Energy management 530 kWh

On an annual casting production of 95 million metric tons, with ferrous alloys costs conservatively set at $1.2 per kg, the total foundry market is well in access of $100 billion. Approximately 15% of these costs are energy costs ($15 billion) and 75-80% of the costs are in the melting process alone. A 10% saving in energy efficiency is equivalent to a saving of $1.5 billion along with substantial reduction in harmful greenhouse gas emissions.

A quick Google search will discover that the foundry industry is on the radar of various governments" agencies in order to meet emission targets set by them. For example, the European Union"s 20-20-20 targets would reduce greenhouse emissions by 20% of 1990 levels, and increase energy efficiency by 20%, both by 20201. The U.S. Environmental Protection Agency2 has announced similar targets. In the recent UN Climate Summit even China has committed to reduce harmful emissions3.

The U.S. Department of Energy has compiled examples or suggestions on best practice energy use in the metalcasting industry4. The European Commission has also funded complementary projects and the findings5,6 are available online, along with number of guidelines and suggestions. Some of the guidelines require substantial capital investment that may not be an option for every foundry.

7Epsilon and Energy Efficiency

This case study concerns a foundry that planned energy improvement solutions as part of a wider effort, and was introduced to the 7Epsilon7,8,9 philosophy on process improvement. The 7Epsilon initiative, led by Swansea University, brought together a

consortium of European foundry experts, process engineers, trade associations, universities and institutions to develop a philosophy that would go beyond Six Sigma thinking on knowledge management and continual process improvement. Since 2012, over 175 foundry process engineers in Europe, the U.S., and India have been introduced or trained in the technique.7

Figure 2. Click to enlargeThis report discusses a foundry"s experience implementing energy optimization by adopting 7Epsilon principles. The gray iron foundry in India produces 2,500 metric tons/month of good castings for cylinder blocks and heads. It had induction furnaces based on heel melting principle as a result of low powered (mains frequency) requirement. The foundry had energy meters installed with continuous monitoring of energy data with a web-based communication system (Fig. 1) offered by Customized Energy Solutions10. The company maximizes value of existing and emerging electric infrastructure through active resource management for over 300 clients in all seven competitive electricity markets in USA and India.

The web-based communication system allowed comparing energy consumption with respect to process output as well as production shifts. The typical load curve is shown on the graph (Fig. 2.) The objective as described in the graph is to ensure that there are no peaks or valleys and the optimized power demand is fairly constant. The Specific Energy Consumption (SEC) variation in kWh/ metric ton of melt for three furnaces is shown in Figure 3 for three shifts over a three-day period. It is observed that the variation in one furnace is higher than others.

Figure 4. Click to enlargeFurther optimization opportunities can be discovered if the energy consumption is monitored at much shorter durations e.g. every 30-90 minutes (Fig. 4) and is related to in-process observations. In this example, the graph shown in Figure 4 is used to discuss a roadmap to lower energy consumption. The average value over the three-day period was 683 kWh/metric tons of melt, and the monthly average value was 660 kWh/metric tons of melt.

The 7 Steps of 7Epsilon to ERADICATE defects or non-conformities are:Step 1: Establish process knowledge [x"s], [y"s]Step 2: Refine process knowledge [y = f(x"s)]Step 3: Analyze in-process dataStep 4: Develop hypotheses (potential solutions)Step 5: Innovate using root-cause analysis and conducting confirmation trialsStep 6: Corrective actions and update process knowledgeStep 7: Build aspiring teams and environments by monitoring performance.

Step 0 has been implicitly designed in that it defines a project goal, similar to any Six Sigma project. The major difference between a Six Sigma and 7Epsilon project is that the DMAIC cycle focuses measuring the data on critical process variables. Six Sigma techniques focus on creating new knowledge by discovering new combinations of process inputs with significantly different tolerance limits (design of experiments philosophy.) 7Epsilon is about continual process improvement with focus on making small adjustments to several process inputs.

An interdisciplinary team is formed to gather process knowledge. Typically, [y"s] are process outputs or responses and [x"s] are process inputs or measurable factors. The traditional brainstorming sessions can be employed to create process maps.