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Stop Melting Money Away: Run Furnaces Efficiently

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Recently we received a frantic phone call from a customer that went like this: "Help!" My gas bill just went up 60 percent! What can I do to reduce my energy costs?" I told him to buy a smaller car, turn the thermostat down to 68 degrees and put on a sweater. Then I realized he was talking about his melt department.

Even though the U.S. Department of Energy's Web site states that the U.S. has more stored natural gas reserves than before the October 1998 averages, (***http://tonto.eia.doe.gov/oog/info/ngs/ngs.html***) we seem to be gouged by increases from the gas and electric companies. Consumption has skyrocketed since the conversion of many of the nuclear power plants to natural gas. What we are seeing is a panic rise in prices due to the lack of developing a cost effective alternative fuel source. Natural gas suppliers know we are going to run short this winter, so they react by increasing the prices, which will add to an increase in profits. This effect enables the companies to buy or explore more expensive natural gas in the future.

So much for the reason gas prices are so high, now on to the solution. This is what we sent the customer.

TIPS TO HELP FURNACE EFFICIENCIES:

1. Remove all fans that blow on the furnaces. This will result in less heat loss off the casing where the fan is hitting the furnace. Instead use individual cooling stations that bring the air in from overhead only to a specific spot where the operator can stand to cool off.

2. Install well covers whenever the furnace is idle for longer than a half hour. (See figure 1).

3. Make sure reverberatory furnaces are utilized at full capacity and charge at a rate of ¼ of their hourly melt rate every 15 minutes. Over charging the furnaces causes dramatic swings in temperature and increased sludge build-up on the floor of the furnace. The more sludge on the floor, the less likely a furnace will melt at rated capacity. The furnace may not melt anywhere close to its designed BTUs/# of metal melted.

4. Install a half flue cover over the flue during long idle conditions. **WARNING**: The flue cover must be removed before turning the furnace to high fire. At low fire, the flue opening is still sized for 100 percent output of the burners. Without flue pressurization, holding efficiencies will drop slightly.

5. Reduce molten metal temperature over weekends by 20 degrees or more if feasible.

6. Clean furnaces during idle shifts or idle times... but clean them daily! This will cut down on the amount of oxides growing in the furnace. Oxide is dense and absorbs additional BTUs from the metal. Don't over flux the melters. Over fluxing of the walls can

Figure 1: *Pneumatic well cover.*

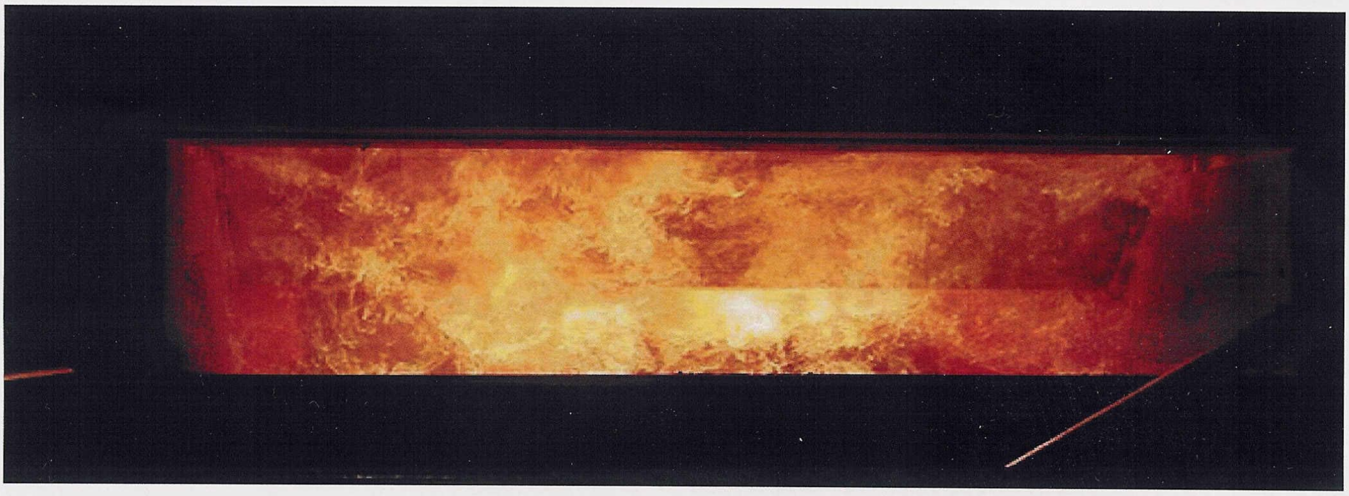

Figure 2: Gas fired furnace out of adjustment.

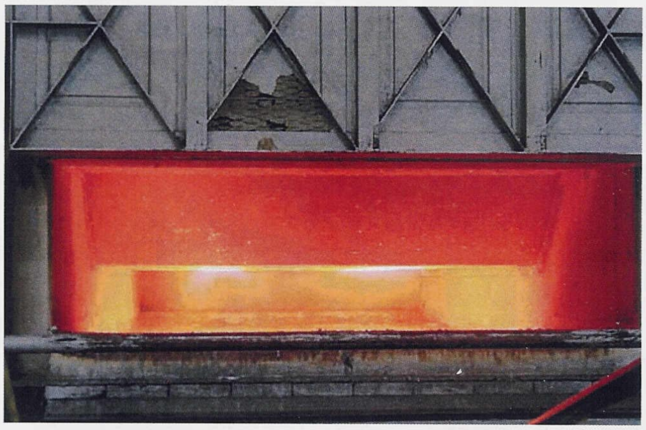

Figure 3: "In ratio" radiant roof gas fired furnace on high fire.

break down the binder in the refractory and cause premature erosion of the belly band area.

7. Clean or change combustion air filter regularly. Take a dollar bill and hold it 2 inches away from the filter. If it does not draw the bill to the filter rapidly, it is time to clean or change the filter on the blower.

8. Double check and monitor combustion set up for maximum burner performance (requires a manometer). If there is a wall of flame coming out the flue, chances are there is a fuel rich condition inside the furnace. The raw gas that does not have enough air in the furnace for combustion ignites when it reaches the atmosphere just outside the flue because of all the free air available to it at the flue and hood junction. Over pressurization of the furnace can also cause this condition. (See figure 1).

9. In reverberatory (radiant roof low headroom or high headroom) furnaces all ingots must be pre-heated on charge well (wear plates) or on a hearth before putting into the bath. Pre-heat all sows on a hearth before pushing them into the bath. When a sow or ingot begins to sweat, the internal temperature is close to 900°F. There is no moisture left in the sow and it can be safely charged under the bath of aluminum, where the stored BTUs in the metal help finish the melting process. Ingots left on a well wear plate to pre-heat will reach 250° after 20 minutes — this is sufficient to load into the bath. Some bubbling may occur from moisture left in the very center of the ingot.

10. Metal delivery to the holding furnaces should be every 20-30 minutes. Less frequently will mean overcharging the melters and drawing down the metal too low in the holders. The closer the metal is to the heat source, the faster the transfer of BTUs. Approximately 10 percent in efficiencies is being lost by drawing holders too low. By making sure the metal tenders put back what they take out in the melters, a difference in metal temperature stability will be evident. (See figure 3).

11. Remove dross build-up whenever it gets thicker than ½". Over ½"thick and the dross begins to act like an insulator and makes the furnace work harder to do the same job. A completely clean bath surface will reflect the heat, so do not to clean it any more frequently that once a shift. If a furnace creates a dross layer over ½" in less than 6-8, hours, the furnace is creating more dross than normal. Treat the cause not the symptom. Investigate why the furnace is a dross generating machine. Typical reasons are:
    a. Air leaking in and around the doors.
    b. Drawing the furnace down below the submerged arches or door blades.
    c. Burners that have a flame that touches the bath or scrubs the solid metal on a hearth.
    d. Too large of a flue opening for the BTUs connected will cause the furnace to draw in more air.
    e. Burners are not stoichiometric. The combustion system must be set up properly or more dross will be generated. Typically most natural gas fired burners are set up on a 10-1 air to gas ratio. At this ratio, 95 percent of the oxygen in the burner system is consumed. However, if a furnace is set up with ratios in excess of this, dross will increase in the furnace. On the other hand, a furnace that is set up fuel rich will produce a colder flame and make the furnace work harder to get the job done. Keep it in ratio!

TYPES OF FURNACES RELATIVE TO ENERGY COSTS

There are many different types of furnaces on the market today. The basic rule of thumb in melting metal is this: A furnace should melt at 1500 BTUs/#of metal melted or less. The furnace must be easily cleaned. To buy a furnace that melts at 1100 BTUs/# but is difficult to clean could cost most of the fuel savings in refractory maintenance in a year.

PRE-HEAT HEARTHS

Try to purchase furnaces that allow sows and ingots to be preheated. This can save 15 percent in fuel per year. By allowing a sow or ingot to sweat on the hearth, one raises the internal temperature to about 900°F. There is no moisture left in the sow or ingot, thus making it safer to charge. Now the stored BTUs in the bath finish the melting process, further saving energy. (See figure 4).

Figure 4: Pre-heat hearth.

MOLTEN METAL CIRCULATION

In furnaces that are large enough to warrant it, circulate the metal. On a radiant roof reverberatory furnace, a circulation pump discharging into a charge well gains these advantages: 1) The metal temperature in the entire bath of metal (top to bottom, inside and out in the well) is the same and kept homogenous due to the constant circulation and stirring action; 2) The tendency for sludging is greatly reduced due to the even bath temperature; 3) Metal can be melted faster in the charge well due to the forced convection of the metal; 4) Energy is saved, or capacity increased due to more rapid exchange of BTUs from the thermal head in the top of the furnace through the metal and out into the charge well. The pump will increase overall furnace efficiency by 12-15 percent; 5) To further conserve energy, the pump should have an electric motor rather than an air motor *(PLANT AIR IS THE MOST EXPENSIVE ENERGY SOURCE IN THE PLANT)*. A small blower keeps the pump cool; and 6) If sweetening the alloy in a furnace, then using circulation pumps will help distribute the alloying agent and rapidly mix it into solution. (See figure 5).

Figure 5: Circulation well and pump.

METAL MELT LOSS (A True Story Of Melting Aluminum)

As energy costs continue to climb, these simple steps will help to save energy. However, currently, **the most expensive operating cost one can have is molten metal loss.** Even if a company purchases the most energy efficient furnace, if the metal melt loss is high, (more than 3 percent) than more money is lost than saved in energy. Here is an example:

A die casting/foundry customer planned to change the way aluminum was being melted, to address metal quality and maintenance problems and... they hadn't even considered... "THE CARROT". The carrot in this approach was to change melting methods as a substantial operational savings. If the larger of the two castings that is being produced (a 20# casting every 20 seconds) is considered, the projected melt cost savings, when compared to their existing melting methods (shaft type melters), will be approximately...

$370,000.00 + Saved Per Year... Year, After Year, After Year.

1. Based on a very conservative 2 percent difference in metal loss (the 5 percent figure used is being experienced in a customer's shaft melters vs. a maximum of only 3 percent in the wet bath reverb) the calculations are: 20# each casting x 180 castings/hr. = 3,600#/hr. required; 22 hours/day x 6 days/week x 50 weeks/year = 23,760,000# of aluminum alloy/year; at 2 percent melt loss difference = 475,200# saved at an estimated $0.80/# = $380,160.00 saved.
2. If molten metal is transferred out of the wet bath reverb furnace by way of a heated launder, ¼ of 1 percent metal savings by eliminating the turbulent transfer into the transfer ladle amounts to another 59,400# saved at $0.80/# = $47,520.00/year.
3. Liberally, credit a 400 BTU/# melt advantage to the shaft melter at $0.60 therm fuel cost = $57,024.00/year.

Total Saved/year = $370,656.00/year

So in this example, having what they thought was the most efficient furnace was actually costing this customer more than $370,000 a year. Now, after installing a radiant roof melter they are saving this year, after year, after year...

HOLDING FURNACES

Everyone thinks all holders do is hold metal at temperature. In theory this is correct, until cold metal is delivered to the holder. Now the entire bath temperature must be raised several degrees. In order to do this, it must have enough BTUs, or KW to overcome the heat loss and raise the metal "X" number of degrees as quickly as possible so as to not effect the casting. In plants all across North America, there are electric holding furnaces with too little KW connected to adequately do the job. If a furnace holds 2400# and only has 15-18 KW connected, that is asking for trouble. To make matters worse, some of these holding furnaces do not have full proportioning controls. Consequently, they are on 100 percent output all the time. If it takes 10 KW to hold temperature in a holding furnace under normal conditions and a fan is suddenly blowing on the casing or well, the furnace is drawn down 5 inches before refilling takes place (moving the metal further from the heat source) and someone delivers 500# of 10 degree colder metal, then the furnace temperature will take over an hour to recover. This is not holding metal efficiently.

Some control instruments do not monitor the temperature frequently enough to know when the metal temperature begins to decline in order to compensate for that drop in temperature by increasing the KW to the bars gradually and soon enough to make a difference.

Figure 6: Low energy holding furnace.

Gas holding furnaces recover faster than electric. But a properly sized holder, with the right amount of KW connected and full proportioning controls can be very efficient. (See figure 6).

REFRACTORY LININGS

Be very careful here. Not all refractory contractors are created equal. Some may not know all the requirements to contain molten aluminum. There are more new products available today for aluminum applications than ever, so don't reline or buy new furnaces today with 40 year-old refractory technology. There are super insulating boards that reduce skin temperature 15-18 degrees. There are super non-wetting hot face materials that resist aluminum oxide penetration three times longer than conventional castables. The refractory lining can save on energy cost and reline maintenance cost by using the most cost effective lining for furnaces. The cheapest price is not necessarily the most cost effective. (See figure 7).

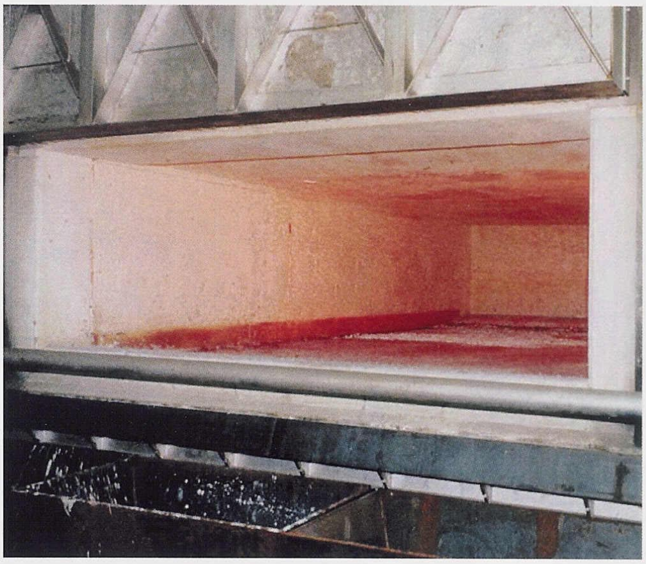

Figure 7: Furnace after 18 months of operation.

CONCLUSION

There are a lot of variables to consider when saving money in any melt department. An in-depth energy audit of the facility is the best way to start, so higher inefficiencies can be fixed first. The bottom line is to look at all aspects of the operating costs in the melt department, from cleaning and fluxing, to gas vs. electric holding to determine what is best for the application and the "bottom line". The energy is there to be saved and it won't be difficult to find.

The customer that had called is now relaxing in his hot tub, comfortable in the knowledge that by implementing some of these ideas and others, he saved his company 21 percent in energy costs. As he drives his SUV to work each day paying $1.65/gallon of gas, he is secure in his job for another year. MAYBE!