Optimization of Energy Consumption at a Billet Foundry

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Abstract

Increases in energy costs for industrial consumers can have undesirable effects on operations and production profit. In the aluminum industry, these increases are particularly significant given the high amounts of electricity required, directly and indirectly, for the production of metal. Those currently at risk of energy cost increase are smelters and foundries that do not have a subsidized energy contract and which are subject to more volatile profit margins given their lower yearly production yields. An aluminum foundry located in Quebec specializing in the production of various types of alloyed billets fits the aforementioned criteria. Their recent installation of a water cooler system resulted in a one (1) Megawatt (MW) increase in electrical consumption and a subsequent impact on profit. A study was thus performed to determine technical solutions to eliminate at least 1 MW worth of rated power and therefore allow the required water cooling system installation and conservation of their original energy contract.

Keywords: Aluminum casthouse, energy efficiency, billet casting, peak energy usage.

1. Introduction

A billet foundry specializing in the production of several different alloys sought to identify energy savings opportunities with desirable payback periods of 2 years or less. Exploiting these opportunities was of particular interest given electricity consumption and peak power utilization increased dramatically after the installation of a new 1 MW water cooling system. In addition, the cost of electricity was also increased considerably by the utility provider, creating a challenge with respect to annual electricity expenditures and production profit margins. The present study aimed to eliminate at least 1 MW of power utilization at the foundry to allow for the installation of new equipment and conservation of the original energy contract.

1.1. Process Description

The billet foundry originally consisted of a complete aluminum smelter equipped with Søderberg technology in operation since 1942. In 2013, it was decided to close down the potlines given the obsolescence of this technology and the prevalence and efficiency of the newer prebaked smelters. Nevertheless, all equipment pertaining to the casting and thermal treatment of billets was kept in place and remains in production to this day.

The facility now receives aluminum in solid or liquid form from external suppliers and is immediately transferred into either the remelt furnace (if solid) or into tilting furnaces. In these tilting furnaces, the metal is heated to around 800 °C and alloying elements are added in preparation for casting. Once the metal reaches the target temperature and alloying elements have dissolved, the metal is cast using a single direct chill casting table into billets of various quantities. Between 8 and 15 casting drops are performed each day (24 hours) of up to 40 different types of aluminum alloys.

Having cast the billets, it is essential that alloy elements are evenly dispersed throughout the metal to guarantee uniform mechanical properties for the intended clients. To reduce segregation, billets are inserted into batch homogenization furnaces which heat the alloy to a set temperature (stage 1) then are soaked for a specified period of time (stage 2). Each family of alloys possess its specific homogenization regime depending on composition, diameter, etc. As the alloys complete their soaking cycle in the furnace, the batch is subsequently taken out of the furnace and placed in cooling chambers for a controlled cooldown to complete the homogenization process (stage 3). The billets are then finally loaded on train wagon or truck to be shipped to clients.

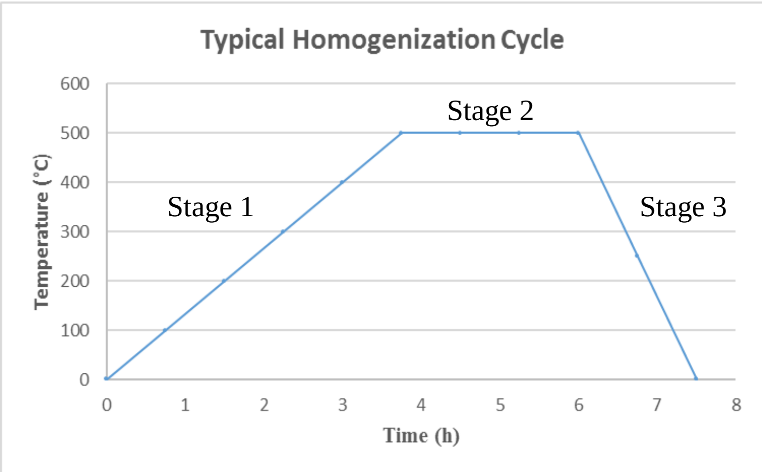

Figure 1. Typical homogenization schedule for aluminum billets including 3 stages.

2. Current Electrical Consumption

2.1. Electrical Usage Analysis

Total electrical capacity for equipment at the billet foundry amounts to 7.5 MW. This only accounts for electricity, natural gas consumption is not included in this study. There are 4 major electrical power consumers at the foundry:

- Homogenization furnaces utilize up to 5.7 MW of electricity, representing 76 % of the total plant electricity usage.
- Electrical motors with rated power superior to 25 HP utilize a total of 1.14 MW of electricity, representing around 15 % of the total plant usage.
- Space heating utilizing 420 kW (6 %).
- Building lighting which consume 207 kW (3 %).

It is clear that opportunities with greatest impact will necessarily target the homogenization furnaces consuming the majority of electricity at the foundry. Additionally, in contrast with the current state of electrical usage, the additional future installation of a water cooling system having a peak power usage of 1 MW represents a major increase with respect to the current total capacity of 7.5 MW. Figure 2 represents a summary of current major equipment electrical utilization.

4. Conclusion

Energy savings opportunities were identified to reduce consumption and power utilization and to maximize the savings of operating costs. By implementing an operating sequence algorithm to minimize peak energy usage of homogenizing furnaces, it was seen that 500 kW of power utilization could be eliminated. Additionally, the installation of radiant tube burners and the exploitation of the cooling chambers were also seen to potentially cut 1.5 MW (for 3 furnaces) and 500 kW respectively. As not one option will surmount the challenge of increased consumption and energy costs alone, it is important to consider a combination of the above solutions to find an equilibrium between investment and benefits.

Therefore, this study aimed to highlight a sound action plan to rapidly minimize energy consumption and power usage and keep similar primary metal producers competitive in an ever changing global environment.