Case Study

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Waste Heat Recovery Project

The Challenge

The client, a large engineering and castings company was looking at how they could reduce their high energy bills through heat capture from two 9t, and two 4t cupola induction furnaces.

The investigation was conducted at high level providing a snapshot into the potential for heat capture. However, the challenge wasn't in the heat recovery process, it was in its application. Catalyst needed to understand how efficient the current casting process was to help provide an accurate baseline and required data on fuel to air ratios, burner temperatures, pressure details as well as an understanding of furnace losses including:

- Heat storage in the furnace structure
- Losses from the furnace outside walls or structure
- Heat transported out of the furnace by the load conveyors, fixtures, trays, etc.
- Radiation losses from openings, hot exposed parts, etc.
- Heat carried by the cold air infiltration into the furnace
- Heat carried by the excess air used in the burners.

The bottom line was to get the best possible energy efficiency from furnaces and ovens, reduce the amount of energy carried out by the exhaust and lost to heat storage, wall conduction, conveying and cooling systems and radiation.

The Solution

The stoichiometric, or on-ratio combustion was producing higher temperatures than required and was originally done deliberately to obtain certain operating benefits. However, it was found that the burner system was out of adjustment also, creating higher temperatures that was required. Excess air due to negative pressures was also lowering the furnace efficiency due to the draft effect of hot furnace stacks. Designing an efficient heat recovery system is not difficult but determining the feasibility of a heat recovery system is. Fluctuating utility prices and changing regulations complicate payback calculations. However, the science and technology of heat recovery is well developed and the skillset required lies in the application.

Due to several characteristics such as the cupolas being one of the only methods of melting which is continuous in its operation and at high melt rates. The furnace showed a significant potential of converting low-efficiency cupolas to high-efficiency designs. To determine power generation potential, two scenarios were evaluated: The power generation potential lost due to combustion of exhaust for blast air preheating; and the power generation potential of the hot gas after combustion.

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The Outcome

Catalyst has identified two distinct areas of potential low cost but high energy savings for the client. The first deals with achieving the best possible performance from the existing equipment. The second involves equipment modifications and upgrades that can make substantial reductions in energy consumption.

Optimising the system performance was shown to provide 16% energy efficiency and included the addition of a furnace pressure control system.

During combustion of the cupola exhaust for preheating blast air, approximately 38 percent of the potential to generate electricity is lost. However, assuming that a combustion turbine with an efficiency of 30 percent is used to generate electricity during combustion of the cupola exhaust, the generation potential is significant.

The operating times and electricity costs appear to have a reasonable potential for financial return, and is worth investigating further, based on the assumed conditions.

Power generation potential of the hot cupola exhaust after combustion indicates that the potential for power generation from the hot cupola exhaust is also substantial. Depending on the type of heat exchanger employed in the design we are finding typical thermal efficiency of a suitable heat exchanger is showing around 56%.

To take the findings to the next stage, Catalyst recommended a comprehensive investigation of waste heat losses, recovery practices, and barriers: in order to better identify heat recovery opportunities and technology needs.