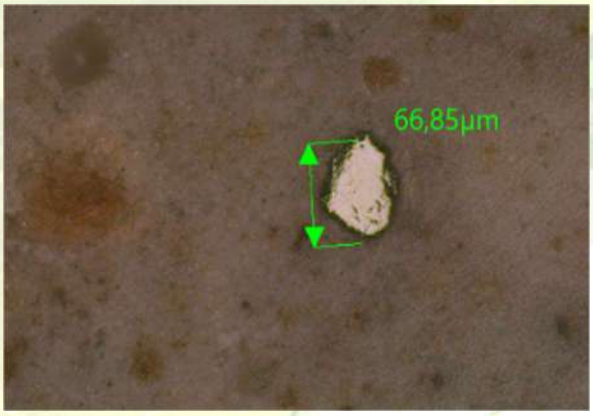


Figure 6. FeO × Fe $_2$O $_3$ (Fe3O4)

CWO contains about 1.2% iron oxides. Because the CWO has undergone several high-temperature stages, the phases do not correspond to the original hypogene minerals (sulfide enrichments). According to chemical analysis, welts oxides consist mainly of zinc oxide and significant amounts of lead oxide. In addition to the mineral and man-made products shown in the sample images, the part consists of small particles of zinc and lead oxides.

CONCLUSIONS AND SUGGESTIONS. It was confirmed that the components are distributed along the process gas tract based on the laws of physics and chemistry in the process of finding the charge consisting of RWOs of different composition collected in the sequence of the process gas tract devices of the process of rolling zinc cake with the presence of hard reducers with carbon content. We can see this situation in volatile components such as sulfur, cadmium, zinc, lead, chlorine, fluorine, reductant and high boiling point components such as iron, silicon dioxide, copper and lead oxide. For example, the mass fraction of lead in CWO is higher than that of SWO, it proves that all RWO and CWO are in the form of lead oxide (boiling temperature – 1 535 ℃).

The presence of very small amounts of spirit and lead sulfide minerals, cadmium oxide and hematite complexes, and small amounts of magnesium in the RWO samples confirms that the welching process also carries charge particles to devices downstream of the dust chamber through the process gas path.

In CWO samples, the reflectivity is close to that of hematite, but there are iron oxides compatible with magnetite according to their morphological features, a small amount of magnesium, and an anisotropic man-made product. Zinc and lead sulfides, which are present in small quantities in RWO, can be decomposed during the smelting process (780-800 ℃).

Today, the volume of waste product formed in the dust chambers of the welt furnaces of “Almalyk MMC” JSC zinc plant is 2-5% of the welt furnace slag. The process performance of zinc cake rolling can be improved by reducing the size of

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the return product. It is possible to increase the technical and economic indicators of zinc metal production through high-quality preparation of the slag of the welding furnace, temperature control of the sulfate decomposition of the welding furnace, reaction and clinker formation zones, and the temperature control of the RWO furnace, and the pressure control of the process gas tract.

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