3. Energy Efficiency Improvement

All melting carried out on site at Brock Metal in the course of zinc alloy manufacture uses natural gas as the heat energy source. Electricity is only used in the factory for lighting and powering a small number of machine drive motors. Site gas consumption is consequently over 30 times the site electricity consumption.

Our energy efficiency improvement work is therefore focussed on reducing gas usage through improving the melting efficiency of the manufacturing process. Gas usage is closely monitored by taking readings from the mains gas meter every week. This gives the total gas consumed on site. To gain a more detailed break-down and analysis, the gas used in separate production processes is monitored on a monthly basis through meter-transmitters which send data to a central computer.

Gas consumption is recorded for the main processes as an absolute figure (m^3) which is converted to kWhr via the appropriate conversion factor and average calorific value of gas supplied. Additionally, a specific consumption figure is calculated (kWhr/tonne) and this is recorded monthly within our Key Performance Indicators (KPIs).

For tracking and recording electricity consumption, the site mains electricity meter is read weekly. This shows the number of units (kWhr) used on Rate1 (day) and Rate 2 (night).

A multi-phase programme of improvement work has been conceived and implemented over the last several years designed to increase melting efficiency through a mixture of improved operational practice and carefully targeted capital investment. The most significant steps in this programme have been as follows:

1. Increasing process utilisation levels

Keeping furnaces in operation, rather than frequently switching them on and off reduces specific energy usage (kWhr/tonne) because it reduces the energy losses sustained in having to re-heat furnaces that have cooled off. Volume growth and operational improvements such as reducing plant downtime through better maintenance and engineering has meant that process utilisation levels have risen significantly

2. Regular setting of furnace burners

Experience has shown that one of the most effective ways of controlling gas consumption is to ensure that all furnace burners are set at the correct stoichiometric ratio, that is the air-fuel ratio is set so that the burner draws in just the right amount of air for complete combustion of the fuel. If insufficient air is drawn in, incomplete combustion results which wastes fuel; if too much air is drawn in energy is wasted heating the excess up in combustion.

Brock Metal maintenance technicians therefore carry out regular checks on the air-fuel ratio settings of all furnace burners, up to 4 times per year. Once a year, the air-fuel ratio of all burners is checked and set by an external specialist contractor. We have learned that it is also necessary to set the air-fuel ratio at a defined power output (kW). Therefore, the specialist is also tasked with ensuring the correct air-fuel ratio is being delivered at a specific power output specified by Brock Metal. This power output has been defined through experience as the optimum compromise between lower energy usage and longer crucible life (higher power gives less time for heat loss and therefore higher melting efficiency, but higher power also leads to shorter crucible service life).

3. Capital Investment

Over the last 5 years a number of small scale capital investments focused on improving energy efficiency have been designed and implemented. An overview of these developments is given below.

Background

Over 97% of Brock Metal's production output is melted and mixed in crucibles made of cast iron. They are heated by gas burners in 14 'standard' furnaces. There are 9 such furnaces feeding the new automated ingot casting and stacking plant and 5 feeding the block casting plant. Each crucible can hold 5 tonnes of zinc alloy and to improve both productivity and energy efficiency 6 tonne crucibles are being introduced. Historically at Brock Metal, all such cast iron crucibles have been open to atmosphere with no cover.

The heat lost by radiation from a clear molten zinc surface is known to be about 15kW/m^2 (54,000kJ/m^2hr). Convective losses are also significant. Experiments carried out at Brock on the rate of cooling of zinc melts in the 5 tonne crucibles have suggested that at typical alloying temperatures (say 500°C) the total rate of heat loss from the melt is around 80kW.

Steps to reduce heat losses by radiation and convection are thus very effective at improving energy efficiency of open crucible furnaces such as those used at Brock Metal.

In recent years Brock Metal has pursued two main initiatives to improve the energy efficiency and productivity of these furnaces:

i. The design of a 'passive' insulating lid to cover the crucible during melting

ii. The installation of recuperative burners on standard furnaces

Available Energy Savings and Current Results

The passive lid is found to reduce energy consumption during melting by 18%. The recuperative burner is found to reduce energy consumption during melting by a further 20% beyond that achieved with a passive lid alone. The total potential energy saving is thus 18% + 20% = 38%.

Figure 4: Reduction in energy consumption through lid and burner developments

Eight passive lids have been manufactured and these are in normal production use across all 14 standard furnaces in the Brock Metal factory.

Two recuperative burners have been installed to date. They have demonstrated a good financial payback. There is potential to install a further 12 units on the other 12 furnaces.

Because recuperative burners have not yet been introduced across all standard furnaces, the energy savings currently being achieved are less than the full potential. The actual energy savings being achieved at the time of writing are summarized in Figure 5 below.

[1] With 2 out of a potential 14 recuperative burners installed to date the energy saving is 2/14 x 20% = 3%

Figure 5: Energy savings currently being achieved with lid and burner developments

It can be seen that to date an energy saving of 18% + 3% = 21% has been achieved. These developments have thus been a significant driver behind the 25% reduction in gas consumption per tonne of alloy produced seen at Brock Metal since 2013. This reduction is shown for Plant 1 & 2 in the KPI graph in Figure 6 below. A similar result is seen on Plant 3. Together these Plants produce over 97% of Brock Metal's production output.

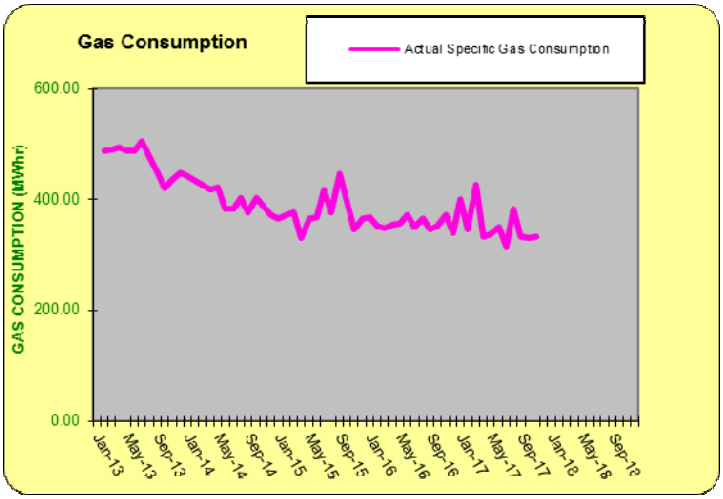

Figure 6: Gas Consumption per tonne on Plant 1&2

Future Work

Work is now underway assessing the potential benefits of another energy saving technique. This is to install guides in the walls of the furnace well in a spiral configuration with the aim of encouraging the gases to circulate around the crucible for longer before exiting the furnace flue. This gives more time for heat transfer to occur and hence improves energy and melting efficiency.