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Reheat Furnace Efficiency at Laverton Rod Mill

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INTRODUCTION

The manufacturing of steel is a highly energy intensive process; in 2015 alone, the iron and steel sector accounted for 5.1% of the world's total energy consumption[1]. To reach a state malleable enough to be rolled, a steel billet is required to be between 1000 to 1200°C[2]. In a steel mill, the reheat furnace is responsible for a significant portion of a mill's total energy consumption. It is therefore beneficial to find methods to improve the furnace's energy efficiency as incremental increases in efficiency can be highly beneficial from an environmental, financial and productivity standpoint[3]. For the purposes of this research, efficiency was defined as a ratio between furnace gross heat input, Q_{in} (MW), and usable heat transferred to billet, Q_{billet} (MW).

Liberty Steel's Laverton, Australia plant consists of an electric arc furnace which feeds both a rod mill and bar mill, with an annual capacity of 780,000 metric tonnes per year (tpy) of construction grade steels. The Rod Mill, where this study is based, comprises of 28 cantilevered-style roll stands with 550,000tpy capacity of round and deformed rod, ranging in size from 5.5mm rounds to 16mm deformed rod. The Rod Mill's reheat furnace is a Danieli walking hearth design with internal dimensions of 18.6m x 13m x 1.6m (LxWxH). It consists of three fired zones, powered by 35 'Bloom 2180' burners and one recuperative, non-fired zone. Initially constructed in 1996 with a design capacity of 80 tonnes per hour (tph), incremental upgrades have enabled the furnace to increase capacity to 93tph cold charge. The mill's rolling capacity of 105t/hr means the reheat furnace is currently the limiting step of the overall process. A 150% increase in Australian natural gas prices over the last 3 years[4] has resulted in a significant increase in furnace fuel costs. Increased operating costs along with increasing capacity were driving factors in the need to improve furnace efficiency.

In analysing the inputs and outputs of operating reheat furnaces, previous research has been able to successfully produce a working energy balance of the furnace and from this, determine furnace efficiency[3, 5, 6]. One method has been to use the Process Heating Assessment and Survey Tool (PHAST) to assess a furnace operating at full production (85tph), partial production (65tph) and idle (0tph)[5]. That research demonstrated that flue gas was the greatest contributor to heat losses from the furnace and reducing production rate negatively impacted efficiency. This was further reiterated through the use of mathematical modelling to strengthen the relationship between energy consumption rate, billet retention time and energy consumption amount[6]. They found that while low production required a low energy consumption rate, the necessary increased retention time resulted overall in more energy being consumed than for a *typical* or *high* heating rate.

Flue gas losses account for approximately 30% of gross heat input to a steel reheat furnace[5], it is therefore beneficial to implement systems to recover the maximum amount of this heat. Previous studies have shown that the addition of a recuperator can recover up to 47% of flue gas heat[6]. Research has also shown that in addition to a recuperator, using flue gas to preheat billets to 315°C can further reduce energy consumption by up to 23.6%[5].

Although previous energy-saving studies have been conducted on reheat furnaces, this paper will investigate solutions unique to the Laverton furnace. Areas of current interest are: findings from previous energy-analysis on reheat furnaces and

