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Resource-Saving Method for Secondary Cable Production

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ABSTRACT: The article contemplates the relevance of recycling technologies development. It is clear that human waste products have formed a significant recourse, along with natural resources. Criteria for recycling technology performance assessment are provided. The volume of cable production waste, the economic efficiency of recycling for its reuse in production is analyzed. A brief analysis of the issues of the development of recycling technologies in cable production is given.

KEY WORDS: Material resources; cable production; consumer wastes; waste recycling; waste utilization; copper rod; polymer waste.

I.INTRODUCTION

The issues of the economic independence development of any country are directly related to the continuous fight for resources, including labor, financial, and material resources. Fight for these resources is the cause of all the conflicts emerging recently. Only a country with an adequate resources supply can feel independent, and able to build own lifestyle independently.

Natural minerals appear to be decisive with regard to material resources. In recent decades, the exhaustion of individual deposits and the emergence of new ones are evidential, which is accompanied by a significant change in their location geography and, as a result, significant geopolitical turmoils. Steady depletion of natural minerals reserves is a negative global trend. New deposits exploration and conservation and effective use of natural minerals are vital tasks of the state.

Natural deposits depletion comes along with significant growth of human waste products number. Some reports suggest, in Russia, as a whole, about 3.4 bln.t waste, 30 to 40% of which are industrial wastes, are generated annually. Based on expert estimates, from 10 to 50% of industrial waste can be recycled for reuse.

II. RELATED WORKS

Sustainable growth of consumption waste volumes has been observed. Waste has developed into one of the significant material resources, the proper and efficient use of which is a crucial task. Those countries that are going to invest significant budget and corporate funds in the development and introduction of new technologies, including the reproduction of material and energy resources from secondary raw materials, at higher rates, claim to become leaders of the world development [1].

The development of technologies for cable production waste processing (recycling) appears to be particularly effective. To assess the effectiveness, we compare the technology for copper rod production from ore and copper waste. Technological conversions of rod production out of the ore are as follows:

Mine → processing plant →anodic copper →cathodic copper → rod.

Technological conversions of rod production out of waste are different:

Waste collection → waste treatment →anodic copper →cathodic copper → rod.

The technological cycle for copper rod production out of ore and waste contains the same amount of conversions, but the energy costs, labor intensity and capital intensity of the first two conversion stages are beyond compare. Energy costs alone in the processing of copper waste into anodic copper are 6 times less (in the processing of

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aluminum waste — 20 times [2]) as compared to the cost of anodic copper production, starting with the mine. Copper waste has a fairly high degree of homogeneity. The technology, based on modern recycling methods, can provide a high quality recycled materials.

As is known, cable production has a high material consumption. In some products, such as enameled wire, the copper content reaches 90% of the price of one kilogram of enameled wire. Given the high cost of copper, it can, therefore, be concluded, that for the production of the most cable products, lowering of the rod price is a fundamental parameter ensuring the cost reduction and increase in the production competitiveness. Considering the significantly lower costs for the production of copper rod out of the waste compared to the production of rod out of the ore, we can expect high economic efficiency of copper recycling for use in cable production in the process chain as a whole.

It should be noted that recycling efficiency is determined not only by economic indicators. Thus, the recycling efficiency assessment is determined by the following formula [3]:

$$Ier = F\,(E,\,Ec,\,M) \rightarrow 1{,}0$$

where, $I_{er}$is the recycling efficiency index; E is an indicator of the recycling economic efficiency, which shows the ratio of the cost of a product out of waste from primary raw materials (the cost of waste processing shall tend to a minimum); EC is an indicator of the recycling environmental significance, which reflects the environmental damage caused by technologies for obtaining a product out of waste; in theory, recycling shall not harm the environment; M is an indicator of the relative volume of the proposed recycling; in theory, 100% waste shall be recycled.

At the maximum compliance with the specified conditions, I_{er} tends to one. The I_{er} indicator points to the recycling efficiency for society as a whole, which, in turn, indicates the need for the deep state involvement in the formation of regulatory incentive documents related to the stages of development, storage and recycling of waste. This is necessary, in particular, due to the fact that for individual contractors, the issues of the environment and the depth of wastes recycling remain outside the focus.

The arguments of financial efficiency come to the fore. Small contractors skim the cream off and do not care about environmental issues and completeness of processing. This explains the fact that despite the existing well-developed technology for cable waste processing, the main method remains the copper burning technology.

The amount of cable waste production with a certain time step corresponds to the amount of cable and wire consumption. The time step is determined by the product life. The life of the most cable products is usually 25-30 years. However, this period depends on the operating conditions. For example, for oil submersible cables, this period is reduced in some cases to 1 year due to a significant change in conditions in the wells.

However, currently, the consumption of imported electrical and cable products increases sharply. Based on expert estimates, in general, due to domestic production and the supply of copper in imported cable and electrical products, the consumption of copper has increased by about 20%. Some products have already worked for 25 years and require replacement. Therefore, we can expect an increase in the volume of copper waste for recycling. A high degree of localization of places for the operation of electrical products containing copper shall also be mentioned. Transformer substations, cable lines, generating capacities, electrical energy distribution systems, mobile technical devices, electric motors are under constant control, repairs are performed by specialized enterprises.

It can be assumed that the degree of copper return for processing reaches 80%, therefore, the annual receipt of copper waste for processing from the operation of cables and equipment containing cable products only will be up to 280.0 thousand tons.

Historically, cable waste management has evolved in the following steps [2]:
- disposal of waste together with other wastes and human wastes;
- incineration in order to extract metal elements (primarily, copper);
- grinding and separation into metallic (with subsequent separation into metals) and non-metallic parts.
- new ways of cable waste recycling.

III. METHODS

Let us consider some problems, the solution of which requires new technologies. These include:
-the processing of polymeric wastes and their further use as construction materials;
- the heat treatment of polymers in compliance with sanitary standards and the use of heat energy generated during this process.

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IV. RESULTS AND DISCUSSION

At the present time, polymer waste in the overwhelming majority of cases is either incinerated or buried, however, the development of technologies for polymer processing into products with consumer properties is advancing. In some cases, polymeric materials, for example, can be used as binding material for the composite materials production. On the Russian market, a number of enterprises purchasing polymeric materials waste for the production of road and paving slabs, packing tape and other products emerge. Enterprises processing and supplying polymer wastes to the market in the form of high-quality semi-finished products are present.

Polymer thermal processing technologies have been developed. Three directions are represented on the Russian market: deep thermal oxidation of polymers to carbon dioxide, low-temperature pyrolysis, and plasma treatment. A number of such enterprises demonstrate their technologies at specialized exhibitions.

The first technology uses two oxidation steps. In the first stage, thermal destruction of the polymer occurs under the influence of the energy of natural gas combustion, in the second stage, the combustion products of degradation to carbon dioxide occur. This technology is extremely simple and mobile. But it lacks the technology of absorption of aggressive gases, such as chlorine, fluorine, phosphorus, present in many polymers.

In low-temperature pyrolysis plants, under the influence of 450–500 °C temperature, polymers are destroyed without the oxygen access. The output is ethane, methane, and liquid polymer. Gases are used to maintain their own process technology. In the event of the polymer processing with fillers (for example, tires), commercial carbon black is obtained. A liquid polymer in its characteristics corresponds to furnace fuel. There are also plants that process up to 12 tons of polymers per day. In addition to fuel production, the advantage of such plant is the yield of fine metal during the processing of structural products. This happens during the car tires processing.

In the case of cable processing plant utilization, the following technology can be predicted. An armored cable is loaded into the unit without preliminary separation of the polymer, and heating oil and pure copper are produced at the output. When using this technology, there is no need to use a number of plants to separate polymers from copper.

In plasma generators, the polymer is processed by plasma. The output is clean gas. In this plant, the absorber is provided to absorb aggressive gases. In the case of processing of a sufficient amount of polymer, it is economically efficient to utilize the resulting thermal energy.

The deterrent of the copper waste utilization for the production of the rod is the high contamination of waste with metallic and non-metallic impurities, the technical complexity of their removal during processing. For example, when processing oil submersible cables, copper is clogged with metallic and non-metallic materials, formation fluid. The improvement of waste processing technology shall be followed by its transfer to the waste generation stage. In this case, a preliminary selection of waste and its preparation for further processing is possible, which will significantly reduce waste clogging with related materials. Such an arrangement will reduce the complexity of waste processing technology, eliminate the copper waste clogging by impurities. The technology of waste pre-selection is widely used in world practice while collecting, in particular, plastic waste.

V. CONCLUSION

It may be concluded that various types of recycling technologies have been developed to date. The complex approach to solving the recycling problem in cable production will eliminate all technical and organizational difficulties.

Recycling technologies are presented in the form of industrial plants, where the issues of waste processing into marketable products without negative impact on the environment are solved in an integrated manner. Only large-scale enterprises with specialization in the collection and processing of cable waste may most efficiently arrange such technologies. Such enterprises have sufficient resources for a complex solution of all the problems relating to the centralized collection and recycling of waste and sale of the resultant commercial products. In our opinion, those enterprises, that while processing the cable waste, neglect the modern recycling technologies development, are not able to ensure the high quality of the secondary product and low cost of production and will inevitably face environmental problems.

Summing up, we may note that recycling technology development in cable production is distinguished by a number of features:

- recycling may be of high social significance;
- in terms of severity and importance, recycling technologies are comparable with cable production;

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- recycling is economically motivated for processing enterprises and materials consumers;
- modern recycling technologies are possible only with significant capital expenditures and are primarily available for large specialized enterprises.

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