Conservation of Energy in Al Cast House – Technology Advancement to Overcome Challenges

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Abstract

Aluminium smelter cast house (CH), operates at approximately 800°C, generates heat (furnace burners and incoming hot aluminium molten metal from potroom) that have numerous opportunities to conserve and reuse it to support sustainability and carbon footprint. It helps in saving gas/fuels and other consumable materials.

This paper focuses on advanced technology and approaches to overcome challenges to conserve, reduce and reuse energy and materials in cast houses. In normal process this heat energy is exhausted through stacks. Normally, 0.6 million tonnes per annum (Mt/a) capacity smelter cast house wastes around 35 MJ/s of energy (reaches to 135 MJ/s at peak operation) considering 30 % maximum thermal efficiency of the cast house. This energy could be reused for launder preheating and could also be extended further to other preheating opportunity e.g., scrap, casting moulds, tools preheating, etc. Moreover, preventing loss of heat of molten metal flowing through launders not only conserve energy but also help in achieving quality of casting value added products.

Energy potential in aluminium cast house is well known and efforts are underway worldwide to optimize it. Lean technology concepts of conserving and reusing energy should replace the conventional complex system during operation within facilities. It helps optimising quantity and design of equipment and systems in cast houses. This paper put further emphasis on use of technology and continual effort in the direction to commercialize concepts to conserve energy to support sustainability and reduce carbon footprint.

Keywords: Cast house, Sustainability, Carbon Footprint, Energy Efficiency, Productivity.

1. Introduction

In view of the challenging global sustainability goals, it is pertinent to pursue energy saving initiatives at each stage of the aluminium smelting process value chain. In an aluminium smelter molten metal is produced in the potroom and transported to cast house for converting to solid products. Considerable amount of energy is lost in the process which if addressed properly could open avenues for energy savings. The contribution of cast house in the overall smelter energy scenario is comparatively less but quantum of savings on a yearly basis is significant. Energy saving is possible during each process step of hot metal management by using modern techniques for heat retention and recovery. The areas of interest are metal transport from potroom to cast house, cast house furnace metal holding and scrap management.
This paper focus on energy quantification, opportunities for energy savings through improved operational practices and technological advancements in this field.

2. Energy Potential

Cast house (CH) is an integral part of a primary Aluminium smelter where the molten metal is solidified into various shapes.
Heat energy potential of CH is majorly categorised in two divisions:

1. Incoming hot aluminium molten metal from potroom (161 MJ/t of Al)
2. Burning of fuel (natural gas, HFO, etc) (see Table 1).

Heat potential of incoming hot aluminium molten metal (850–900 °C) is from potroom of reduction area until it gets solidified to product. Pure Aluminium metal starts solidifying at 660 °C. Heat is also released from burning of fuel which is required to maintain desired temperature of molten metal in the holding and melting furnaces before start of casting and heating of tools and auxiliary casting equipment. The residual flue gases are exhausted to atmosphere through stack.

Both the above energy potential sources inside CH could be conserved, reduced, and reused by various opportunities which are elaborated further below.

For a typical 0.6 Mt/a capacity smelter having product mix as 50 % billet and 50 % ingots, the fuel energy distribution details for CH are provided in Table 1. Natural gas heating source is used as basis of calculation.

Table 1. Typical 0.6 Mt/a smelter, CH energy distribution.

Description	Nominal	Maximum*
Holding/Melting type Furnaces	53 %	6 ×
Continuous Homogenizing	12 %	N/A
Batch Homogenizing Furnace	25 %	N/A
Billet VDC	1 %	N/A
Ingot caster	4 %	1.25 ×
CCF	5 %	1.20 ×
TOTAL	**100 %**	**3.7 ×**
Energy released at 39 MJ/m^3 calorific value of fuel - natural gas at Total nominal and maximum gas flow	2 785 MJ/t Al	4 450 MJ/t Al
Energy waste considering 30–35% maximum thermal efficiency of the cast house	1 811 MJ/t Al	2 892 MJ/t Al

* - Maximum is calculated considering scrap melting in the furnace.

3. Areas of Opportunities

The Aluminium smelter CH has numerous opportunities to conserve, reduce and reuse energy and material by optimising processes, increasing efficiencies and adopting advanced techniques. Opportunities for the same including alternate clean energy options with equivalent energy consumption for decarbonisation are listed and discussed below.

- Crucible turnaround
- Furnace heat loss
- Launder heat loss

products conversion process. The energy potential due to the incoming hot metal and burning of fuel is 4 611MJ/t Al. Around 63 % the heat identified is lost during the operations involved in solidifying the metal. In this process the paper identifies energy savings of 39 % by implementing improved operational practices and utilising modern technologies.

Summary of Energy Potential & Savings as depicted above in this paper is shown in Figure 10:

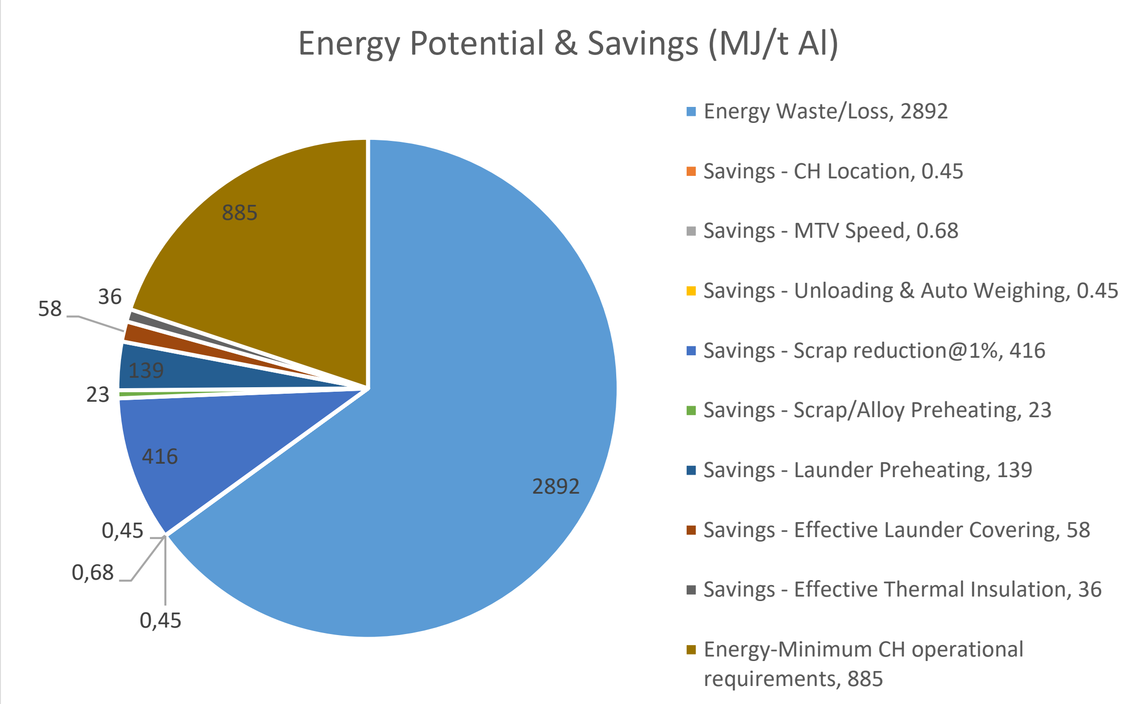

Figure 10. Summary of energy potential & savings.

Although efforts are underway worldwide to optimise energy, further emphasis to use technology and continual improvement in the direction to commercialise energy conserving concepts is need of the hour to reduce carbon footprint.

5. References

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