TECHNICAL-ECONOMIC PERSPECTIVE OF USING COMPOSITE ALTERNATIVE FUELS IN METALLURGICAL PRODUCTION

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Abstract

The conditions of enterprises operation in steel sector for the globalization era are constantly changing. In line with its ambition to strengthen its competitive position it is necessary to look for sources of competitive advantage. This should be done through both strategic and operational decisions. The advancement of resource efficiency can be achieved by the use innovative, alternative fuels in metallurgical production. Fine tailings produced as a result of hard coal beneficiation process and its preparation, not so long ago regarded as useless materials, are gaining more and more often value as minerals. Increasingly, intense research is being conducted on the possibility of using them as carbonaceous materials in metallurgical processes, e.g. in the iron ore sintering process, in the pyrometallurgical processes for the preparation of copper or in the process of recycling of metal-bearing materials. This paper presents the possibility of using composite alternative fuels for use in the processes of pyrometallurgy of copperas an alternative reducing agent as well as an energy carrier (alternative fuel) to currently used coke breeze. These fuels are mainly based on waste carrier of "C" element, and the composition of the fuel is modelled in order to obtain the appropriate energy an demission parameters as well as strength parameters. The paper presents benefit analysis of using composite alternative fuels in metallurgical production.

Keywords: Innovative fuels, alternative fuels, optimization of metallurgical process, waste materials

1. INTRODUCTION

The processes of globalization, increase of competitive pressures, business cycles but also new opportunities for cooperation pose new challenges for businesses in terms of management, search for new technological solutions as well as new alternative raw materials and fuels. These challenges are frequently associated with changes in the strategic and operational management. Modifications in corporate management systems are an expression of aspirations of those organizations to increase their competitiveness and efficiency. The changes mainly provide new rules and structure of business models whose special role is played by various forms of innovation. Therefore, business models able to generate and diffuse the innovation become increasingly important. Defining their role and significance in the accepted, implemented policies and operational activities carried out by the company frequently determines achieving competitive advantage and expected income. Creating the competitive advantage is increasingly possible by the ability and effectiveness of the company of leading in various types of innovation, both being their own solutions as well as innovations applied due to transfer of them [1]. Therefore, in the recent years the issue of the structure of business models which are capable of application the innovation meets the great interest in scientific research both practitioners and theoreticians of management [2]. Occurring phenomenon triggered sweeping changes in the business environment and, consistently, forced organizations to seek for other than existing ways to increase their competitiveness. Metallurgical companies conduct extensive innovative activities to achieve this goal [3]. These activities serve to the use of technical progress, information revolution and emerging technology and innovation breakthroughs. There is a growing importance of technological leadership.

2. TECHNOLOGY AND INNOVATION - INTEGRATION OF TECHNOLOGY ISSUES INTO STRATEGY

In the current decade, innovations are an integral part of economic processes. First theoretical concepts of innovation appeared in the nineteenth century. A. Marshall drew attention to the role of knowledge as a key factor in development [4]. Issues of technological progress were also present in the concepts of the first generation of institutionalists. T. Veblen, as a basis for socio-economic transformations recognized continuous improvement of techniques and technologies that break the resistance of traditional institutions and create new ones. However, the indicated concepts of innovation issue are not treated in terms of priority. Progress in this area for the innovation theory was made by J. Schumpeter, who - at the beginning of the twentieth century - placed the innovation in the central area of the growth theory. In his theory the profit was the reward for entrepreneurship, which is based on innovation [5]. In economic we may find many definitions of innovation, such as [6]:

- introducing a new product or significant changes to existing products,
- introducing a new production process in selected industry,
- opening the new market,
- introducing to the use of a new type of material,
- changes in the structure of an organization.

M. Porter to the concept of innovation includes technological improvements, better methods and ways to do a thing, as well as changes in products and processes, and new approach to marketing and forms of distribution [7]. In the next part of his work, such innovative change has been analyzed. It had its source in innovative activities, which consists engaging the companies in various activities: scientific, technical, organizational, financial and commercial, that lead to or are intended to lead the innovation. Some of these actions are innovative, while others are not novel but are necessary for innovation. Innovative activity also includes research and development activities (R & D), which are not directly related to the development of a specific innovation. Innovativeness is the way to innovation, it is relative to the primary phenomenon that is associated not only creativity but also with the ability to application the innovation. It is an attribute of competing companies in situation where their competitive advantage is based on innovation.

Many valuable solutions may emerge, if the expectations of industry and proposals of the R & D centres are confronted in one place. It is a difficult task because while creating specialized products it is essential to use the latest technologies at wide range. Being aware of the great challenges that the industry is facing, initiatives are undertaken to build networks of cooperation for effective development. Challenges and competitiveness factors for the steel industry are being examined, which gives the ground for formulating an effective innovative actions [8]. A key problem is the proper use of technological innovation in the enterprise, also incorporate it in the strategy of the company.

Theoretical and empirical studies show that technology not only plays a key role in creating new products or processes, but at key points of punctuation it changes the fundamentals of industry structure by radically redefining ‘the rules of competition’. [9] Development of technological strategies should not be an isolated activity, but rather should take place in cooperation with people responsible for strategy and business plans of functional units. Scheme of such cooperation can consist of a gradual and iterative integration of technology in typical steps: setting strategic objectives, analyzing the enviroment, analyzing the company, elaborating strategic options, taking strategic decisions, implementing the strategy [10] (see **Fig. 1**). It means - determining strategic business objectives - strategic alignment for technological purposes. Carrying out such technology gaps closing procedure uses an approach, which is frequently observed in strategic business planning. These vulnerabilities are usually informative and can be seen in the following areas: technology objectives, technology forecasting, and assessment; technology networks relating technology and business units or relating product technologies to procrss technologies; market-product-technology analysis; defining

technology potential; identifying the strategic technology position portfolio; defining technology projects consisting of R&D projects to develop product and processtechnologies. [10]

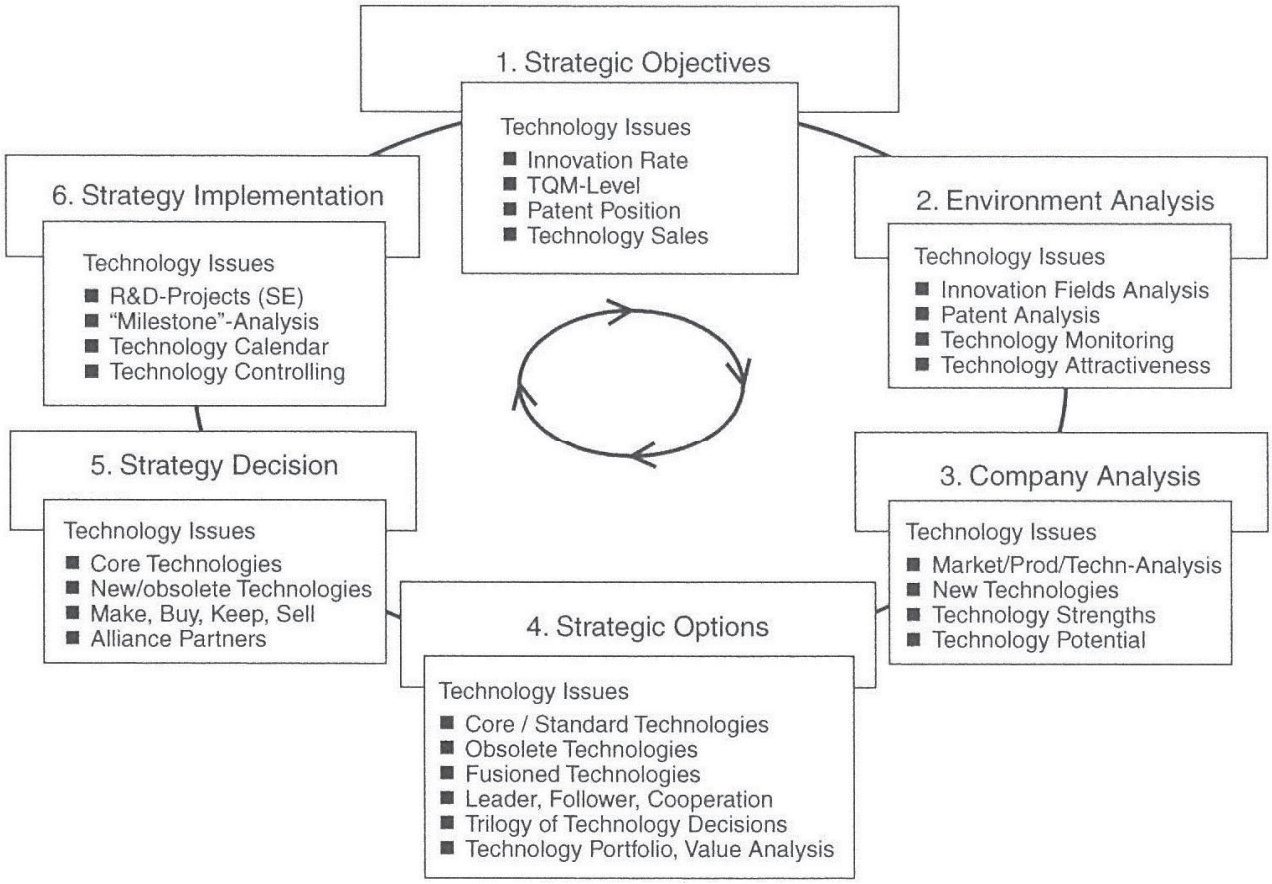

Fig. 1 Integration of technology issues into strategic business planning [10]

Using this approach will allow to plan the assumptions for the technology development as well as its proper use in business. Parsed example: using composite alternative fuels in metallurgical production, seen in technical-economic perspective.

3. PERSPECTIVE OF USING COMPOSITE ALTERNATIVE FUELS

In a number of pyrometallurgical processes, in addition to metalliferous material, basic component of the feed is coke, coke breeze or anthracite. Mainly they play the role as an energy carrier and reductant. For many years, research has been carried out in a wide range of applications of cheaper alternatives to these materials in metallurgical aggregates. This applies to the process of sintering ore, blast furnace process, non-ferrous metal smelting process in shaft furnaces and processing technologies of various kinds of secondary metallurgical raw materials [11-14].

As alternative fuel for metallurgical processes there are used coal-bearing fine-grained fractions from coal enrichment process, coke waste and biomass. Some of them have already found a wide range of highly successful application e.g. in the energy sector. [15]. It should be pointed out that a major problem of these processes is the emission of pollutants in the form of dust, CO_2, SO_2, CO, NO_x and other products of incomplete combustion, which is particularly harmful to the environment [16], [17]. One way to improve this situation that gives immediate effect is the replacement of the current fuel with fuel with modified combustion kinetics and much better energy - emission performance. Such fuel can be the carbon composites formed on the basis of

waste from the refining of coal and biomass waste. By appropriate selection of the proportion, such fuel may have a significantly lower emission of gaseous and solid pollutants as well as it can be characterized by parameters specific to a particular technology for example higher reductive parameters.

This type of fuel, apart from the appropriate purely chemical and process parameters, must also have adequate strength parameters. An example of a metallurgical process, where the modified formed fuel may be used is the process of sintering iron ore. This process requires appropriate fuel granularity, which on the one hand does not reduce the breathability of the sinter mix and on the other hand does not contribute to the so-called combustion delay.

The example of alternative formed fuels and its parameters are shown in **Table 1**.

Table 1 Characteristics of alternative formed fuels based on waste carrier of "C" element

fuel no.	graining / mm	composition of dry mass	calorific value / $MJ \cdot kg^{-1}$	compressive strength /MPa
1	pellet ϕ 12 L = 20 ÷ 30	67 % fine coal*) 30 % fine brown coal 3 % binder	26.71	1.281
2	pellet ϕ 14 L = 20 ÷ 30	15 % fine coal*) 68 % breeze coke 15 % fine brown coal 2 % binder	28.62	1.168
3	pellet ϕ 20 L = 30 ÷ 35	68 % fine coal*) 30 % coke dust 2 % binder	27.95	1.172
4	pellet ϕ 20 L = 30 ÷ 35	78 % fine coal*) 20 % fine brown coal 2 % binder	27.90	1.175

*) product of flotation

The forming of fuel composite is the process of concentration of the loose substance by compressing it under high pressure and often at an elevated temperature, wherein the substance must have some free space between molecules. The forming can be done by briquetting, pelleting or extrusion. The choice of a forming method is determined by the rheological properties of the mixture undergoing forming. The forming of substances can be divided into forming without a binder and with a binder. In the process without the binder, bonding forces will be direct interactions of material particles which undergo the forming process. However, by using a bonding adhesive, which is a few percent addition to the mixture undergoing forming, it is intended to bind together the particles acting as an adhesive by increasing the intermolecular interaction forces. The strength of pellets depends on the forces that bind the carbon particles together [18, 19, 20].

During the studies the applicable potential of alternative formed fuels based on waste carrier of "C" elements as carbonaceous materials in metallurgical processes, e.g. in the iron ore sintering process, in the pyrometallurgical processes for the preparation of copper or in the process of recycling of metal-bearing materials was confirmed. The composite alternative fuels may be used in the processes of pyrometallurgy of copper as an alternative reducing agent as well as an energy carrier (alternative fuel) to currently used coke breeze. Furthermore, using alternative formed fuels affects the intensification of the combustion process due to an increase in reaction surface area. Small coal particle presents in alternative fuels results in about a 25% increase of the combustion temperature. This affects the rate of chemical reactions resulting in lower emissions

of incomplete combustion components. This fuels are also characterized by a higher reactivity, which manifested by increased reducing properties. An analysis of the obtained researches data shows that:

- average emission factor has been reduced about 27.6%,
- the cost of alternative formed fuels is about 21 - 40 % lower than currently using coke with kept technological parameters as strength and calorific value,
- level of Cu in waste slag has been decrease to 0.19 - 0.27 mas. %.

4. CONCLUSIONS

Increasing competition and globalization are forcing metallurgical companies to develop their adaptabilities. Today's competition conditions in this sector require business models focused on generating and diffusion of innovation. The key activity is well designed innovative action, which becomes a strategic challenge. Creating a competetive advantage is possible through the capacity and effectiveness of the company for introducing various types of innovation.

Phenomenon of formation and implementation of the innovation is very complex, multidimensional issue. Innovation rarely occurs as an isolated process, it is rather a highly interactive cooperation in continuously growing and diversing network of stakeholders. Because of this cooperation, companies can gain knowledge from many different sources through: partnerships, joint ventures or alliances, or even in the form of agreements for conducting R & D or purchased licenses. Cooperation allows to extend the competence of the company, becoming the way of widening the scope of development projects.

Theoretical and practical research show that the technology is not only the key activity in creating a new products or processes, and can also radically change the industry basis structure by redefining the rules of competition. Designing appropriate technical and economic parameters of new technology and its implementation requires a methodical approach to the process. This challenge can be met if we take into account technology issues on every step of the scheme: strategic objectives, environment analysis, company analysis, strategic options, strategy decisions, strategy implementation.

In surveys the potential use of composite alternative fuels based on waste carrier of "C" element such as carbonaceous materials in metallurgical processes, e.g. in the iron ore sintering process, in the pyrometallurgical processes for the preparation of copper or in the process of recycling of metal-bearing materials - was confirmed. Composite alternative fuels can be used in copper pyrometallurgical processes as reducing agent as well as an alternative energy carrier (alternative fuel) to actually used coke breeze. The analysis of the data obtained shows that the technical and economic parameters of the new technology will improve significantly the efficiency of the process.

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