

BACK TO BASICS: **WHEN CHOOSING AN ALUMINUM MELTING FURNACE**



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Sales Support
THE SCHAEFER GROUP

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ARTICLE TAKEAWAYS:

- Understanding each type of furnace
- Furnace energy usage
- Metal melt loss for each furnace

One of the most frequent questions we get asked is: what is the right furnace for my operation? Our next step is to ask questions to get to the heart of what it is you are trying to do. Yes, we know you are trying to make an aluminum casting either by die casting, permanent mold, sand castings, tilt pour, investment casting and of course lost foam.

But other than making lots of parts, what are your goals for this casting? Be prepared to discuss:

1. Goals, in priority: highest quality metal, low upfront costs, energy cost, metal melt loss, and safety.
2. Alloys you are using.
3. Temperature desired to cast your parts and if you are modifying the alloy in any way.
4. Do you want to melt chips or recover inserts?
5. Space you have to work with.
6. Do you need gas, propane, oil or electric fired furnaces?
7. Preference for central melting or machine side melter holders.

Once we have this information and your plant layout, we can better recommend what type of furnace best fits your plant and goals. Let's cut through all the hype that is out there and define the basics of each type of furnace. I will not get into induction melting of aluminum simply because we do not build those furnaces.

FUEL FIRED DRY HEARTH FURNACES

This type of furnace is well suited to knock down and melt heavy solids as cold solids absorb heat readily. Solids are loaded onto a dry tapered ramp and many manufacturers directly fire at solids like sows or ingot bundles loaded on the sloped ramp. The metal loss

from direct impingement of the flame and burner velocities is quite high especially on lighter weight scrap. The efficiency of these type of furnaces ranges from 1800 to 2000 Btu per pound. Because you have two separate chambers (melt and hold) and two separate combustion systems these tend to cost more than a low headroom reverb melter.



Gas fired Dry Hearth Melter

FUEL FIRED STACK MELTERS

This type of furnace is typically used for ingot and scrap melting only. This design is an off shoot of dry hearth as the ingots are loaded into a tall tower (stack) type flue where the stack is supposed to be kept full. At the bottom of the stack is a sloped dry ramp and usually opposing burners firing directly at the stacked-up ingot and scrap. The spent gasses mingle with the balance of the ingot and scrap stacked up in the tower. This allows the flue gases to transfer their heat into the load prior to exiting the furnace at a lower temperature

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SIMPLE SOLUTIONS THAT WORK!

than most other types of furnaces resulting in a greater utilization of heat energy. The efficiency of these types of furnaces ranges from 900 to 1100 Btu per pound. These furnaces are also typically far more expensive. Even though they hold less than reverbs typically hold they still take up about as much room because of their loading mechanism attached to the stack to carry the scrap and ingot up to the top of the stack and dump it. It is highly recommended that you load the hearth from the bottom with ingots before first using the dump hopper to plummet the load of ingots and scrap down on the refractory hearth. Most of these units as well have high melt losses when melting lightweight scrap. Typical die cast and foundry losses are between 5-7% depending upon the density of the scrap.



Tower or Stack Melter



High Headroom Melter

FUEL FIRED HIGH HEADROOM REVERBS

The next most common type of furnace is called a reverb taking its name from years past where a separate chamber that was coal fired reflected its heat off of a sloped wall and the furnace roof to heat the molten bath of metal. Most reverb furnaces are closed box type furnaces with a bath depth of around 22-30 inches. Many have high side walls and the dimension from the molten bath to the underside of the roof is 4 feet or greater. These higher walled furnaces have tall door openings and usually wall fired burners. These burners usually are convective and depending on the type can cause agitation of the metal as they are trying to push the heat into the metal. The efficiency of these types of furnaces ranges from 1700 to 1900 Btu per pound. Many in the extrusion industry use this type of furnace as they have rejected extrusion sections, they need to charge that are bulky. This is commonly known as a batch melter. Most secondaries use these furnaces because of their capability to melt a lot of metal sizes range from 80,000# capacity to 350,000# and more. It is advisable to circulate the metal in these large furnaces to keep the metal more homogenous and the alloying agents in solution.

Sometimes these are referred to as... **Well Melting Furnaces** taking its name from an external well that either scrap or return parts or gates and risers are charged into. These types of furnaces or versions similar are found in the die casting, foundry and secondary industry. The external well is an ideal place to charge dirty scrap and thin sections as there is a greatly reduced metal loss when these items are melted by submersion into a molten bath versus being exposed directly to the products of combustion or direct flame impingement. The other benefit is that the coatings and volatiles are burned off in the external well that is hooded and ducted to a baghouse. Further as most well melters have submerged openings to allow circulation of the hot metal to the well the drosses, oxide and residue from the dirty scrap remain in the well and do not enter the main chamber. The dross and residue are easily skimmed from the well metal surface. The main chamber therefore remains a little cleaner and acts more as the heat sink

Most of these units are side wall fired and have high side walls and tall door openings to accommodate cleaning their large interior areas. The heat absorbed by the main chamber is typically transferred to the well through the submerged eyelets in the hot wall separating

the main chamber from the well charge area. To augment the heat transfer the use of a molten metal circulation pump greatly increases the efficiency of these types of furnaces. The hot metal from the main chamber is pushed across the cold charge in the well greatly increasing the melt rate. With circulation you can gain about 200 Btu's/# or 1500-1700 Btu's/# melted.

FUEL FIRED LOW HEADROOM FURNACE

At the Schaefer Group we have spent many years refining our more efficient type of reverberatory furnace with a lower clearance from the molten bath to the underside of a radiant fired roof. As the majority of all heat transfer in melting aluminum is accomplished through radiation, we have made this aspect central to our design. Using a series of highly radiant burners evenly distributed in the roof we bring this radiant heat source closer to the bath than other furnace manufacturers. Having the heat source close to the bath greatly increases the efficiency of the Schaefer design. We overcome the obstacle of a lower roof by having cleaning access to the main chamber at both ends of the furnace. On many furnaces we then add component aspects that some of the other furnaces' types have, depending on our customers particular needs. Many of our units have a preheat hearth at one end. This feature allows for sow and ingot loading at one end in a manner without the metal losses that occur in a dry hearth as we draft the waste gasses across the sows minimizing the metal losses. Once they sweat then they are pushed into the hot metal bath where the stored Btu's in the aluminum help finish the melting process.



Low Headroom Melter



Electric "in cell" melter

We also add external side wells that allow easy charging of returns, gates and risers back into the furnace. We combine this with a properly sized circulation pump for the greatest available efficiency in well melting. When we combine all the best features along with a properly insulated lining you end up with a furnace that has an efficiency of from 1230 to 1500 Btu per hour fuel usage when melting and a furnace that provides or minimal metal losses (3-4%).

ELECTRIC HOLDING AND MELTING FURNACES

The Schaefer Group is the inventor of the electric radiant reverb, supplying the first unit in 1974. Electric melters and holders have far lower metal loss than a fossil fueled furnace either at or below 1%. Melting can be accomplished at .20 -.23 kW which equates to approximately

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785 Btu per pound and holding in our low energy holders that utilize electric immersion elements can be accomplished in the 18-20 Btu per pound range if you convert the electric usage to Btu's. We happen to think that this will be the foundry of the future using electric melter holders at the machine to give high quality inclusion free aluminum to the machines.

CRUCIBLE MELTER/HOLDERS

Let me start by saying that if you are comfortable using crucible furnaces, you really don't know how much they cost you a year. With worker comfort issues, maintenance, crucible bowl costs, downtime, reline costs when they leak (and they will leak eventually) and workers comp or safety costs associated with these units, they can cost more than the dollars you save in space, metal inventory (3-1 hold to melt ratio) and lower upfront costs.

Crucibles have their place, don't get me wrong. If you change alloys a lot, shut furnaces down often for extended periods of time and have extremely limited space, then you really have no choice but to go to another crucible furnace. Also remember crucible furnaces do not recover very quickly so they must be very evenly charged. Whatever you take out in 15 minutes you put back in as scrap or ingots.

There are some ways to eliminate some of the headaches involved in crucible melting and holding at the machine. Pay particular attention to the design approach in making crucibles. There are a lot of companies out there offering quick change electric elements - because you have to change them often. Elements should last at least two years. Some companies use only one burner on large units and they should be using two.



Gas fired Crucible



Electric Crucible Elements

BASIC ADVICE ON CRUCIBLE OPERATIONS

- Never allow a bowl to be drawn down more than 4 inches. After that the temperature differential at the top of the bowl and the middle is so great that the top expands and cracks prematurely.
- Do not allow ingots to be dropped into the bowl. This can cause the cracks to occur in the bottom of the unit. With a little pre-planning and care you should be getting a year or more of life out of your crucible bowls.

We have always taken basic melt rates very conservatively in order to ensure good crucible life and metal quality. Through years of experience of foundry men pushing melt-to-hold rates on crucibles at 2 to 1 range have resulted in drastically reduced life. Also, many times chilling or sludging results, causing alloy desegregation, inclusions and

metal chemistry problems. Due to these facts, we have gauged our melt rate on the conservative side. We have a minimum 3-1 hold to melt ratio and a lot of times go to 4-1 to ensure a more even temperature. If a customer wants to melt beyond rated capacity then make sure the furnace has the input power to perform the task.

Evenly charging the furnace with ingot or small scrap (while it is still hot) will increase the efficiency of a crucible furnace. The rule of thumb is put in whatever you take out every 15 minutes. Unless you are casting very large sand castings or permanent mold casting that require most of the liquid metal in the bowl do not batch charge a crucible! It will greatly reduce the life of the silicon carbide bowls.

Follow these few guidelines to minimize down time usually associated with crucible furnaces.

METAL MELT LOSSES

This also is a good time to discuss the value of metal lost.

Here is a recap of their typical metal losses.

Dry Hearths Direct Fired: 3-3 ½% based on firing at large solids

Dry Hearths Direct Fired: 7-12% based on firing at scrap ranging from beefy sections to light gauge

High Headroom Side Wall Fired: 3½ to 4% based on melting heavy solids

High Headroom with External Charge Well: 3- 4 % majority of melting done in well of clean materials

Stack Melters Direct Fired: 1% when melting all ingot and 5-7% when melting a lot of lightweight scrap.

Low Headroom Radiant Roof Melter: 3% average based on mixed load melting

Electric Glow Bar Melter: 1% or less average based on ingot and/or scrap melting in the charge well.

Crucible Melters: 4-5%

EXAMPLE

If we were to add an additional ½% of metal loss to your operation of 7,000# per hour melt rate based on a three-shift operation, here are the numbers you would be losing. Today on the spot market Aluminum had a value of \$1.00s a pound:

- 1% of 7,000 pounds is 70 Pounds per hour X 20 hours of melting a day equals 1400 pounds at a value of \$1.00/# equals \$1,400.00 dollars a day or if production runs 325 days per year that is \$455,000 dollars over a year.

That's on just on one furnace! As you can see choosing a furnace that consumes less energy and has a lower overall melt loss can save your company big money.

Little things to help furnace efficiencies:

1. Install well covers whenever the furnace is idle for longer than a half hour.
2. Install a half flue cover over the flue during long idle conditions. Warning: You must remove flue cover before turning the furnace to high fire. At low fire the flue opening is still sized for 100% output of the burners. If you do not have automatic flue pressurization your holding efficiencies will drop considerably. The furnace may not have to be on high fire as much.
3. Make sure the furnace is used at full capacity and charged at a quarter of its hourly rated capacity every 15 minutes. Overcharging the furnaces causes dramatic swings in temperature and increased sludge build up on the floor of the furnace. The more sludge you have on the floor the less likely your furnace will melt at rated capacity. The furnace may not melt anywhere close to

the Btus/lb of metal melted, which it was designed to do.

4. Reduce your molten metal temperature over weekends by 20° or more if feasible.

5. 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 your melters. Over fluxing of the walls can break down the binder in the refractory and cause premature erosion of the belly band area.

6. Don't over buy a furnace. Buy only what you need. We (as most furnace manufactures should) connect more power than you will ever need at rated capacity. This gives you a passing gear should you ever need it. Under utilization of the furnace will result in loss of efficiency unless you have the ability to shut burners off or reduce electrical output during the lesser capacity production runs. All of the Schaefer furnaces have full proportioning controls so you only use what you need to melt. The extra capacity is there as a back up when you get power outages or get behind and need to melt more metal than rated capacity.

I know there is a lot to consider when buying an aluminum melting furnace. Spend the time to properly determine the right solution for your company's goals with a furnace that fits your production floor space and provides you with the highest quality metal at the right temperature with the minimum amount of energy spent.



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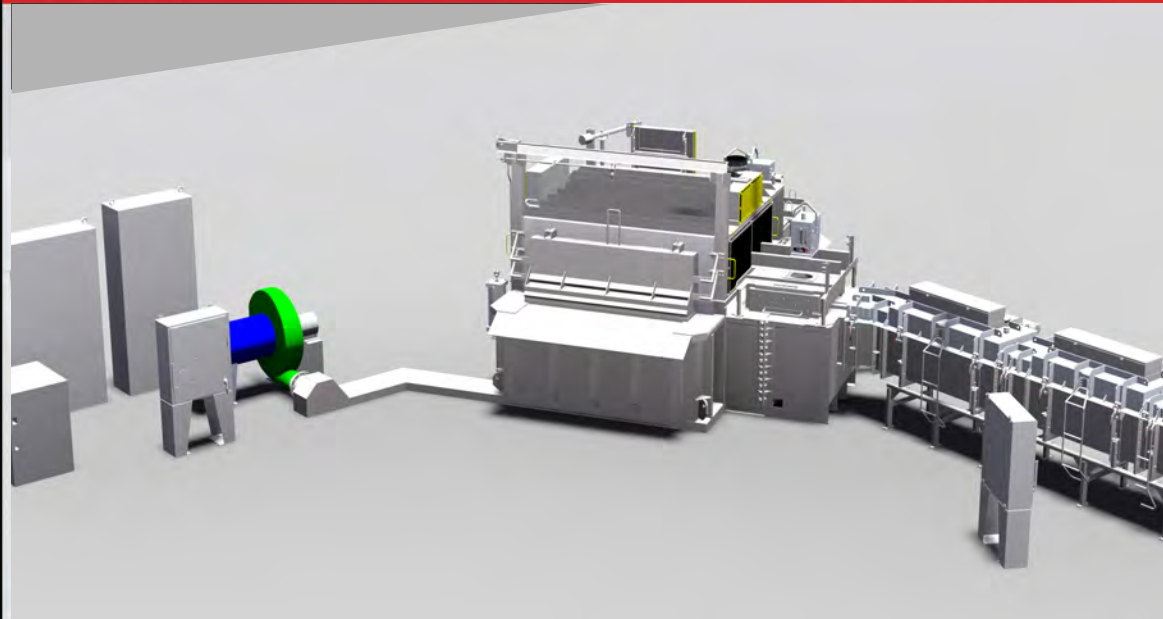
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