EVALUATION OF RAW MATERIALS BASE OF TECHNOLOGICAL WASTE OF LOW-CARBON AND HIGH-CARBON WIRE IN SELECTED BRANCHES OF PROCESSING INDUSTRIES AS A SUPPORT FOR THE USE OF PROTECTED WORKSHOPS IN THE CZECH REPUBLIC

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Abstract

The article deals with the issue of wastes from the predominantly imported raw material sources of drawn high-carbon and low-carbon wire. The acquired knowledge is based on an analysis in a selected spectrum of branches and disciplines dealing with the processing of wire and wire products in the conditions of the Czech Republic. Causal analysis, factor analysis and marketing segmentation have been performed. The result of the research is the display of economic opportunities to achieve a higher added value of the selected product group in the wired program fields of expertise. Compared to the global wire producer in South Korea, the Czech Republic has abandoned a number of product lines in the field of brushes, springs, fasteners of secondary metallurgy, textile and leather haberdashery, electrotechnics requiring a higher proportion of human work, manual and craftsmanship skills. The authors come up with a proposal to restore some craftsmanship skills using protected workshops.

Keywords: High-carbon wire, low-carbon wire, technological waste, recycling of technological waste from wire, added value, protected workshops.

1. INTRODUCTION

Wire processing and wire processing technology has a long tradition in the Czech Republic and creates significant future potential for the development of a wide range of industries. The authors of the article focused on the specific area of use of this raw material in terms of other possibilities of technological waste processing in sectors that do not show high productivity with the necessary high degree of automation and robotization of technological processes. Wide range of wire products that, like in South Korea, enter the chain of processors of semi-finished products and products in the areas and industries create an opportunity to strategically diversify and support finalization alongside innovative processes.

“Twentieth century wire processing advances included such items as in-line annealing and heat treatment, sophisticated wire-handling systems that allowed high drawing speeds, multiple strand drawing systems, and a variety of proces automation and control innovations.” [1]

Along with the growth of this group of wire-working manufacturers, mainly in the industrial product sector, there is an open opportunity for small and medium-sized enterprises, using the process of maximizing the value of the raw material that makes part of the technological and re-cycled waste. The authors come up with a proposal to use the process of protected workshops built for a higher degree and opportunity for the involvement of handicapped citizens in the field of wire products requiring a higher proportion of manual work, craft skills and the development of creative activities, especially for products enriching the consumer market and increasing added value.

2. BASIC CHARACTERISTICS OF AVAILABLE RAW MATERIAL RESOURCES OF WASTE WIRE

“Putting waste in holes in the ground, i.e. landfilling, could therefore be considered as long-term storage of materials rather than actual disposal. Is this the most efficient way to manage such materials however?

Concerns over conservation of resources have led to lalls for, firstly, general reductions in the amount of waste generated, i.e. waste minimisation or waste reduction, and secondly, for ways to recover the materials and/or energy in the waste, so that they can be used again. Recovery of resources from waste should slow down the depletion of non-renewable resources, and help to lower the use of renewable resources to the rate of replenishment." [2]

The basis of the resource of waste wire is the characteristics of its production technology. Due to the wide range of wire products as a primary steel product and non-ferrous metal wires that constitute the backbone of the industrial structure of the downstream industries, it is possible to provide at least the basic classification scheme (see **Figure 1**).

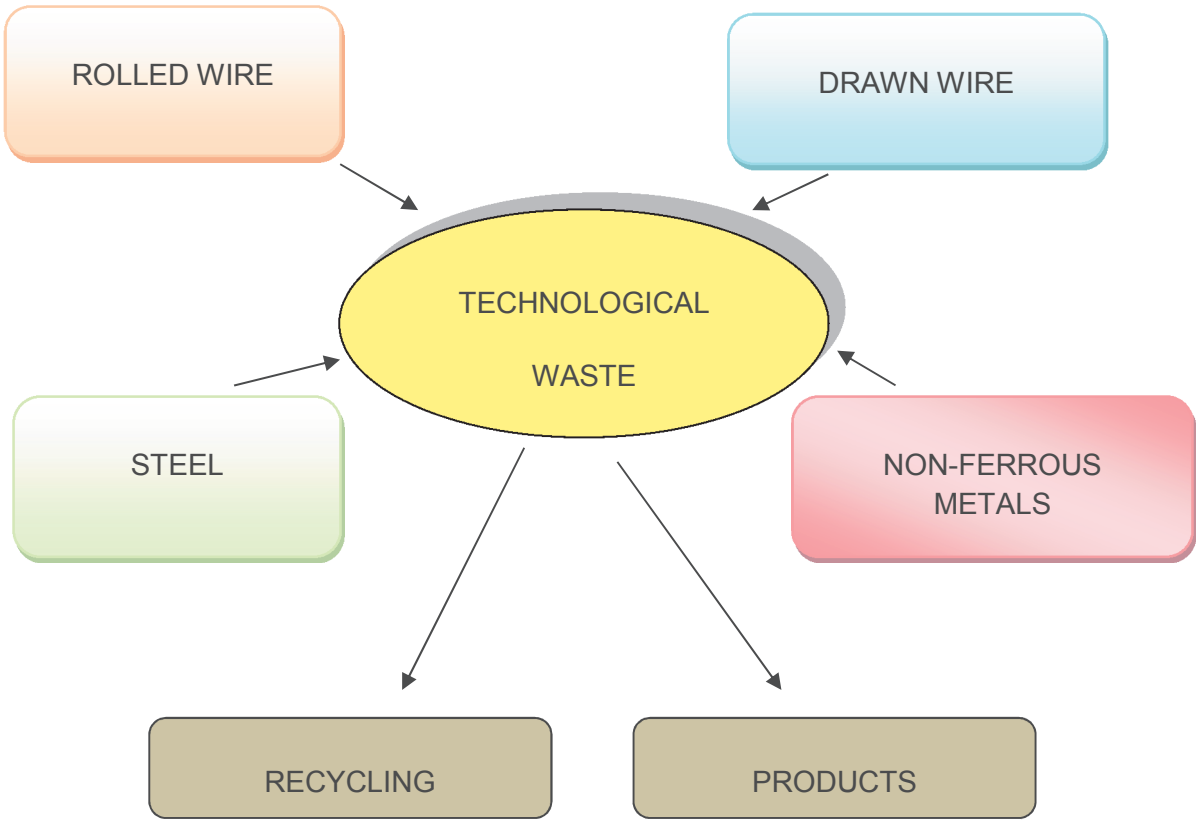

Figure 1 Basic scheme for the classification of technological waste in primary raw material phases

At a closer research in the conditions of the producers in the Czech Republic it is possible to provide a number of examples that are comparable to the world producers and allow, both in the area of rolling technology and in the area of drawing and welding of wire, it is possible to define certain places which are the source for future higher valuation of the raw material. These are especially the processes of winding and unwinding of the wire, especially with regard to the input and output operations, the thread of the wire on the coil and the process associated with the introduction of a high degree of quality control using ultrasonic technology. It is a high demand for continuous quality parameters throughout the wire coil winding before downstream technological operations, especially for high-carbon wire, designed for the production of ropes, springs, high-strength screws, and wire cords for the automotive industry. A separate area consists of non-ferrous metal wires for power engineering, electronics, and electrically conductive strands.

The technology associated with the processing of low-carbon wire are also an important source of usable waste material. Here, the possible use in protected workshops is much more promising, as these wires do not require more complex single-purpose machines for their further processing, but only relatively simple products

can be used to reduce total cost and to develop craft skills. “Wirebond equipment form different vendors have different features and what is useful for you particular manufacturing facility depends on the product portfolio, volume of product, location of plant, level of operators, capability of maintenance personnel, cost of bonder and a host of other critical criteria.” [3]

From the point of view of the total volume capacities it is possible to document the perspective of the resource growth in the conditions of the development of the Czech Republic - see **Tables 1 and 2**.

Table 1 Total wire production growth

Production volume (%)	Year 2000	Year 2016
Rolled wire	100 %	142 %
Drawn wire	100 %	121 %

Table 2 The total use of produced wire in the area of domestic consumption shows a decrease in the given period

Production volume (%)	Year 2000	Year 2016
Rolled wire	48 %	42 %
Drawn wire	44 %	39 %

The above results document not only the opposite trend for a higher degree of valuation of a significant domestic raw material but also the need to change the assortment, and respond with less flexibility to the innovation needs of the final finalizing producers both in terms of properties and composition of materials and in terms of capacity to deliver sublimit volumes.

3. EXAMPLES OF USE OF AVAILABLE RAW MATERIAL RESOURCES OF WASTE WIRE

A quantitative survey aimed to identify if and to what extent is the waste material, which is produced in wire winding and unwinding by Czech wire producers, used by the managers of Czech sheltered workshops for the fabrication of their unique products or if they would be willing to use it was conducted by the authors of this article in 2017. The survey was made in the form of direct acquisition of relevant primary data using telemarketing. It was conducted following the qualitative survey from 2015 - 2016 aimed to identify which works are performed in the Czech sheltered workshops. [5]

The survey showed that the waste material produced by Czech wire producers is not used by any Czech sheltered workshop and 37 % of respondents were interested in using this waste. This result is due to lack of information on application potential of waste from this industry. The article authors endeavour to improve the liaison between industrial production generating waste and social sphere represented by sheltered workshops where there is a high potential for making products with high added value thanks to manual work.

Over the past period, the production was stopped due to the low economic efficiency, innovative dynamics and the need for substantial technological investments. In a relatively short investment period, the world´s market underwent a turnover and a whole range of wire program programs, which requires a relatively high proportion of human work and managerial skills, is replaced by imports. Supplying wide range of assortments at considerable distances induces extra costs associated with multiple handling and redistribution with a relatively high share of business and logistics margins. The area of higher utilization of raw material resources of waste wire creates an opportunity where there are branches that are not already the subject of exports of the wire program of the Czech Republic. For the sake of simplicity, it is possible to introduce them, for example, in a chain of drawn wire (see **Figure 2**).

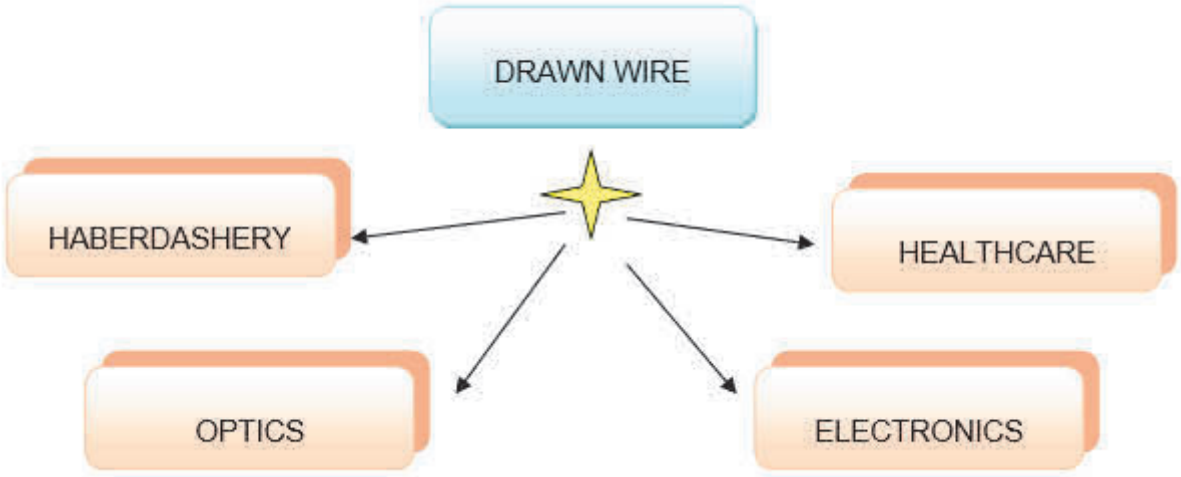

Figure 2 Examples of use of available raw material resources of waste wire

The dynamics of innovation requires the promptness of response not to the current supply and demand for drawn wire, but in particular to the future needs of dynamically developing industries with high innovation potential for end use of production. There are emerging trends of small flexible manufacturers that fill the niches of big companies with extraordinary skills and talent for outstanding final products. An example illustrating the complexity of the structure of the needs of the assortment and material structure of wires may be found in a selected group of the electrical industry.

Wire resistors also include carbon electrodes, which are used, for example, in electric arc furnaces or platinum and iridium electrodes, which are used in spark plugs of automobiles. The main requirement for resistive materials is the property of being 10 times to 100 times worse conductive than copper. As a rule, alloys of two metals are used:

- Manganin - manganese bronze with nickel. It is used to produce resistors where it is necessary that the resistance properties change with the pressure. The disadvantage of this material is that it is unstable in time and cannot be aged artificially.
- Constantan - nickel bronze. It is used to produce strain gauges that measure mechanical stress, resistance sensors and thermoelectric cells. Chromium nickel - up to 1,200 °C. It is well resistant to oxidation and chemical influence. However, it is expensive.
- Cr-Ni-Fe alloys - 900 - 1,200 °C, including Cekas, Ferronichrome, Ferochronin.
- Fe, Cr, Al alloys - up to 1,350 °C. This group includes Fechral that is harder, more brittle, less ductile and cheaper than the above materials.

The abovementioned quotes of the corporate material evaluating the interface of economic and technological variants document the demands for knowledge and dynamics of changes in the current needs and the future needs of the upcoming products.

4. CONCLUSION

High-quality craftsmanship, capable of exploiting the available resource possibilities of raw material base from domestic sources, contributes to the growth of the industrial potential of the territory and the state. From the point of view of future development trends, it is obvious that it also helps to develop the knowledge potential and approximates the conditions of primary and applied research to real practice and vice versa. Everywhere where the research and development pass by, this space is in real-time filled with the world´s market offer. The opportunity to exploit the dynamics of resource production over the period from 2000 to 2016 to a higher

added value per 1 kg of exported production requires an efficient involvement of knowledge and skill resources, including handicapped fellow citizens, as is the case of the industrialized countries.

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