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Energy Consumption Processes Overview in Metallurgical Sector for Aluminium Production: The Case of Albania

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Abstract

Nowadays, most of the Albanian economy target in the industry sector is concentrated on metallurgy industry. All the largest metallurgical industries have been focused on the production of the metals respectively the production of steel, aluminium, copper, and chromium. The materials and energy needed for the production of materials and their transformation into products are extracted from natural sources like ores, minerals and fossil hydrocarbons. Due to global energy crises and sustainable development, our research work will be focused on the process's identification overview of energy consumption in the "Everest ltd" company for aluminium production that operate in Albania.

Keywords: *Metallurgy; Industry; Energy Consumption; Aluminium; Sustainable Development.*

INTRODUCTION

During the last two decades, metallurgical industry in Europe is a vital component of the region's industrial landscape, encompassing various subsectors and playing a significant role in the European economy [1]. The metallurgical industries in Europe is diverse and includes several subsectors by producing ferrous and non-ferrous metals such as steels, aluminium, copper, chromium, and zinc [2-5]. Each these manufactured products have its own unique characteristics and market dynamics. The European steel industry is one of the largest in the world which is focused on the production of various steel products for different engineering applications like construction, automotive manufacturing, and other related industries. Furthermore, Europe is a significant producer of non-ferrous metals where aluminium is widely produced and used in essential sectors like automotive, aerospace, and construction. Recently, the European metallurgical sector faces several challenges, including global competition, and environmental concerns [3-5]. The sector is actively working to reduce carbon emissions, improve energy efficiency, and minimize environmental impacts.

In the aspect of metallurgical sector, Albania has several metallurgical plants and processing facilities for producing ferrous and non-ferrous metals such as steel, chromium, aluminium and copper. Albania as a developing country that want to join European Union needs also to fulfil regulations and policies significantly impact the metallurgical sector, particularly in terms of environmental standards, safety regulations, and trade agreements. The Albanian metallurgical sector has faced challenges, including issues related to environmental concerns and the need for modernization. Based on it, the government has made efforts to attract local and foreign investments to the sector to improve its

competitiveness. The main metallurgical companies in Albania has been focused on the steel, aluminium and chromium.

In our research work we have selected one of the leading metallurgical company for producing aluminium profiles in Albania called "Everest" ltd with annual capacity production correspond to 10000 tonnes [6]. The materials and energy needed for the production of materials and their transformation into products are extracted from natural sources like ores, minerals and fossil hydrocarbons. Due to global energy crises and sustainable development we will be focused on the process's identification overview of energy consumption in the "Everest ltd" company of aluminium productions that operate in Albania.

MANUFACTURING SECTORS

The production of aluminium is energy-intensive, and different important energy consumption sectors contribute to the overall energy usage in the aluminium production process [6-10]. The technological scheme for the manufactured process of different aluminium profiles are shown in Figure 1.

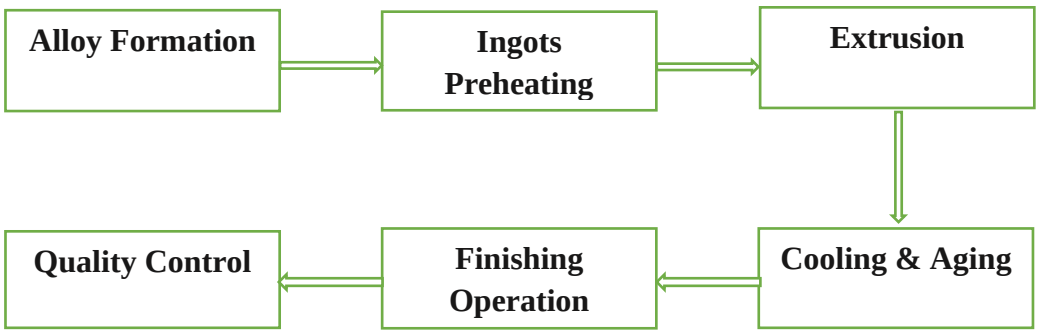

Figure 1. Technological scheme of the manufactured process of different aluminium profiles [6]

Based on this metallurgical scheme we have investigated all the energy consumptions sectors for productions of the different aluminium profiles. The main energy consumption sectors are as follows:

- Foundry
- Homogenization
- Extrusion
- Aging
- Painting
- Mechanical department
- Cooling process

Primary metal production like aluminium is generally a large consumer of energy This process is typically carried out in foundry by using the Hall-Héroult process. The energy is consumed by the electrical resistance heating required to reach the higher temperatures more than 950°C which is necessary for the reduction.

Homogenisation is another energy consumption process that can depend on different factors by including the type of equipment used, the size and volume of the material being processed, the specific aluminium alloy, and the process parameters.

Furthermore, extrusion process is energy consumption that varied from the type of extrusion process, the size and complexity of the extrusion profile, the equipment used, and the efficiency of the operation. In the Everest ltd company are two extruder equipment's that has been used for creating the desired shape of the aluminium profiles. One is related to hot extrusion and the other for cold extrusion process where both of them have significantly impacts energy consumption.

The aging process in aluminium production is focused on the primary source of energy consumption called heat treatment of aluminium alloys which is used to improve their mechanical properties. Energy consumption during the heat treatment process can vary on the type of alloy, the size and quantity of the material being treated, and the specific heat treatment parameters.

Another energy consumption process is the painting process of aluminium production such as painting of different aluminium profiles or sheets. Most of the factors that can influence in energy consumption depends on several factors like he size of the products being painted, the painting technology and equipment used, and the specific process parameters.

The energy consumption in the mechanical department of aluminium production that includes various mechanical processes and machinery will be based from several factors which are as follows:

- Type of mechanical operations,
- The size and scale of the production facility
- Efficiency of the equipment used

The last energy consumption process of aluminium production is cooling process. The cooling process varied from specific cooling methods used, the size and scale of the production facility, the type of aluminium products being produced, and the environmental conditions in the area.

ENERGY CONSUMPTION ANALYSIS

The distribution results of the energy consumption for the main sectors are shown in the Figure 2.

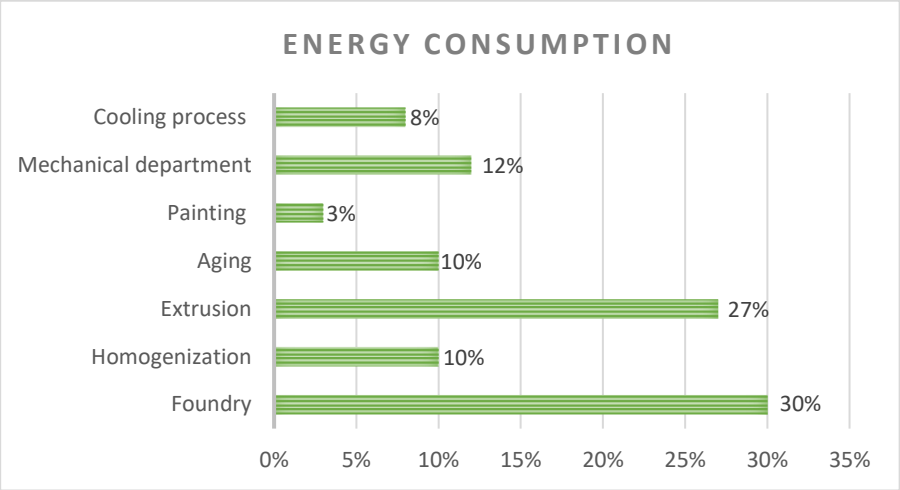

Figure 2. Energy consumption distribution for aluminium production process

The energy consumption analysis is based on the main sectors of aluminium production mentioned in the previous section. The annual energy consumption in one year correspond to 3 GWh/year. Analysis of the energy consumptions will be focused on the main contributors' sectors such as foundry, extrusion, mechanical department, homogenization and aging. Afterward it will be recommended the implementation of improvement of the whole producing process and possibility implementation of the renewable's energy supply in this this metallurgical industry.

Foundry is the largest energy consumption during the aluminium production process which correspond to 30% of the overall energy consumption. One of the reasons is that most of the energy is going for primary production such as conversion of bauxite into alumina. For reducing the energy consumption, it is recommended to use the energy for reproduction from scrap materials which can spend generally less than 50% of the energy for primary production. Fortunately, through recycling process metals have very high technical recovery rates that varies from 60% to over 90%. The use of scrap for the production of aluminium alloys has a direct positive on environmental impact and sustainable development. Furthermore, aluminium recycling reduces environmental impact by up to 95% compared to aluminium production from bauxite. In the production of aluminium from bauxite, every 1 ton of bauxite produces about 1.5 tons of CO_2 and 0.5 tons of SO_2, while in aluminium recycling these emissions are much lower.

Extrusion process is the second largest energy consumption in the aluminium profiles production which correspond to 27% of the annual energy consumption. In hot extrusion, the aluminium ingots have been heated at high temperature and then forced through a die to create the desired shape. The heating stage consumes a significant amount of energy. Furthermore, in extrusion press is also required energy due to exerts pressure to force the aluminium through the die. In case of cold extrusion, we have a more energy-efficient process compared to hot extrusion because it doesn't involve heating the aluminium to high temperatures. Generally, only a few energies are needed to be used for simpler shapes and smaller profiles. For reduction the energy consumption in extrusion sector, it is recommended to focused on investment in energy-efficient extrusion presses and heating equipment, lubrification technique to reduce friction in die design and optimizing the extrusion speed to balance energy consumption and production rates.

Mechanical department is another energy consumption sector which correspond to 12% of the annual energy consumption. There are several equipment's that can be used for production of different aluminium profiles. The main energy consumptions equipment's are as follows:

- Cutting, machining, and milling
- Welding
- Grinding and Polishing
- Material Handling
- Recycling
- Maintenance and Lubrification
- Equipment Efficiency

For reduction the energy consumption in mechanical department sector, it is recommended to focused on investment in energy-efficient machinery and equipment, maintenance practices to keep equipment operating efficiently and to optimize process parameters to reduce waste and improve energy efficiency.

Aging and homogenizations process are two others main energy consumptions sectors for aluminium production which respectively corresponds to 20% for both sectors of annual energy consumptions. One of the primary energy inputs in the homogenization process is the energy required to heat the aluminium material to the desired temperature. The specific energy consumption for heating can depend on the initial temperature of the material and the target temperature for homogenization. The higher the initial temperature and the larger the volume of material, the more energy is needed to heat it. The primary source of energy consumption in the aging process is the heat treatment equipment used, such as aging ovens or furnaces. These ovens or furnaces are designed to heat the aluminium material to the specified temperature and maintain it at that temperature for a set period. In case to minimize the energy consumption for aging and homogenisation process we can recommend company to be focused on:

- Using energy-efficient aging ovens or furnaces
- Implementing advanced control systems for precise temperature control and energy management
- Employing proper insulation and heat recovery systems
- Optimizing process parameters to reduce heating and holding times while maintaining product quality

The main energy demand used in metallurgical sector for production of aluminium comes from hydroelectric power. Due to global energy crises and for green energy it has been seen the needs for implementation of the renewable's energies [11-15]. One is realized by adding of photovoltaic panels and the second is to find possibility for implementing of wind energy farm. Figure 3 depict the photovoltaic panels that is added on the terrace of the metallurgical sector. The annual energy production consists on 0.5 GWh/year.

Figure 3. Photovoltaic panels on the terrace of the metallurgical sector, "Everest" ltd company [16]

This energy demand is not enough to cover all the request of the energy that is needed for aluminium production. The future research work would reveal if it is possibility in any energy crises to implement a wind energy farm for supporting the energy demand that is requested in aluminium production.

CONCLUSION

In this research work we have briefly analysed the overview of energy consumption processes in the metallurgical sector called "Everest ltd" for aluminium production. It has been analysed the main energy consumption sectors and recommendations for minimizing energy consumption. The annual energy consumption in one year were 3 GWh/year. Most of the energy consumptions sectors were foundry, extrusion, aging, homogenisation and mechanical department where each sector respectively corresponds to 30%, 27%, 10%, 10% and 12% of the annual energy consumptions. It has been recommended for using aluminium recycling process for reducing environmental impact by up to 95% compared to aluminium production from bauxite. Renewable energy has been implemented by adding photovoltaic panels with capacity of 0.5 GWh/year annual energy production. The future research work would reveal if it is possibility in any energy crises to implement a wind energy farm for supporting the energy demand that is requested in aluminium production.

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CONFLICT OF INTERESTS

The authors confirm that there is no conflict of interests associated with this publication.

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