PROSPECTS FOR METALLURGICAL PRODUCTION TECHNOLOGIES

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MODERN EQUIPMENT FOR COMPLEX METALLURGICAL PROCESSING OF ALUMINUM-CONTAINING SCRAP AND WASTE

СУЧАСНЕ УСТАТКУВАННЯ ДЛЯ КОМПЛЕКСНОГО МЕТАЛУРГІЙНОГО ПЕРЕРОБЛЕННЯ АЛЮМОВМІСНОГО ЛОМУ ТА ВІДХОДІВ

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Aluminum and aluminum alloys are valuable structural metals with a wide range of applications, from the aerospace industry to medicine and construction materials. The production of primary aluminum from bauxite involves high energy consumption, which contributes to its high cost. Bauxite mining also causes significant environmental damage. In addition, aluminum is a strategically important material for use in the defense industry.

One of the unique properties of aluminum is that it can be almost completely recycled from waste, with its chemical composition restored to 99.98% of the original.

The main waste groups are as follows:

– cable and wire products, insulated, varnished and uncoated;

– construction profiles, waste from their production, slitting;

– clichés from printing plants;

– aluminum and bimetallic heating radiators;

– internal combustion engine housings, crankcases, elements of car bodies etc;

– aluminum tableware, household appliances, beverage cans, etc.

To ensure high-quality metallurgical processing of aluminum-containing waste into vintage aluminum alloys (quoted according to the London Metal Exchange's pricing), scrap pretreatment and melting/refining are typically used. Pretreatment operations include sorting, processing and cleaning of scrap. Melting/refining operations include cleaning, melting, refining, alloying and casting of aluminum recovered from scrap metal.

The problem faced by relatively small companies operating in the non-ferrous waste market is the instability of factors such as the supply of scrap ("raw material"), changes in energy prices, and the need to quickly switch to different types of products (castings) of a given grade.

That is why the modular layout of production lines, combined with high quality and reliability of equipment designs, ease of operation, the ability to quickly bring production back online after shutdowns, sequence of technological operations, and a small number of service personnel are important for the construction of such enterprises in today's environment.

As an example of the successful implementation of the above aspects, the following is the structure of the existing production of aluminum and alloys from aluminum-containing waste of various classes from scrap of the following classes

– piece scrap (class A),

– chip material (class B),

– waste in the form of metal powders (class C),

– all other types of recyclable materials to be processed (class M).

The main technological unit is a rotary reflector gas melting furnace (fig. 1) with a storage bath volume of 5.0 tons of liquid aluminum. The furnace allows processing all classes of waste at high speed and with minimal energy consumption.

The rotary kiln has a regenerative short-cycle gas burner as its heating system. The regenerator is backfilled with corundum layers with a diameter of 25 mm. The content of Al_2O_3 in the material of the layers is at least 97%.

Such a heating system can reduce the specific consumption of natural gas by 37...44 % compared to classical heating systems equipped with surface recuperators.

The natural gas consumption is thus 94...78.5 nm^3 per ton of conditioned alloy. The furnace is designed primarily for melting large scrap, such as engine housings, etc. The finished melt is poured through a system of troughs into a tundish for refining, deoxidation (if necessary) or into a mixer furnace (fig. 2) for subsequent casting into ingots or billets (vertical column, horizontal bar)

Fig. 1. Rotary gas melting furnace

Fig. 2. Mixer furnace

Fig. 3 shows a typical shop floor plan of a mini-plant that can produce up to 30 tons of branded aluminum alloys.

The plan does not show the sorting and procurement areas, the laboratory, amenity facilities, and the operational warehouse.

The production program for the processing of aluminum-containing waste into branded alloys is up to 30 tons per day (500 tons per month, 5500 tons per year) in terms of finished aluminum alloy output, which ensures an average gross revenue of $5.75 million per year.

List of the most popular alloys in the production program: Alloy AV87, AV91, AV97; Alloy AK5M2, AK9M2, AK8M3; Alloy AK7, AK12, AT 0, AT 31, AMG.

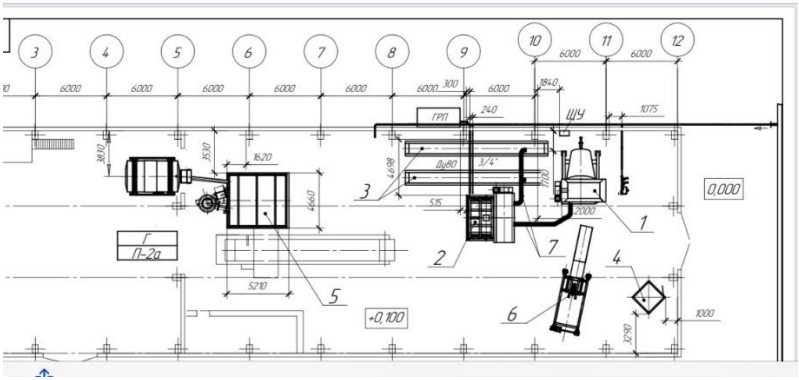

Fig. 3. Workshop floor plan of the mini-plant:
1 – rotary melting furnace; 2 – mixer furnace; 3 – casting conveyors; 4 – operator's room; 6 – loading machine; 7 – mobile chutes for casting and pouring liquid metal

Conclusions

The mini-plant for complex metallurgical processing of aluminum-containing scrap and waste is a modern, highly mechanized and highly mobile enterprise. The reduction of energy consumption per unit of output is ensured by the introduction of modern energy-efficient heating systems in combination with mechanization, a clear sequence of production processes, and the ability to change the production chain in accordance with the needs of consumers. Maximum efficiency is ensured by maintaining a 24/7 working schedule with minimal shutdowns for routine repairs or regrouping equipment for another type of product. Preparation of the raw materials (charge) using standard solutions (sorting, separation into groups, briquetting, shredding) and high qualification of personnel are also important.