FURNACE ENERGY SAVING MYTHS

In traveling across this great land of ours I have found one thing common among die casters and foundries. They are all very concerned with the cost of energy used in their operations. Everything from electricity used per building to the plant air system is being looked at to reduce energy usage. One of the most common areas to look at first is the melting of the metal that goes into producing the part that each particular company makes. It is typically one of the higher usages of natural gas or electricity in the plant. What baffles me is the approach a lot of folks are talking about to reduce the energy consumption in all industrial furnaces.

There are a lot of salesmen selling energy saving ideas. In this article we will weed through the myths and truths of saving energy.

Myth # 1. RECUPERATION

There is a buzz in the industry now for recuperation. How can I recoup all of the energy going up the flues of all of these furnaces? There is a great myth spreading across this country that recuperation will gain the most bang for your buck (in return on investment) where energy saving is concerned.

While there is little doubt that there is a great deal of savings possible in recouping heat lost out a flue, some care needs to be taken as to how far you go with this. Some examples:

1. Keep your recuperated temperatures below 700 degrees F and you will reduce your cost for the system substantially. Below 700 degrees you can stick with mild steel manifolds that are insulated as opposed to stainless steel which has increased in price by 114% over the last 3 years. Even at 700 degree preheated combustion air you can save 25% in fuel usage. Based on numbers produced by a major burner manufacturer at $10.00 per MMBTU's on a 4,000#/hr radiant roof melter, you can expect to pay about $85,000.00-$100,000.00 more for a burner system using a recuperator installed and save about $54,750.00 per year or have a 17.4 -24 month payback on this investment differential. Actual costs may vary due to age of furnace and components or type of furnace and number of burners.

2. The newest heat exchanger on the market allows you to turn the system off during cleaning and fluxing. If you do not buy this one make sure you damper the flue gases to be able to bypass the exchanger when you flux the furnaces. Otherwise you will see excessive wear and maintenance on the heat exchanger.

3. Change the nozzles in the burner to stainless steel to handle the additional temperature of the pre-heated combustion air.

4. You might want to consider (on an older furnace) changing to a ultra low NOx burner. As you increase combustion air temperature your NOx emissions go up.

Mercury Marine 5000 lb/Hr AL Melter Recirculation
Payback for Regenerative/Recuperative

		Cold Air System	Recuperative System*	Regenerative System
Installed Capacity	MMBTU/Hr	10	7.5	6
Used Factor	Percent	0.65	0.65	0.65
Average Fuel Usage	MMBTU/Hr	6.5	4.875	3.9
Annual Usage Hours	Hour	7500	7500	7500
Annual Fuel Usage	MMBTU	48750	36562.5	29250
Fuel Cost/MMBTU		$10.00	$10.00	$10.00
Annual Price for Fuel Total		$487,500	$365,625	$292,500
Fuel Savings per year			$121,875	$195,000
Approx Equipment Cost		$101,900	$170,500	$230,850
Approx Installation Cost		$85,000	$105,000	$210,000
Total Installed Cost		$186,900	$275,500	$440,850
Installed Diff vs Cold Air			$88,600	$253,950
Payback vs Cold Air (yr)	YR		0.73	1.30
Installed Diff vs Recup				$165,350
Payback vs Recup (yr)	YR			2.26

* Recuperative system based on 750degF preheat

Myth #2 REGENERATIVE BURNERS ARE TOO EXPENSIVE!

In most cases from a strictly up front cost basis recuperation will give you a faster payback than does regeneration on smaller 6,000#/hr and less furnaces. When you get into the big guys, that is where the regenerative burners really begin to pay off. In the same 4,000#/hr furnace with a regenerative system on board you will have a differential of about $250,000 vs conventional burner system and your payback will be about 2.73 years. Depending upon the type and age of the furnace you are installing the equipment on this will vary. For these examples, we are using new furnaces. Certainly if your furnace is melting metal at a high end 1800-2000BTU's/# of metal melted then the ROI becomes more lucrative. The myth has been that regenerative burner systems are too costly. When gas reaches $10.00/therm you can afford to look at regenerative. If you are looking at buying a 7,000#/hr melter with regenerative burners to replace a high headroom gas guzzler that melts at 2,000BTU's/# of metal melted, you will see a savings of over $500,000.00 a year in fuel cost. That ROI is less than two years. Based on $10.00/therm. Raise the gas cost to $13.00/therm and your savings becomes $649,987.00/year or a 15-18 month payback depending upon the options you choose on your furnace. This folks is a no brainer. Gas is not likely to come down anytime soon. {These figures are based on 7,000#/hr for 20 hrs of melting a day, 340 days a year and $10.00/ $13.00 respectively per 1000 cubic feet of gas}

MYTH #3 FIXED HEAT LOSS IS THE FURNACE MANUFACTURES' PROBLEM

I can't control what the furnace manufacture puts in the furnace. Yes you can! You are the one paying for it. It is your furnace. Demand highly insulated furnaces. Demand reasonable lining

thicknesses. Don't accept cheep linings to save a few thousand dollars when you will loose 10 times that much in heat loss.

This is an area that is very seldom looked at, but can result in substantial saving with what can be minimal cost. What is fixed heat loss? Fixed heat loss is the amount of energy being absorbed into and passing through the lining of the furnace and out the doors and open wells on the furnace. Some examples of fixed heat loss…

1. If the sidewall casing temperature of a given furnace is 205 degrees F (and there are a lot of them out there) you are losing 300BTU's per square foot/ hour off that casing.
2. By simply reducing that to 148 degrees you save 152BTU's/square foot/hour.
3. If you are scheduled to reline the furnace this year or are buying a new furnace next, choose the refractory construction very carefully. So many times we are so focused on the motel metal contact refractories that little attention is paid to the back up material. The old, OLD school of thought was that the freeze plane (the point where the molten metal would solidify if it leaked through the lining) had to be in the hot face or first layer of refractory material. That is just not the case anymore. With newer non-wetting insulating materials available, the freeze plane, can now be further back in the thickness of the lining giving you much more flexibility to highly engineer this lining to not only contain the metal, but actually save energy. Melting furnace casing temperatures are being designed to 125-135 degrees instead of the old 165-185 degrees of just a few years ago.
4. Now this new super insulating materials can be used in the roof and floor of the furnaces to further reduce energy consumption. Some furnaces have to have individual burner controls, just to keep the furnaces from overheating over long weekends, because of this thermos bottle approach to highly insulated linings. We have effectively reduced the fixed heat loss to the point that the burners on the furnace at low fire will overcome the heat losses and actually raise temperature if they are not turned off. Remember when your furnace used to struggle just to hold temperature. That has been eliminated.
5. Covering up open wells will reduce heat loss substantially. An open well of 1300 degree aluminum with a .5 emissivity of the bath surface in the well will lose 8,214 BTU's/square foot/hr. If the average charge well is 8' long by 3 feet wide you are looking at 24 sq. ft. or 197,136 BTU's per hour you are losing off that well. That is 197 cubic feet per hour or 4,731 cubic feet a day x 340 days a year is 1,608,540 cubic feet lost. That is $16,085.40 worth of natural gas@ $10.00/therm lost a year. Cover those wells when they are not in use.

So you can see some simple things will save thousands of dollars a year if you plan out what you are doing from a refractory relining standpoint and from an operational standpoint (covering the wells between charges). A simple $3,500 automated charge well can pay for itself in three months.

MYTH # 5 MY DOORS HAVE ALWAYS LEAKED

Most furnace manufactures know how to make door that sealed originally. Maintain door seals weekly. One of the most common areas in most plants that lose heat is the doors of furnaces. As furnaces get older the jambs wear down and the furnace door gaskets get worn. In older furnaces, these need to be checked and replaced if needed every couple of months. I have seen doors that are supposed to have refractory blades on them that should be penetrating the metal of an open charge well, completely gone. Air infiltrating the furnace at low fire causes excessive oxide growth and flames shooting out of the open area on high fire is another extra flue and is wasting fuel. Invest in a spare door and blade at $6,000.00-$10,000/ door (depending upon the size of your furnace) and recover the cost in a few months in energy savings.

MYTH #6 I DON'T NEED TO PAY FOR FLUE GAS ANALYSIS:

Have a qualified technician check the combustion system for the proper set up. The burner system should be firing stociometric or in ratio, air to gas. Typically in reverb furnaces this is a 10-1 air to gas mixture. By analyzing the flue gases a technician can determine if indeed your system is running at peak efficiency. This can also be done with a manometer to test pressure (inches of water column) of gas and air, if the technician knows the burner manufactures recommended set up pressures. Fuel rich burners produce a colder flame and some of the gas will ignite when it reaches the atmosphere at the flue level. That is usually what is happening when you see a wall of flame coming out your flue. If the burner is set up too lean or excess air you will see a colder flame and a slight increase in oxide formations and dross in the furnace. This may cause the burners to work harder to produce the same BTU's. Either way, setting up the burners incorrectly, will cost the company money.

MYTH# 7 THE SIZE OF THE TERMOCOUPLE DOES NOT MATTER:

Believe it or not some furnace manufacturers still do not get it. The bath thermocouple controls the temperature of the aluminum. When there is no circulation involved thermocouple placement is critical. For example, in a plant in the Midwest recently their bath thermocouple was 24" long. The metal depth was 22" so naturally part of the thermocouple was up out of the well and in a bracket that set 3" off the top of the metal (which is normal). That means that the tip of the thermocouple was 21" into the bath. This is the absolute coldest section of the furnace. They kept complaining that this furnace would drop temperature drastically every time they charged it with cold metal. No kidding!!!

After putting in a thermocouple length that matched the bottom of their tap out block (13" from the top of the metal), the problem went away. Control the metal temperature of the metal you are using. Floor metal temperatures can vary up to 100 degrees in some large furnaces. You will never use the bottom third of your metal. Why try to control temperature there. Now if you are circulating the metal, the temperature will be homogenous throughout the depth. However, why pay more for a longer thermocouple when it is not needed.

MYTH #8: Those #&@*^*&^ Pumps are a Nightmare.

Circulation is one of the best return on investment for your furnaces. Where the hold capacity is 40,000# or above it is almost criminal not to have circulation in wet bath reverbs. Regardless of the manufacture of circulation pump, the pick up in efficiency is minimal 15% to a whopping 35% in some furnaces. That means you can either melt the same amount for less BTU's or melt that much more metal for the same number of BTU's. By keeping the furnace homogenous from top to bottom you virtually eliminate sludging and save energy. Typical cost of adding a pump well to a large furnace is $35,000-$45,000 (depending upon the size), add in $35,000 to $43,000 for the circulation pump and your costs are $60,000-80,000.00. You will see a savings of over $61,036.00 the first year. The numbers used here are 1600 BTU's/# of metal melted x 15% = 240 BTU's/#/hr saved. 4,000#/hr 20 hrs/day 340 days/year X $8.50/therm. You will experience a faster return if you melt more metal and or are currently melting at much higher BTU's/#. With circulation pumps now getting over a years life in some furnaces, this becomes an easy return on investment of less than two years.

Here is an added bonus! Circulation actually reduces metal melt loss. In all types of radiant roof and high headroom gas fired melters the furnace manufacturer relies on High Thermal head temperatures to transfer the BTU's into the bath of aluminum. This transfer super heats the metal at the surface and causes more oxidation of the metal and thus produces more dross. By circulation you strip the BTU's from the surface into the main bath and reduce that surface metal temperature to the point where there is considerable difference in dross formation. This can save you another 1% in metal melt loss.

MYTH # 9 I LOSE MORE BTU'S THROUGH THE OPEN DOOR THAN THE PRE-HEAT HEARTH SAVES ME

I am not sure who is spreading this misinformation, but nothing could be farther from the truth. If you are ready to load before opening the door, the sows can be loaded in less than 5 minutes once the door is open. If the opening is 3' high by 8 feet wide you will lose about 9,000BTU's/hr/sq ft or 216,000BTU's an hour out that opening. So divide that by 60 minutes/hr and multiply times 5 minutes it takes to load, and you only lose 18,000 BTU's x two events per hour or 36,000BTU's lost opening that door.

By placing 2- 1,000# sows on the hearth and letting them pre-heat to a sweat the internal temperature of that sow is 900 degrees F. You are using the heat normally going up the flue and some radiant absorption from the burners to pre-heat these sows. Now once you place them into the bath as you load the next two sows the stored BTU's in the bath help finish the melting process taking the sows very quickly from 900 degrees to melting temperature. This will save you 15% in fuel for that 2000# of aluminum. If you were melting at 1600 BTU's/# and you now pre-heat you are at 1360 BTU's for every # you melt through the pre-heat hearth. If we use that same 4,000#/hr unit as in other studies above, that will save you 19,200,000 BTU's per day. So your net savings is 19,200,000BTU's/ day saved. That alone saves you $61,087.00/year.

Myth # 10 Oxy Fuel Burners Saves Gas

This is a true statement if you look no further than purchased gas savings. However when you add the cost of the Oxygen and the cost of the increased metal melt loss this is one to really watch out for. Oxyfuel or oxygen enriched burners will burn hotter which is of course the selling point of the change to oxygen fired burners. Usually you can melt more metal with these burners installed. But, this hotter flame increases the superheat on the metal surface and causes an increase in dross. Bottom line is if you have oxygen enriched or Oxyfuel burners you must circulate the metal to gain the maximum benefit. Even then the payback is longer than other energy saving projects unless you melt substantially more metal.

	Cold Air	**100 Oxy Fuel**	**Regenerative**
Installed Capacity	20 MM BTU/hr	12 MM BTU/hr	12 MM BTU/hr
Use Factor	0.8	0.8	0.8
Average Fuel Usage	16 MM BTU/hr	9.6 MM BTU/hr	9.6 MM BTU/hr
Annual Usage Hours	8,000	8,000	8,000
Annual Fuel Usage	128,000 MM BTU/hr	76,800 MM BTU/hr	76,800 MM BTU/hr
Fuel Cost/MM BTU	$8.00	$8.00	$8.00
Annual Fuel Cost	$1,021,000	$614,000	$614,000
Fuel Saving Annually	---	---	---
Purchased O_2 Volume	---	21,907 scfh	---
Purchased O_2 Annually	---	175,253,400 scf	---
O_2 Cost/ccf	---	$0.245/ccf	---
Purchased O_2 Cost Annually	---	$429,370	---
Total Fan Horsepower	40	---	90
Electricity @ $0.05/KWh	$11,931	---	$26,845
Total Energy Cost Annually	$1,021,000	$1,043,370	$640,845
Total Saving Annually	---	**($22.370)**	**$380,155**

Aluminum Furnace Combustion System Cost Comparison

None of these energy saving ideas are free. They all cost money to do. However your return on investment over the next 3 years could make the difference in being" in a profitable business" or going through a going "out of business" sale of all the old gas guzzlers you kept.

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