CENTRAL MELTING VS. ELECTRIC MELTING AT THE DIE CASTING MACHINE

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Introduction – Senior managers and engineers at Rayteq have been designing and building electric melting furnace equipment for the light metal die casting and foundry industries for well over thirty years. They have specialized in helping die casters and foundries develop and maintain a strong competitive edge by taking advantage of the many benefits offered by electric melting.

Over these years, the author has made some observations about the companies that survive and fail in these cyclic industries. It is interesting to note that the majority of the North American die casting plants that have failed financially have employed central melting systems to melt and deliver their molten metal while many of their competitors that do not use central melting have survived. There are a number of important reasons for this.

Central melting has many limitations and critical disadvantages compared to melting right at the die casting machine, and over the years we have helped many die casting plants partially or completely convert from central melting to electric melting at the machine for some very sound reasons.

Energy Costs – Central melting wastes a ***huge*** amount of expensive energy which is absorbed by (a) the central melting furnace which must superheat the metal to get it through the hot metal distribution system, (b) the hot metal transport system itself, and (c) the holding furnaces at the die casting machines. However, if you melt right at the machine, you completely eliminate (b), and you combine (a) and (c) into a single, more efficient furnace which consumes much less total energy.

Planning for Recessions – Die casting and foundry production has always been highly susceptible to the ups and downs of the economy. While many die casting managers never seem to consider it when they're engaged in facilities planning, central melting can become a heavy burden

DRY HEARTH ALUMINUM CENTRAL MELTING FURNACE

when production drops during a recession. The central breakdown furnace must operate 24 hours per day, seven days per week, and there is a large minimum energy consumption whether the furnace is melting or not. If individual die casting cells are shut down due to lack of work, the central breakdown furnace keeps barreling along, and the energy consumption per pound of metal melted skyrockets. But if you are melting right at the machine, you can shut down the melting furnaces that are not needed and only run the ones that are still

producing, and your melting costs per pound remain the same.

A die caster who was a friend of the author had just installed a new, large capacity gas-fired central breakdown furnace to handle heavier production and was forced into bankruptcy when a severe recession reduced his orders by more than half. He couldn't shut down the reverb because he

WET BATH REVERBATORY CENTRAL MELTING FURNACE

was dependent on it to produce the few parts he was still making. His lean and mean competitors down the street who didn't use central melting all survived and are still in business today. It ended up being a tough lesson, especially because the author had counseled him against it. Unfortunately, over the decades this has happened over and over again.

Labor Costs – Whether the central breakdown furnace is a wet bath reverb, a dry hearth reverb, or a shaft/tower furnace, it requires production operators to charge solid metal, skim and clean the metal surface, and deliver molten metal to the hot metal transport system. Maintenance personnel must constantly repair and patch refractory, keep burners adjusted, and chip corrundum away from the metal line to slow metal penetration into the lining. When the lining wears out they have a major job of relining the furnace which can take several weeks.

If transport ladles are used to deliver the molten metal to the die casting cells, operators are required to preheat the ladles with gas torches and take molten metal from the central breakdown furnace to the holding furnaces. There is always danger from splashing metal and overfilling furnaces which make their workers compensation rates expensive. Maintenance personnel must constantly clean and repair the ladle refractory linings and regularly grease the tilting mechanisms.

If a launder system is used to transport molten metal, there is reduced operator expense but increased maintenance expense as personnel must regularly skim the launder, adjust and replace heating elements or burners, and repair the refractory lining. The holding furnaces must also be regularly skimmed and the refractory patched, thermocouples repaired and replaced, and heating elements or burners adjusted or replaced. Launder system users also complain that the launders effectively blockade the plant floor, making it difficult for personnel and fork trucks to move around the plant.

GAS-FIRED TOWER/SHAFT CENTRAL MELTING FURNACE

But if Rayteq electric furnaces are used to melt right at the die casting machines, (a) all central breakdown furnace operators and maintenance personnel are eliminated, (b) all molten metal transport operators and maintenance personnel are eliminated, and (c) all refractory maintenance personnel are eliminated for the holding furnaces. The die casting machine operator or an automatic ingot charging machine takes over the job of charging the furnace when signaled by Rayteq's non-contact molten metal level sensor which paces ingot additions to attain close temperature control. No additional operator is needed for the furnace.

Maintenance consists of replacing the bath thermocouple every six months or so, and the crucible once per year, and after a few

years, possibly a few heating elements. All of this work can be done over a weekend so production can promptly resume Monday morning. There is no refractory lining to patch and repair and the extended downtime for furnace relining is eliminated. Only one fork truck operator is needed, probably on a part time basis, to bring pallets of aluminum ingots to each die casting cell. Thus the labor cost saved through melting at the die casting machine is substantial.

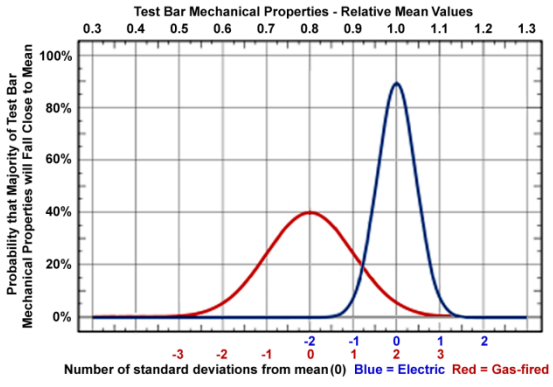
MELTING RIGHT AT THE DIE CASTING MACHINE WITH RAYTEQ ELECTRIC ALUMINUM MELTING FURNACE

Making Electric Melting Competitive – Although the price of natural gas is down right now while electricity costs for the most part have not dropped, Rayteq has leveled the energy playing field through the successful development of its *Fleet Commander*^{tm} kW demand management system that effectively slashes the cost of operating small to large fleets of Rayteq electric furnaces by reducing the demand portion of the user's electric utility bill. This unique system is only available from Rayteq and is now contributing substantial savings at a growing number of die casting plants.

High Investment Cost – Central melting systems, and especially shaft/tower melters, together with transport ladles or launder molten metal distribution systems are inherently much more expensive than Rayteq furnaces melting at the machine because much more equipment and costly floor space is required for central melting.

Metal Quality – Central melting produces lower quality metal because central melters are nearly always gas-fired, and gas-firing contaminates the metal because the water vapor in the products of combustion reacts with the aluminum to form dross and oxide (hard spots) and hydrogen porosity (please see separate white paper on this subject at www.Rayteq.com). The situation is made even worse because of the need to superheat the metal in the central breakdown furnace to overcome the heat losses in the molten metal transfer system, and superheating geometrically increases the reaction rate between the water vapor in the combustion products and the molten aluminum. Also, the two molten metal transfers between the breakdown furnace and the transport ladle, and between the transport ladle and the holding furnace, further contaminate the metal (again, please refer to the same white paper). By contrast, Rayteq furnaces provide superior, high quality electrically melted metal, and the metal quality is further enhanced because both of these harmful transfers are eliminated.

Structural Die Casting – Electrically melted metal typically yields castings with 20% better mechanical properties due to the elimination of water vapor from the products of combustion in gas-fired furnaces, which makes Rayteq electric melting right at the machine particularly beneficial for producing high-strength, high ductility structural die castings on vacuum-equipped die casting machines.



STATISTICAL BELL CURVES OF MECHANICAL PROPERTIES FOR GAS-FIRED VS. ELECTRICALLY MELTED ALUMINUM

Water vapor-free electric melting also reduces magnesium and strontium "fade," while quickly turning freshly-melted alloy into castings inhibits time and temperature dependent sludge formation which can result in casting "hard spots" and weakened mechanical properties.

Even the largest capacity structural die casting machines can be supplied with clean, high quality metal melted right at the machine by installing tandem Rayteq furnaces and using alternating automatic pouring ladles. Immersion tubes can be employed to boost peak melt rates up to 1,250 lbs/hour per furnace or 2,500 lbs/hour for tandem furnaces.

Metal Loss – Fuel-fired melting typically consumes 4% to 6% of all metal melted in crucible furnaces, 5% to 8% or even more in reverb furnaces, and 3% to 5% in tower/shaft melting furnaces (regardless of exaggerated claims suggesting much less) where water vapor in combustion products directly impinges on the metal. Again, because there is no water vapor generated in an electric furnace, the metal loss is typically only 1% to 1½%.

CLEAN MOLTEN ALUMINUM BATH SURFACE WITH ELECTRIC RESISTANCE MELTING

The potential metal loss savings can be considerable. For example, if you are gas melting 250 lbs/hr at a single die casting cell over a single 8 hour shift, 5 days per week, your melting will total around 520,000 lbs per year. If die casting alloy costs $1.10 per pound, and gas-fired metal losses are 5%, the cost of metal loss will be $28,600 per year. But with an electric furnace with metal losses of 1½%, the annual cost will be only $8,580 per year, for a metal loss savings of $20,000 per year. If you run two shifts per day, the savings will double to $40,000 per year. And when you are running multiple die casting machines and using gas-fired central melting, the savings quickly becomes substantial. Thus metal loss savings can pay for the cost of electric melting furnaces very quickly, and this is obviously a major factor favoring electric melting.

Temperature Control – Temperature control of the molten metal bath can be critical and is often cited as a major reason in favor of central melting because adding aluminum ingots to the bath next to the machine can sometimes cause temperature fluctuations. However, Rayteq has resolved this issue through the use of its unique non-contact molten metal level sensor which paces the operator or ingot loading machine by providing a signal at the precise moment when an ingot should be added. Today, many die casting plants all over North America have the ability to run a different bath temperature at each machine, and yet control that bath temperature to a very narrow operating range.

Monitoring and pacing ingot addition smooths out temperature swings and makes temperature control very accurate and even. Melting at the machine also eliminates the central melting problem of under-temperature molten metal arriving at the holding furnace. When this happens, die casting operations may have to stop to avoid producing castings with cold shuts until the holding furnace can bring the metal temperature back to normal, and this may take a long time as holding furnaces are notoriously under-powered.

Alloy Flexibility – Die casting plants with central melters can only supply castings made from <u>one alloy</u> unless they are prepared to add additional, expensive-to-operate, space grabbing central breakdown furnaces. If their customer wants castings made from a different alloy, and in recent

years many casting buyers are specifying some of the new and improved alloys, there is no way to do it, so they lose the business and sometimes the customer as well. This is often the reason central melting die casters first look for new furnaces to melt at the die casting machine—they've lost a good customer because they can't melt other alloys and want to find a way to get the business back. In contrast, by melting right at the machine with Rayteq electric melters, die casters can melt a different alloy at every machine if they need to and keep the business. Custom die casters really need this kind of alloy flexibility to serve the varying needs of their customers, and central melting simply cannot accommodate them.

Floor Space – Central melters with hot metal delivery systems and holding furnaces require an excessive amount of expensive floor space. By eliminating central melting and instead melting at the machine with compact Rayteq electric furnaces, floor space can be made available for more productive uses.

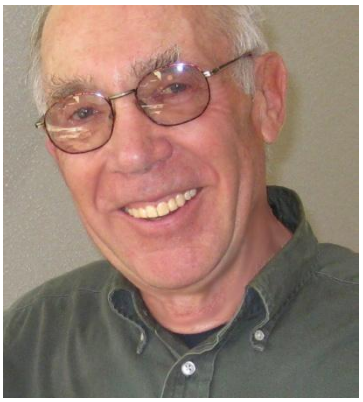
Rayteq's Electric Furnaces – Not all electric melting furnaces are equal, and we like to think that Rayteq offers many advantages over competitive furnaces. Our electric melting furnaces offer completely silent operation, cool outside steel shell temperatures which keep operators comfortable, virtually eliminate air emission problems, etc. Operators love to work around our furnaces, particularly in the hot summer months, when inside plant temperatures can be uncomfortably high. Rayteq electric melters currently offer the highest melting rates per square foot of occupied floor space. Seventeen models of Rayteq furnaces are available in a full range of sizes from 450 pounds capacity with a 225 lbs/hour melt rate all the way up to 4,200 pounds capacity with a 1,250 lbs/hour melting rate. Thus there's a Rayteq furnace to fit nearly every application for aluminum melting.

RAYTEQ ELECTRIC FURNACE MELTING RIGHT NEXT TO 950 TON BUHLER-PRINCE DIE CASTING MACHINE

Rayteq Heating Elements – The heating elements used in electric resistance melting furnaces are clearly the heart of the furnace, and the design of these elements is critical to furnace performance and reliability. Rayteq has pioneered the development of its heating elements which now have the highest power density and the longest proven operating life in our industry. To compare Rayteq heating elements with competitive elements, simply visit www.rayteq.com and look under "White Papers" for a full discussion and comparison of most of the heating element systems currently on the market.

RAYTEQ HIGH POWER DENSITY, LONG-LIFE ELECTRIC HEATING ELEMENT

About the Author



FRANK B. SMITH – AUTHOR AND PRESIDENT/CEO OF RAYTEQ LLC

Furnace Building Experience – Between Rayteq and my previous company which I founded and solely owned and operated for 20 years, I have designed and built more than 2,000 electric resistance crucible-type melting and holding furnaces, the majority of which are used in the die casting industry. Thus a die caster who chooses to go with Rayteq electric furnaces will be working with a very experienced electric furnace manufacturer.

First Steps – Please bear in mind that changing over from central melting to electric melting at the machine doesn't have to happen all at once. You can begin by converting one or two or three die casting cells and watching the results. If you like what you see, you can continue the process until the central melting system is no longer needed and can be dismantled. In the end, when the process is completed, your die casting plant will be lean and mean and nimble with greatly reduced labor, utility, maintenance, and metal loss costs for the same manufacturing output, and will be able to respond to the changing needs of your customer base by offering custom die castings from any aluminum alloy poured at any temperature. Perhaps more importantly, it can also better weather the inevitable recessions by eliminating the large fixed overhead costs of central melting.

A Word of Caution – The most difficult part of making a change like I have described above is convincing the plant personnel that such a change will be for the better. In my experience, the shear momentum of *"central melting is how we've always done it around here"* is a **very** powerful force, and has kept companies that desperately needed to eliminate central melting from making the change. From my past experience, I can tell you that some heavy arm-twisting and hard selling to central melting plant personnel will likely be needed. But in the end, the change will be very worthwhile and might well preserve the company's future along with the jobs of its employees. Having a strong partner assist with the conversion is essential, and anyone who asks Rayteq to help them take on this challenge will have Rayteq's full support if they decide to give it a try.

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