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Energy Efficiency in Steel Casting Production

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Energy Efficiency in Steel Casting Production

(energy$/lb)

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Introduction-

Energy costs have been low and stable for most of the past two decades. In the past 5 years, energy prices have become volatile and have increased dramatically. While still a relatively small portion of the cost of steel casting production, it is worthwhile to consider our current energy efficiency and identify possible improvements.

In some ways energy efficiency is simple to improve. Better insulation, more efficient equipment, better recovery of waste heat, better plant maintenance, etc. are all straightforward steps to improve energy efficiency. The challenge is that often the energy cost savings does not make this a profitable endeavor. Many processes can be improved by 10 to 20% with equipment upgrades but the cost of the capital investment cannot be recovered by the improved efficiency. In many ways, capital recovery is the key hurtle to improving energy efficiency.

Our industry is operating at near capacity. As a result, new equipment investments are being made and future investments considered. Because of the opportunity to improve energy efficiency when making capital investment, it is useful to identify the best, most profitable, opportunities. As an industry we need to explore both common solutions like better management and materials as well as considering energy efficiency as we prepare for new capital equipment investments. (Elliott, 2008)

The last two industry profitability/cost surveys showed the metalcasting industry operating profit to be 2.4% in 2005 and 5.7% in 2007. One could take the average and state that over the last several years the metalcasting industry has an operating profit around 4%.

Cost/energy surveys show energy costs running between about 5 to 7% of sales. Energy and utilities are benchmarked to be 6% of sales. (Monroe, 2007) This matches up with the numbers in Table 1 reported for energy as a percent of sales in the US trade study. (USITC 3371, 2005)

Table 1 Energy Costs as a percentage of Sales ($/short ton)

Year	1999	2000	2001	2002	2003
Energy cost	109 (4.9%)	136 (5.2%)	157 (6.1%)	148 (6.2%)	151 (6.4%)
Gross profit	418	484	377	341	345
Total price	2215	2611	2563	2417	2358

However, for the sake of discussion, the profit/energy relationship could be proposed in the following manner:

It takes about $1,000,000 in sales to generate $40,000 in operating profit.

Now the simple question, "Is it easier to generate $500,000 in new, profitable sales to generate an additional $20,000 in profit or is it easier to find $20,000 in energy savings and not have to find that $1/2 M in sales. With $12M in annual sales, the annual energy cost is about $720,000. Thus, an energy saving of 3% will generate more than the desired $20,000. Based on numerous energy/productivity metalcasting assessments, it's a very valid conclusion that the $20,000 is readily found in any operation.

However, the savings don't just "drop-off-the-tree" into the hands of those who want the savings – even the low hanging fruit. The savings come from an organized, systematic approach where Btu's and kWh are carefully picked from the energy tree and care is taken to maintain those savings. Savings will not come from a "we've always done it that way" or "I can't get my guys to do it" or "I just worry about getting production out the door." A champion is needed and that champion must have support from the very top management such as the president or CEO. Too many operations try to generate energy savings without a champion – it does not work. Critical to the effort is the generation of good metrics before and after implementation of the energy saving effort. Unless one puts a dollar value on the specific savings/and or investment of a project, the positive results are lost in the "how many tons or pounds did we ship today."

Energy Basics-

Steel foundry operations use energy to heat things, move things, and light things. Most of our production process energy is consumed in heating things, melting steel and heat treating castings. Since we buy steel scrap at room temperature and ship castings at room temperature, all of the heat energy used for production is ultimately discarded. Improved use of heat energy is a significant opportunity for energy efficiency. To produce castings we must move molds, castings, operate grinders, move air, etc. For people to see we need to light the facility.

Heating things requires energy. Basically, heating things requires adding energy to the material based on the material's heat capacity:

Eq 1 $E_i = W\ C_p\ (T_2 - T_1)$

Where, E_i is the energy required to increase the temperature of an object weighing W with a heat capacity of C_p from the starting temperature T_1 to the final temperature T_2. Extra energy is required to melt or vaporize a material. (Himmelblau, 1974)

Heat can be transferred into the steel to melt or heat treat by conduction, convection, radiation, by induced electrical current, or by applied electrical current. Conduction occurs when one atom increases the energy of (bumps into) its neighbor. This is described by:

Eq 2 $E_a = k\,A\,(T_h - T_l)/\,t$

Where, E_a is the energy transferred when conduction causes heat flow from the higher surface temperature T_h to the lower surface temperature T_l through a material of thickness t with a thermal conductivity of k and a surface area of A.

In a similar way, convection occurs when groups of atoms at different energies flow around in fluid. This can be described by:

Eq 3 $E_a = h\,A\,(T_h - T_l)$

Where heat is transferred from the higher surface temperature T_h of the solid to the lower fluid temperature T_l with a heat transfer coefficient of h across a surface area of A.

Radiation is completely different and is energy transferred by electromagnetic waves based on the temperature of a surface. It can be described as:

Eq 4 $E_a = \sigma\,A\,(T_h^4 - T_l^4)$.

Where, E_a is the energy applied to the surface of area A when radiation causes heat flow from the higher temperature T_h to the lower temperature T_l and σ is the Stefan-Boltzman constant (0.1714×10^{-8} Btu/(hr*ft^2*°R^4).

So, energy transfer always depends on how high the temperature is above room temperature. The higher the temperature, the more energy required to achieve and the greater the energy lost to the surrounding area. The higher the temperature of the process step, the greater the opportunity to improve the energy efficiency through reduced production delays, improved insulation or recuperation of energy to perform other lower temperature operations. (Bennet, 1974)

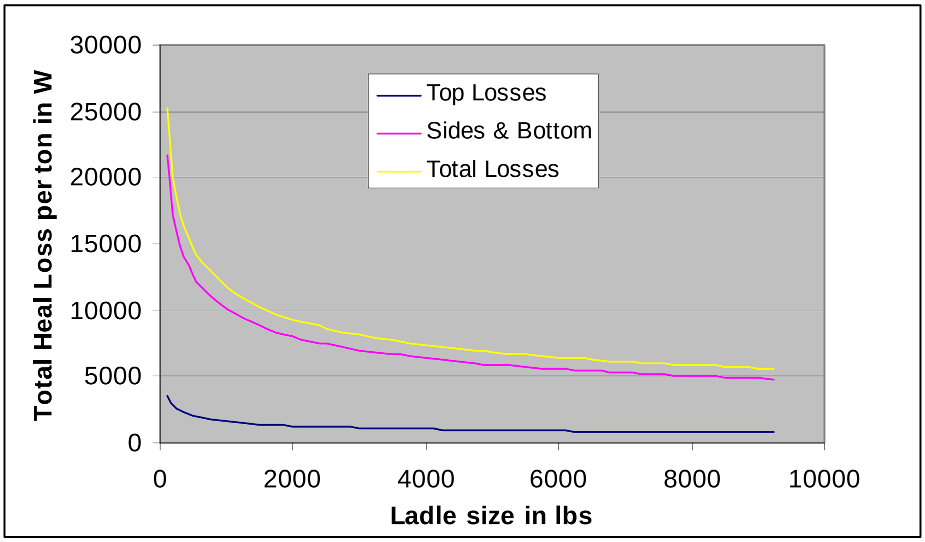

Figure 1: Effect of ladle size on the rate of heat loss through the top, sidewalls and bottom of a ladle

As seen in Figures 1 for steel at 3000F, heat size has a significant effect on the heat loss. This is a simple matter of modulus. Just like solidification rate, heat loss is determined largely by the surface area to volume (SA/V) which is the modulus. As the heat size increases, the thermal losses decrease. The calculation of the rate of heat loss assumed a cylindrical ladle with an inside height 20% larger than the diameter, an average of 7" of refractory (k = 2 W/mK) on the sidewalls and bottom with an outside steel shell (emissivity of 0.75) and stagnant air ($h_{conv} = 10\ W/m^2K$) and 1" of slag (same thermal conductivity as refractory and emissivity of 0.9).

The greater heat loss rate for smaller batches can be seen clearly in the temperature loss in ladles as shown in the measurements in Figure 2. (Peaslee, 2007)

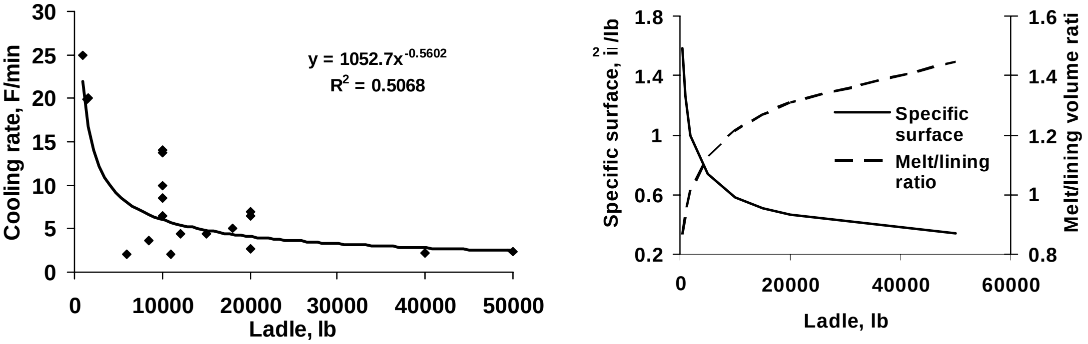

Figure 2 Temperature Loss and Specific Surface of Ladles

Melting is done primarily with electrical energy. The energy required to heat cold scrap steel to the melting temperature, melt it and then raise it to the tap temperature is significant. For example, using iron's heat capacity and heat of fusion, it requires 331 kWh/ton (1.13 MBtu/ton) to take scrap from room temperature to the melting temperature (~2800°F) and then an addition 23 kWh/ton to superheat the steel to the tap temperature 3100°F to result in a total of 354 kWh/ton (1.2 MBtu/ton). Based on an electrical energy cost of $0.08 kWh, it would cost $28.32 to melt steel as an absolute minimum. A U.S. Department of Energy study conducted a few years ago concluded that the actual minimum energy requirement when considering required slag production and sensible heat in the offgas is 600 kWh/ton or $48 to melt. (Fruehan, 2000) Good normal melting practices in the minimills using EAFs typically use 770 kWh/ton for a cost of $61.60/ton and 2,000,000 Btu/ton of natural gas or about $20/ton (see Table 2). Of course minimill EAF normal melting practice substitutes chemical energy for some of the electrical energy requirement. (Stubbles 2000) 1 kWh is equivalent to 3,413Btu.

Table 2 Electrical and Natural Gas used to produce a ton of Steel

Plant Type	Electricity	Natural Gas
EAF Minimills >25 million tons shipped Stubbles	770 kWh/ton shipped	2.0 MBtu/ton shipped
Steel Foundries Schifo and Radia	2350 kWh/ ton shipped	10.92 MBtu/ton shipped

Steel foundries use significantly more energy than steel mills during melting because of the smaller heat size and less efficient melting practices. For a typical foundry, the average heat loss from an induction or arc furnace is 50-200 kW/ton or 170,000-750,000 Btu/hr-ton. With an average heat time of 2 hours, the electrical energy used to make up for the heat losses is 100-400 kWh/ton (1kWh=3412BTU) or $8.00-32.00/ton. Small heats require more than large heats. The greatest amount of additional costs are during holding and finishing where the typical heat may be at temperature for 30 min and add $7-21 dollars per ton.

Total energy used in kWh can be estimated from the following equation:

Total kWh = Electrical kWH + 0.137 (SCF O2) + 0.276 (SCF Natural Gas) + 40 (gal Oil)

By knowing the total energy usage in similar units it helps a foundry know the total consumption of energy and opportunities for substituting one energy source for another based on cost. In addition, certain delays and melting practice changes increase the total amount of energy used (see Table 3).

Table 3Effects of EAF Furnace Practices on kWh/ton

Refining delay	Yield	Tap Temp	Delay between heats
+1.5 per min	+9 per 1% drop	+6 per 10°F > 2900F	+0.5 per min

Steel mills have significant advantages compared to foundries when improving their energy efficiency. They use much larger and efficient furnaces, focus on production of steel using the EAF primarily as a melter and finish the heat in a ladle furnace. Yields in continuous casting are typically greater than 97% because all of the liquid ends tapped ends up in the final product eliminating all yield losses typical in foundries such as risers, gates and pigging at the end of the heats. The mills use ultra high power transformers, a hot heal practice (leave at 10 to 30 tons liquid in furnace), bottom tapping and multiple sources of chemical energy resulting in typical tap-to-tap times of 35 to 55 minutes.

Table 4 Electrical and Natural Gas used to produce a ton of Steel Castings

Energy Use By The Steel Foundries Participating In The Assessment (Annual Good Tons Produced)									
Type of Melting Facility	**Type of Molding Process**	**Type of Steel**	**Electrical KwH per ton**	**Electrical Therms per ton**	**Natural Gas Therms per ton**	**Fuel Oil Therms per ton**	**Approx. Total tons/year**	**Total therms per ton**	**Total Tacit Energy Therms per ton**
Induction	Primarily airset	Primarily Stainless	6,570.0	224.2	267.2	0.0	1,200.0	491.4	908.3
Arc	70% green sand 30% air set	Low Carbon	2,701.0	92.2	114.8	0.0	3,230.0	207.0	378.4
Induction	Airset	Low Carbon	2,018.0	68.9	103.6	0.0	2,700.0	172.5	300.5

Steel foundries must riser the castings to produce the desired quality. Gating systems are required to allow the mold to be poured. Apart from melt losses, the yield for steel casting can be a low as 30% and as high as 80% with most producers around 50%. (Beckermann, 1998) This suggests that steel foundries would at best be half as efficient in melting compared with mills. The mills with shorter heat times, continuous operation with fewer cold starts, and much larger furnaces and lower furnace modulus would be even better.

For steel mill production in the EAF, the average electrical requirement was 770 kWh/ton and the natural gas required was 1.8 MBtu/ton. (Stubbles, 2000) For three typical steel foundries, the average for steel foundries was 2,350 kWh/ton and 10.92 MBtu/ton. Steel foundries average more than three times the energy used by the mills to create a ton of steel product.

Figure 3 summarizes the energy required for the production of cast steel product on a per ton good castings shipped basis as developed by SFSA. A member energy survey and published energy consumption numbers from US DOE were used to produce the graph.

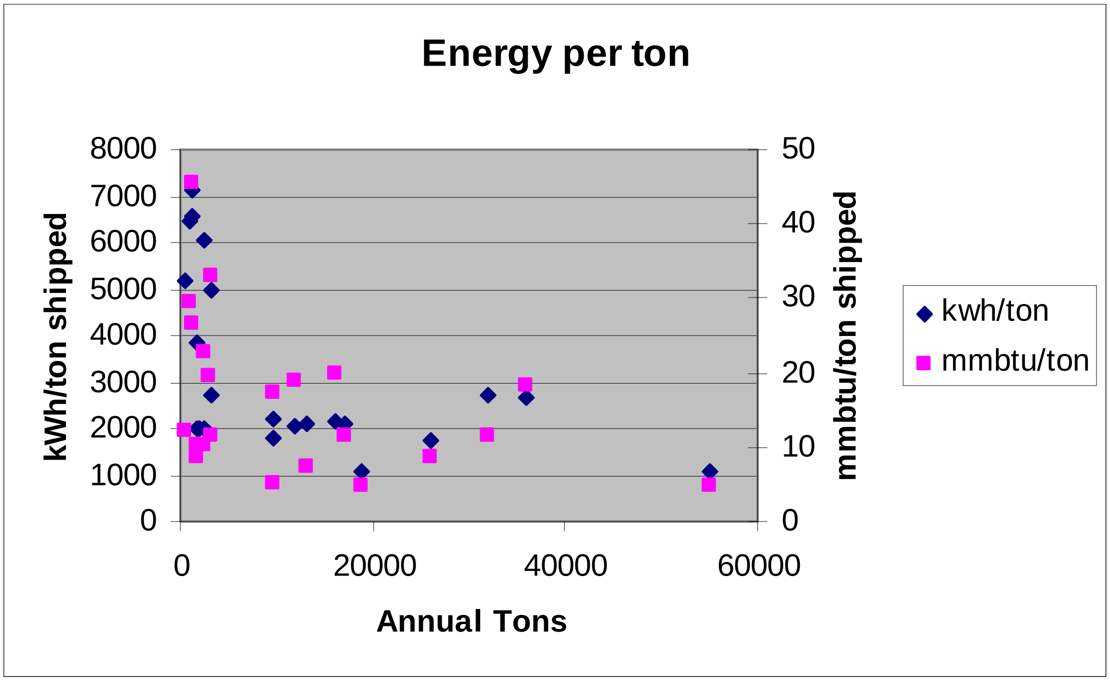

Figure 3 Energy per shipped ton for steel foundries

If you assume production of eight heats a day and 250 days of melting a year, then dividing the annual tons by 2000 estimates the typical heat size in tons. This would also mean that the annual tons on x-axis is also equal to the typical heat size in pounds. Note that the shape of the graph is similar to the early Figures 1 and 2 with dramatic increases in energy required for small heats on a unit weight basis.

The pie chart (see Figure 4) shows the electrical energy used in a typical EAF steel foundry. Note that melting consumes nearly half of the energy used for casting production.

As expected the story is similar for induction melting. Since induction furnaces are smaller, we would expect them to be energy inefficient. The pie chart (see Figure 5) shows that for an induction melting plant, melting took 51% of the electrical energy required.

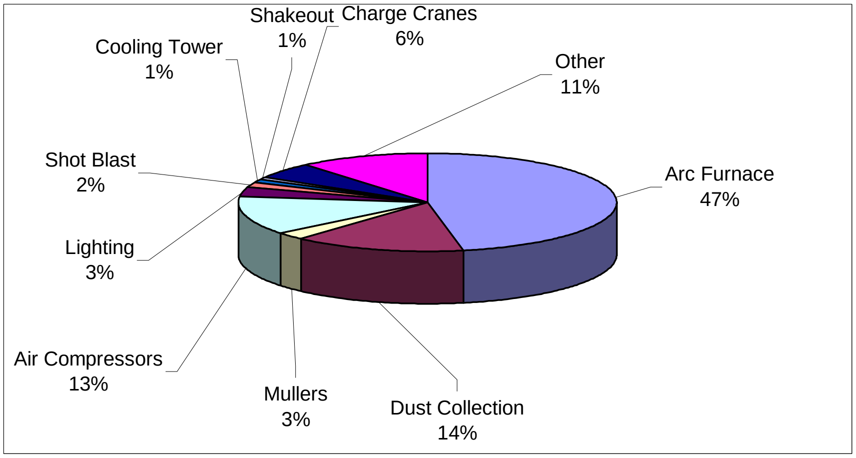

Figure 4 Energy use per ton shipped – EAF steel foundry

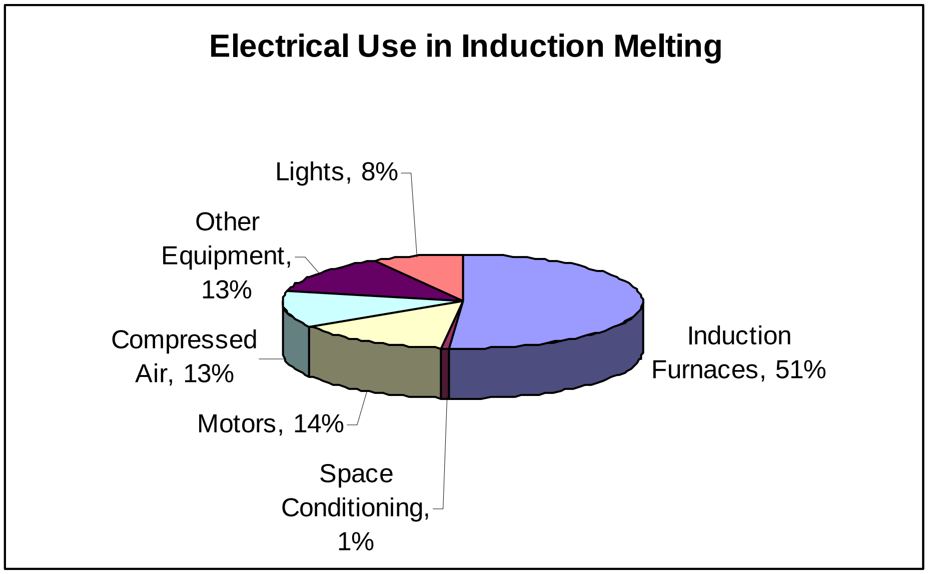

Figure 5 Energy Use per shipped ton – Induction Steel Foundries

The electrical requirement for melting steel in foundry furnaces has been studied and a useful correlation is (Peaslee, 2005):

$$\text{KWH/t} = 1364 - 169*(\text{EAF}=1;\ \text{IF}=0) - 1.3*\text{Year} + 0.91*\text{Tap to tap time, min} + 0.57*T_{tap}, {}^\circ\text{F}$$

The R^2 for this equation was 0.54, indicating fairly good correlation of the data with this equation.

The multiple regression analysis showed that the following independent variables had an influence on the energy consumption for melting steel (from strong to weak influence):

- increasing “tap temperature” increased energy consumption (strong influence)
- increasing “tap to tap time” increased energy consumption (strong influence)
- “EAF” has lower energy consumption than “IF” (strong influence)
- newer equipment (“Year of installation”) decreased energy consumption (strong influence)
- increasing “specific transformer power (KVA/ton)” decreased energy consumption (weak influence)
- increasing “furnace capacity” decreased energy consumption (weak influence).

EAF melting requires less energy both because of the furnace size but more importantly because of the use of the oxygen blow adding supplemental chemical energy to the melting process. Table 5 shows the heat loss and gain from additions to the bath. The temperature increase in Category 4 is the result of this chemical energy addition. (Peaslee, 2005) The installation of an oxyfuel burner or co-jet in the EAF can improve this further. In one plant, the installation of a furnace co-jet reduced electrical energy consumption about 10% and decreased the heat time by 10%. (Peaslee, 2008)

Table 5 Temperature Change for Additions to the Melt

Group description	Additive	Melt temperature change (F)
1. Additives (1 weight %) with endothermic heating/melting and endothermic chemical effects	C	-99
	FeMn (78%Mn 6%C)	-48
	Cu	-38
	Low C FeMn (78%Mn)	-31
	Mn	-31
	Fe	-30
2. Additives (1 weight %) with endothermic heating/melting and exothermic chemical effects	Cr	-18
	Mo	-9
	Nb	-7.2
	Ti	-7.2
	FeSi (50%Si)	-7
	Al	0
	FeSi (75%Si)	+7
	Si	+28
3. Inert gas blowing through the melt (0.1 weight %)	Ar	-3
4. Chemically active gases (O_2) oxidizing 0.1 weight of elements in the melt	Mn	+12
	C (to CO)	+23
	Si	+59

Cold starts in foundry melting practice are a significant cause of energy inefficiency. You can see from one plant induction melting (Table 6) that the energy penalty in melting is around 30%. It is a key to manage the process to minimize cold starts.

Preheating the furnace can help extend refractory life and reduce the cold start penalty as well.(Peaslee, 2005)

Table 6 Effects of Cold Starts on Energy Use

Year	Steel	Lining	Charge	Corrections, #	Melting Time, min	KWH/t
2004	WCB	Cold	Solid	1	207	653
2005	WCB	Hot	Solid	1	114	519

We look now away from melting to other heating applications fueled by natural gas combustion. Comparing heat loss at lower temperatures, Figures 6 and 7 show the heat losses by a steel surface temperature (emissivity of 0.75 and convective heat transfer coefficient of 15 W/m^2K for a spherical steel part) at 1000F, 1500F and 2000F. Radiation is the predominant heat transfer mode when above 750F and the heat losses are more significant for smaller than large parts.

Lower temperature operations like heat treating, scrap preheating or thermal sand reclamation are normally heated by combustion of natural gas. If a furnace containing one ton of parts being heat treated is losing 5,000 Btu, the natural gas consumed is 5 SCF/min. At $10 for 1,000 SCF, this would cost $0.05/ton/min.

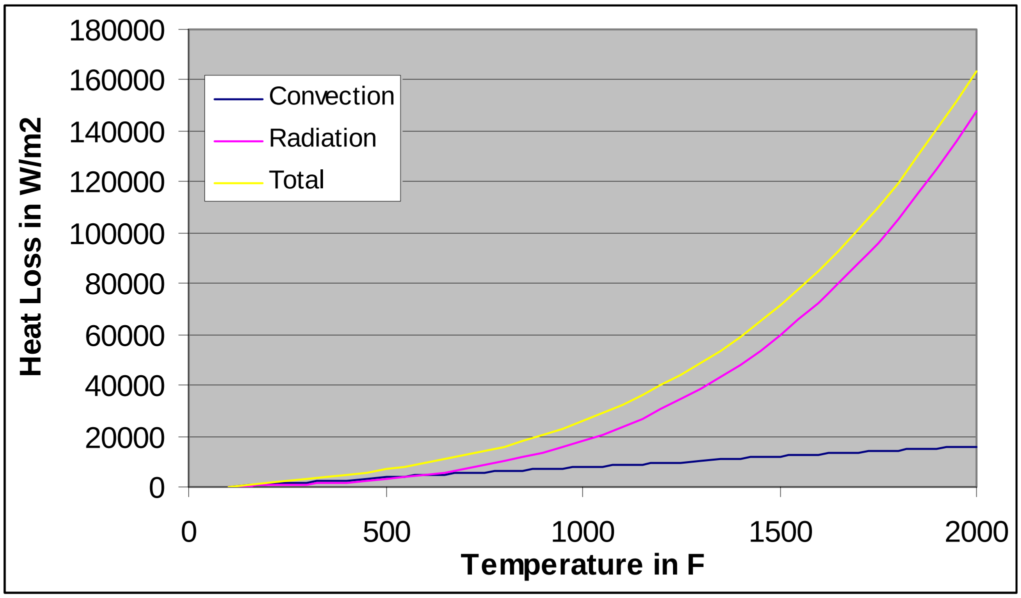

Figure 6 Comparison of Convection and Radiation Heat Losses based on Temperature of Steel Surface

Since we buy scrap and alloys that are at room temperature and ship castings at room temperature, all the energy used in heating for the production of steel castings is lost. In Table 7 the various thermal operations required for steel casting production are listed. In collocated operations such as ladle preheating, scrap preheating, and melting, it could be possible to recuperate the sensible heat in the off-gases from the higher temperature operation and transfer to the lower temperature operation This table is helpful in identifying possible operational combinations that might be cost effective.

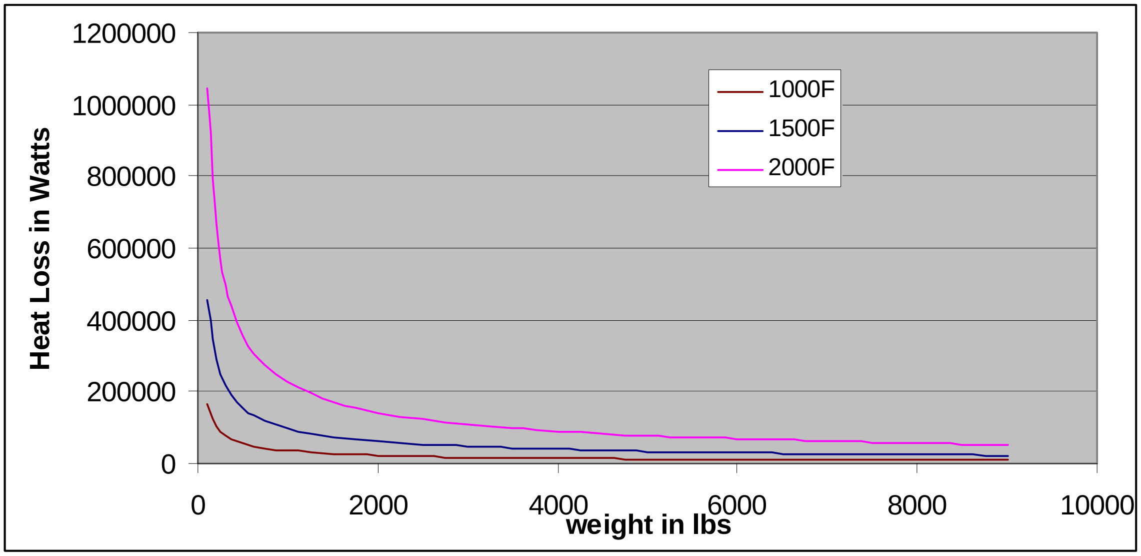

Figure 7 Effects of Surface Temperature and Steel Size on Heat Losses.

Table 7 Characteristic Temperatures for Process Heating

Operation	Characteristic Temperature	Operation	Characteristic Temperature
Scrap preheating	1000-1800 °F 550-1000 °C	Weld preheat	200-500 °F 90-250 °C
Ladle Preheating	1000-1800 °F 550-1000 °C	Post Weld Heat treatment	1000-1200 °F 550-650 °C
Melting	2800-3200 °F 1550-1750 °C	Sand Reclamation	1000-1800 °F 550-1000 °C
Thermal cutting Preheat	200-600 °F 90-300 °C	Steam	200-300 °F 100-150 °C
Heat Treat High Temperature	1600-2150 °F 850-1200 °C	Hot Water	100-150 °F 40-70 °C
Heat Treat Low Temperature	400-1200 °F 200-650 °C	Heat	80-95 °F 25-35 °C

The two greatest uses of natural gas in one EAF shop are for heat treating and ladle preheating (see Figure 8). The most effective use of exhaust heat from these operations is to provide the heat needed for a collocated operation.

For example, the use of the exhaust from ladle preheating could be used to preheat the next charge. It could also be used to preheat the furnace if cold to reduce the energy required for melting the first heat.

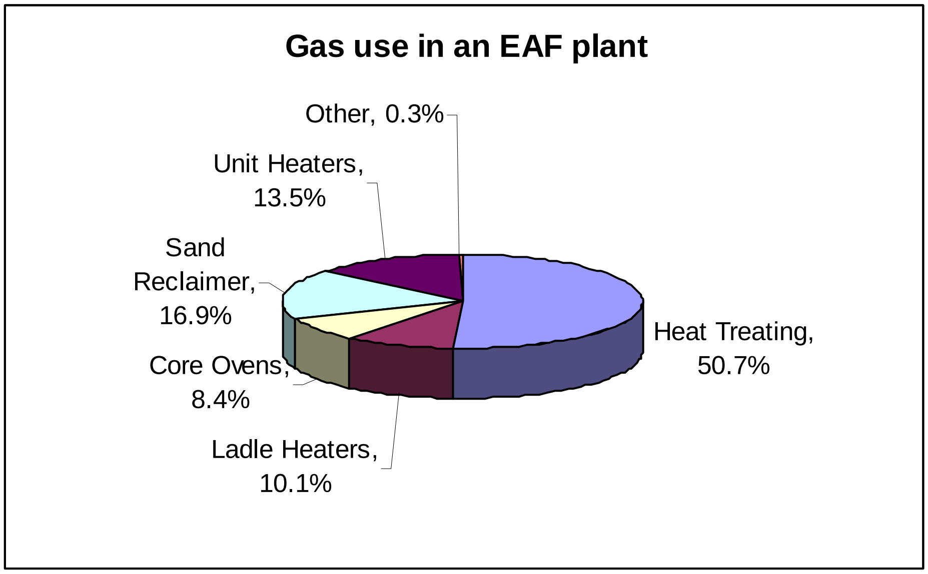

Figure 8 Natural Gas use in EAF based foundries

In heat treating, the exhaust from austenitizing could be used for sand reclamation if these operations could be co-located. The high temperature heat treating operations could directly supply the heat to a lower temperature operation.

The normalizing or austenitizing operation exhaust could provide most of the heat required for tempering. The exhaust from tempering could be used to preheat or post heat for welding operations. In one induction melting plant (see Figure 9), heat treating operations accounted for more than 90% of the natural gas used.

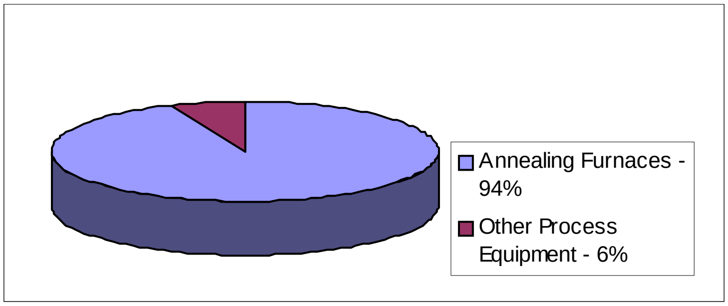

Figure 9 Natural Gas Use in Heat Treating

Alternatively, the hot exhaust from these thermal operations could be used to preheat the combustion air for the same or another operation. It is often attractive to use a heat exchanger to capture the energy in the exhaust gas. Modest temperature exhaust gases can provide significant reductions in energy costs as shown in Table 8. This heat recovery can be an attractive investment with today's energy costs. However in most cases the heat exchanger investment is too costly to make an attractive rate of return on the investment. Using the heat for a collocated operation is a more attractive investment.

Burner control is also an opportunity to improve energy efficiency. Most burners operate with some excess air. This is to ensure complete combustion of the fuel. Unfortunately, all the excess air used in combustion must also be heated to the needed temperature and then the heat is discarded in the exhaust. Figure 10 depicts how excess air limits the energy efficiency of a burner.

Table 8 Percent Fuel Savings from Preheated Combustion Air

	Preheated Air Temperature, F					
Furnace Exhaust Temperature, F	600	800	1,000	1,200	1,400	1,600
1,000	13	18				
1,200	14	19	23			
1,400	15	20	24	28		
1,600	17	22	26	30	34	
1,800	18	24	28	33	37	40
2,000	20	26	31	35	39	43
2,200	23	29	34	39	43	47
2,400	26	32	38	43	47	51

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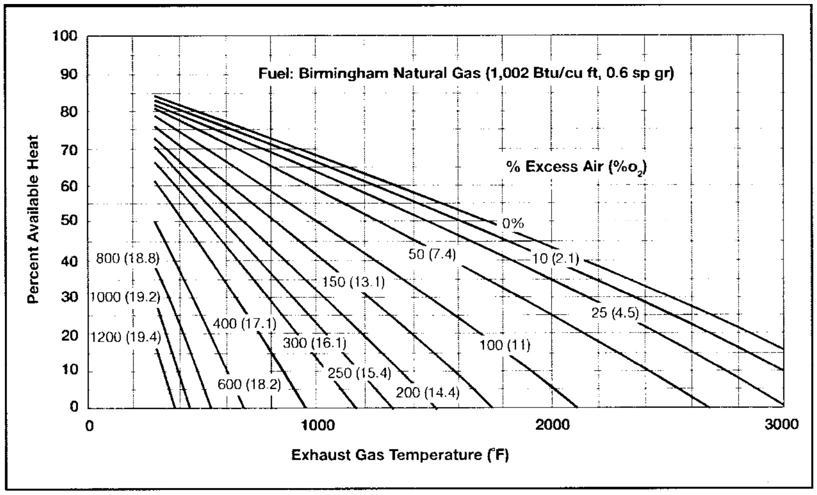

Figure 10 Effects of Excess Combustion Air on Energy Efficiency

Not only does excess air reduce efficiency, the use of air instead of oxygen reduces efficiency. All of the nitrogen must be heated and is discarded in the exhaust. While oxygen is expensive, the use of oxygen enrichment can be a useful tool especially around the melt shop. Well designed ladles preheat operations with oxygen enrichment offer the potential of higher temperature preheat and less fuel consumption (See Figure 11).

Our control systems are also lacking. In heat treating our cycles are longer than needed and our control less than desired.

One plant has installed wireless controls in steel blocks to improve combustion control and heat treatment cycle times. They have reported an almost 10% reduction in energy required and a 30% reduction in heat treat cycle time. (Oyarzabal, 2008)

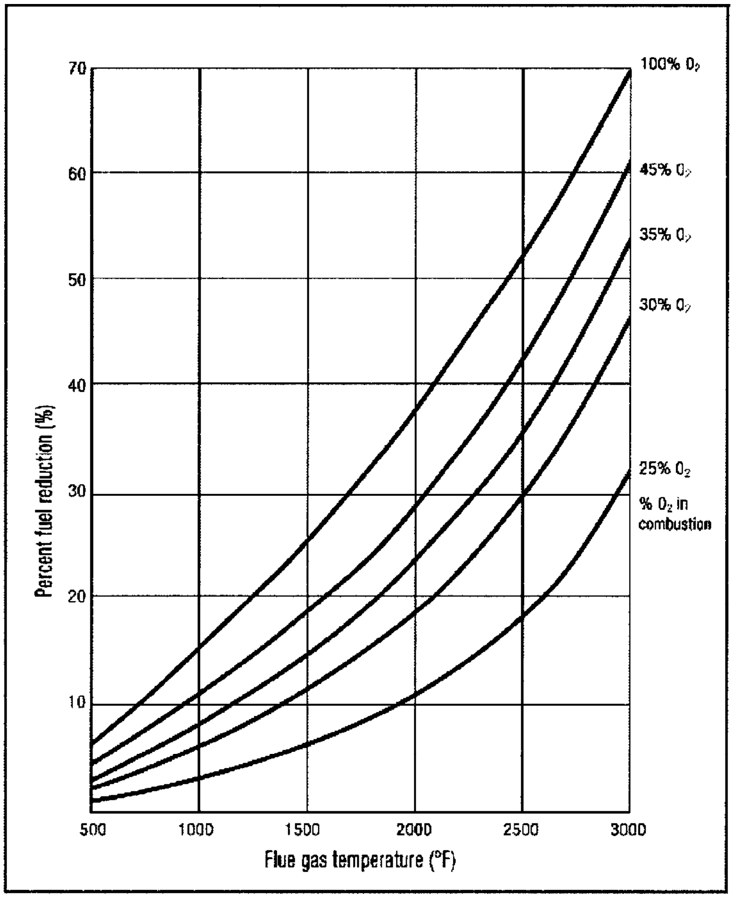

Figure 11 Fuel Savings from Oxygen Enrichment

ENERGY EFFICIENCY – UTILITIES AND MATERIAL HANDLING

Once the champion is chosen, an excellent starting point is to contact a **DoE sponsored *Industrial Assessment Center (IAC)***. These centers are at 26 different universities around the country. They typically operate out of the mechanical or industrial engineering departments. A team of 3-5 experienced senior or grad students, lead by an engineering professor will conduct the one-day assessment.

These centers are performing approximately 26 assessments annually. Virtually all the steel foundries meet the criteria for an energy assessment from one of these centers. Details on these centers can be found at:

http://iac.rutgers.edu/

If you chose to have an assessment, it's recommended that arrangements also be made for a metalcasting/steel foundry consultant to accompany the Industrial Assessment Center Team and participate in the final report and recommendations. There is no cost for the assessment by one of the Industrial Assessment Centers; of course if you chose to have a consultant accompany the assessment team there would be a separate cost for that individual.

Also, the IAC database can be searched for top-ten recommendations based on SIC/NAIC codes. Determine if any of these top-ten recommendations "fit" your facility.

Energy savings can come from a number of sources, including improved yield based on utilization of the latest solidification/flow modeling techniques. This effort also includes careful placement of risers that facilitate easy removal, and thus less energy and the associated increase in productivity. The savings can also come from implementation of process controls and processes, such as shrouded pouring that will minimize repair-welding efforts.

This section will emphasize the non-process aspects of energy saving. Note that none of these are related to electric demand control, etc. They are related to the facility and support equipment.

Compressed Air

Compressed air is expensive. Too often it is treated as "free" just because it's easy to run an air-hose to an overhead pipe or it keeps capital cost down when purchasing a molding system. It costs four times as much to utilize air for performing work as it does to do the same thing electrically. However, there is no question that air-powered equipment is needed in a steel foundry operation. The mill room (finishing department) is a large consumer as is the core department.

Question 1

How many compressor horsepower are available and how much is being used during production?

Question 2

How many horsepower are being used to keep up with leaks?

Typically, the compressed air leak rate accounts for around 25% of the horsepower; but leak rates up to 40% have been observed. Thus if the total compressed air horsepower at the facility is 600 HP; the **wasted** horsepower will be 150. Assessments at several facilities showed air-leak rates greater than this due to broken underground pipes and extreme leakage conditions. Wasted air at one facility was greater than 300HP and still climbing as all leaks were identified and fixed.

The cost of a wasted 150 HP for 24 hours a day for one year is around $70,000 which would require an additional $1.75 M in sales to make up for the lost profit. Table 9 summarizes the cost of various air leaks and the potential savings.

Table 9 Cost of Air Leaks

Hole Diameter (in.)	**Air Leakage at 100 psi (cfm)**	**Cost per Year at $0.08/kWh**
1/32	1.62	$210
1/16	6.5	$844
1/8	26	$3,376
¼	104	$13,472

Poor maintenance of the post-compressor chillers leads to condensation and the solution for this – trying to make two wrongs a right – is shown in Figure 12.

Figure 12 Drum for collecting condensation

In many foundries, the compressed air delivery system just "sort of" evolved as equipment was added. Often, little thought was given to the design of the piping and use of strategically placed receivers. Compressors are added without interactive controls between the other compressors. Many of these and other topics are covered in the following references

Energy Saving in Compressed Air, Air Power USA, 2003
DoE AirMaster
(http://www1.eere.energy.gov/industry/bestpractices/software.html)
www.compressedairchallenge.org)

Motors

The starting point on motors is very simple – don't run them if they are not performing useful and necessary work which is easy to say – much harder to execute. During a number of assessments, numerous hydraulic motors have been found running long after the shifts are over. Ventilation systems and shaker conveyors running when there is not production. Exhaust fans exhausting on Saturdays and air makeup units running as well. Though computer controlled shut-down systems would be the ultimate way of controlling things – this is not mandatory. Someone must take individual and departmental responsibility!

Now with that said, the selection of motors and the decision to purchase or rewind can be reduced to a well-established decision making processes. The DoE and DoE sponsored web-sites have numerous publications and software to facilitate the decision making process. Some of these references are:

1. DoE MotorMaster+
(http://www1.eere.energy.gov/industry/bestpractices/software.html)
http://www1.eere.energy.gov/best practices/pdfs/mc-2463

2. DoE – ITP Best Practices
(http://www1.eere.energy.gov/bestpractices/tip_sheets_motors.html

3. www.advancedenergy.org/motors_and_drives

4. Evaluation and Application of Energy Efficient Motors GE Bulletin GEA-M1019
Achieving More with Less: Efficiency and Economics of Motor Decisions – Prepared by Advanced Energy.

This is just a sample of some of the references that can be quickly found on the described sites. Additional ones are readily available through the use of web search engines.

For example, the website

http://www.advancedenergy.org/motors_and_drives/hp_breakpoint_tool.html

will lead one through the analysis for buy versus rebuild decisions. A $4300-75 HP motor consumes $142,000 in electricity in its lifetime. The dollars saved in a rewind could (will) be quickly lost if the efficiency declines or the motor was built to the lower efficiency standards of the pre-90s. The references, including the DoE MotorMaster+ will lead one to the proper decision. Figure 13 was taken from the above reference.

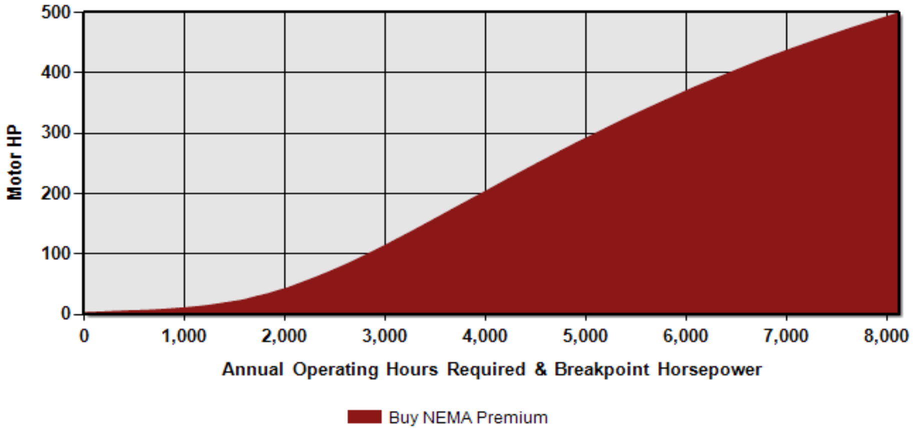

Figure 13 Breakeven Hours NEMA Premium versus Motor Rewinding

In general, if a rewind cost more than 60% of the replacement cost for a NEMA Premium motor – then replace the motor.

These two major areas of energy consumption, excluding melting, are the initial areas to address. Once these have been optimized then smaller savings can be explored in areas such as lighting, v-belt drives, infrared heating for plant personnel, replacement of air-driven devices, such as stirrers for coatings and various vortec, air-powered coolers for control cabinets.

The following site was developed by the North American Die Casting Association (NADCA) as an energy training site for die casters. If one overlooks the obvious aluminum related information, the balance of the numerous individual training modules will be very helpful to the steel foundries. The site is open to all and can be easily accessed at

http://www.diecasting.org/training/energy/intro/energy.htm

The site is also linked to numerous references.

As one can see – there is no single solution. There is no silver bullet. Energy savings will only come from a well-organized effort lead by a champion and that champion will have the support of the president or CEO. Without that champion and without that support, the effort will soon fall by the wayside and the focus will be on finding that new $1M customer to generate that $40K in profit.

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