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Innovative, Eco-Friendly and Economic Technology for Melting and Obtaining Phase Lead, Using All Types of Reusable Materials as Input Material (Oxidic- Or Sulfate- Type, Lead-Based)

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***Abstract*— The innovative technology applied in this project relates to obtaining of raw lead by rotary kiln melting procedures. Thus, impurities in metal (lead in this case) are separated when heated at high temperatures that determine melting. When melting the input material, a metal (plumb) is achieved of a higher quality, together with waste products referred to as slag.**

***Index Terms*—Eco-friendly technology, melting, phase lead, reusable materials.**

I. INTRODUCTION

The world is heading into an age of preservation, which recycling is an integrant part of. Without recycling, material circuit in nature would become a series of events without any logical resolution. Any possible useful materials would become utile expandable and would not be kept on as possible resources. Also, the use of previously processed materials involve significant energy savings compared to the use of raw materials. This provides the paramount certainty, respectively that recycling supports improvement of environment quality.

With regard to metallurgy, reusable materials represent today the source of most important non-ferrous metals. Relatively simple technologies for waste processing, investment and processing costs much lower compared to those applicable to ore metals, products of a comparable and occasionally higher quality compared to those acquired from raw materials cause recyclable materials to have an essential role in industry.

Recycling of used car batteries is the largest source of input materials for lead manufacturing industry. Based on European Union assessments, app. 800,000 tons of car batteries, 190,000 tons of industrial accumulators and 160,000 tons of regular portable batteries are disposed of every year. They contain heavy metals (lead, mercury and cadmium), harmful to environment and human health. The highest weight is held by lead, which represents the raw material for implementation of this innovative technological project, obtaining the phase lead which subsequently, by thermal refining, leads to manufacturing of lead used in production of car batteries.

II. TECHNICAL – ECONOMIC ISSUES

This project has led to the design of a technology for obtaining of phase lead, using all types of reusable materials as input material - lead-based, oxidic- or sulfate-type – innovating and conducive to special technological and economical performances, with low pollution. The lead thus achieved may be used in this state for manufacturing of Pb alloys or for selective refining operations followed by adjustment of alloying elements, to achieve any type of alloy intended. This technology is based on authors' Invention Patent, entitled: "integrated modular procedure to obtain lead grades and alloys".

Problems that are solved by this innovative technology for obtaining phase lead are as follows:

- Significantly reduced costs for thermal and electric power;
- Achieving a phase lead that, after subsequent processing, may be used both for manufacturing of lead grades with a purity between 99.940% Pb and 99.975% Pb, and also for all types of lead-based alloys;
- Very low pollution compared to all other manufacturing methods for phase lead.

Novelty introduced by this technology consists in the following:

a. Reduction of filtering equipment with more than 50% in case gas-oxygen burners are used;
b. Preparation of input material is made following proprietary formulas that allow higher outputs;
c. Execution of a technological flow (based on proprietary formulas) for every waste type, namely: oxidic wastes (which include all types of lead-based oxidic wastes,

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including metallic and oxidic elements resulted following manual or mechanical stripping of used car batteries; sulfated wastes (which include all types of sulfate wastes, including sulfated or desulfated paste, in specific installations, which also results following processing of used car batteries; sulfate-oxidic wastes (like, e.g., groups resulted following stripping used car batteries that include both grill-oxidic wastes and paste-sulfate wastes).

III. OVERVIEW IF THE INNOVATIVE TECHNOLOGICAL PROCEDURE FOR MELTING AND ACHIEVEMENT OF PHASE LEAD

In order to get a better understanding of the innovative dimension and advantages enabled by implementation of this Invention Patent within technological procedure for achievement of phase lead, we shall briefly show below this technological flow, highlighting the elements of **absolute novelty** incurred (we state that the main equipment used in execution of this technological process are: rotary kiln, burner, casting train, collection system and ventilation manifold, filtering equipment).Based on this invention, the procedure for obtaining phase lead follows the steps shown below:

STAGE 1. **–** ***Batch preparation.*** Batch preparation is performed differently for each of the 4 major types of input material, namely:

a. Oxidic lead wastes: wastes-X Kg.; heavy calcined soda -5% of X; coke -3% of X; sand - 1% of X.

b. Sulfate lead wastes: wastes - X Kg.; calcined soda -9% din X; coke -7% of X; cast iron shavings - 5% of X; sand - 1,5% of X.

c. Mixed wastes (groups): wastes - X Kg.; calcined soda -7,5% of X; coke - 5% of X; cast iron shavings - 4% of X; sand - 2% of X.

d. Desulfated paste: desulfated paste - X Kg.; heavy calcined soda - 6% of X; coke - 4% of X; sand - 1,5% of X.

STAGE 2. **– Loading.** The rotary kiln (Fig. 1) is loaded with impugn material, but only when hot - app. 800-900 °C. This operation is performed in batches of 500-800 Kg (depending on kiln's capacity) at 10-15 minutes intervals, depending on level of input material in kiln and on its melting progress. Before firing up the kiln and the **gas-oxygen burner**, the filtering equipment [1], [2] must be connected.

Fig. 1. Rotary kiln

STAGE 3. **– Melting**. After loading the kiln at appropriate capacity, the actual melting operation may be started, using the burner at a capacity of 80-90%.

The optimum melting temperature is: for oxidic lead wastes 500-600°C, for sulfate lead wastes 800-900 °C, for mixed (groups) wastes 700-800°C, for desulfated paste 650-800°C.

It is recommended that, during melting operation, the kiln's direction of rotation should be **inverted** every 15 minutes, to help homogenization of lead.

The burner shall be opened periodically and material in kiln must be stirred using a metallic shovel 4-5 m long (2-6 times during melting, depending on input material).

Time when melting is complete must be determined by the technologist, by visual checks of the progress of melting of material present in kiln, as well as by sampling using a hand spoon.

App. 15-30 min prior completion of melting, the rotation of kiln is stopped, with the discharge hole in horizontal position, ready for discharge.

STAGE 4. – Casting of kiln load. Casting of kiln load may be made in several ways:

- ***Casting of raw lead into ingot molds and of slag into trays***. After kiln rotation is stopped and molten material is discharged, the metallic tray is removed from kiln's outlet and, using a pick-hammer or a hand pick the plug covering the inlet hole is drilled, and then it is directed towards the cast trough.

The fire is shutdown 5 min before casting and it shall not be started until casting is complete. Then the rotating action is operated, in one direction or the other, and this the casting hole rises or lowers allowing adjustment of the flow rate of raw lead which flows from kiln, through the casting trough and into ingot mold (Fig. 2). Each time necessary, the casting hole is unclogged using a metallic rod.

The casting trough must be cleaned immediately after each cast. When the flow of lead is complete and slag starts flowing, the kiln's casting hole must be raised above the level of molten material.

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The status of slag remaining in kiln is checked, and if it is not sufficiently fluid it shall be fluidized and then poured into trays.

The casting operation may be achieved in reverse order, casting of fluid slag immediately after melting is complete, into trays, leaving the kiln to settle and then casting the lead into ingot molds.

Fig. 2. System used for casting phase lead into ingot molds

- ***Casting of raw lead and slag into trays***. Generally, the same operations are executed as in previous paragraphs. The advantage is that the casting hole of the kiln is brought into the position of the tray carriage and both the slag and raw lead are cast, in one operation, into trays. When the kiln is empty, the casting hole is brought into horizontal position, the hole is plugged with a clay plug prepared prior casting, and then the metallic cover is reinstalled above the hole.

IV. CONCLUSIONS

Assessing this new technology for melting and obtaining phase lead using all types of reusable materials as input materials (oxidic- or sulfate- type, lead-based), the execution and implementation of this project into manufacturing processes provides a highly favorable context, considering both the serious environmental problems incurred by lead-based wastes, and also the increasing demand for thermally-refined lead (as we all know, the input material for manufacturing of thermally-refined lead is the phase lead achieved when melting lead-based wastes into rotary kilns).

The input material used in this technological process for melting and achievement of phase lead is represented mainly by lead-based wastes resulted from stripping of used car batteries: terminals, grills, $PbSO_4$ paste. Lead-containing wastes are generated from:

- Industrial processes for manufacturing of primary lead, from manufacturing of lead products or products containing lead apart from other materials;
- Used acid-lead batteries (from cars, trucks, transportation equipment used in industrial facilities and warehouses, DC batteries for emergency supply during electric power fails);
- Slags and dusts from melting furnaces.

Upon implementation of this invention patent, apart from solving a serious environmental issue, the new technology provides processing of all kinds of lead-based, oxidic- or sulfate- type reusable materials, also providing a net increase of output, a reduction in processing time and also a significant decreased of harmful emissions compared to traditional processes.

Cross-referencing the features of this technological process for melting of lead-based wastes and achievement of phase lead, against traditional methods, we highlight the following advantages:

- Special adjustability of the technological process, practically recycling all types of lead-based wastes;
- Consumption of electric and thermal power in this option (OPEX) are almost 30% lower;
- Environmental costs are significantly lower, filtering equipment being reduced by more than 50% due to use of gas-oxygen burners;
- Values of investment works needed for implementation of this technology into the manufacturing process are app. 40% lower.

Internationally, continuous concerns are manifested towards improvement of technologies deployed in manufacturing of raw (phase) lead, both with regards to their efficiency and to achieving the best possible structures and features of these materials, with minimum material, power and human costs, as well as to less pollutant technologies [3]. Assessing the technology proposed above, we may see that it is a perfect fit among international concerns. Furthermore, we may say that perspectives of implementation of this project provides certainty of achievement of well-performing technologies, both scientifically and economically.

Based on implementation of this innovative technological process into the manufacturing activity, a higher quality phase lead is achieved, which involves **a significant increase in competitiveness** for the manufacturing company, providing input materials at competitive prices and higher quality, the dependency on possible providers being restricted to provision of lead-based wastes. This increased competitiveness driven by implementation of this process is materialized by: lower price of input materials compared to the purchase price of various providers; higher quality, shortening of processing time, with major savings of thermal and electric power; performance of manufacturing process in a coherent cycle, and not in cycles dictated by provision of input materials from various providers; higher quality of thermally refined lead achieved, providing opportunities to increase the number of potential internal clients and to improve penetration on external markets [4].

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