FURNACE IMPROVEMENTS THAT WORK

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ARTICLE TAKEAWAYS:
- Return on investment in 16 to 28 months
- Cutting-edge enhancements for sustainability
- ROI prioritized enhancements by highest return

In the competitive landscape of aluminum production, operational efficiency isn't just a goal—it's a necessity. This article explores the transformative impact of adopting advanced furnace technologies and enhancements in aluminum foundries. By investing in smarter furnace designs a materials, foundries can not only achieve significant energy savings but also enhance their overall productivity and profitability. From strategic upgrades that promise rapid ROI to innovations that prolong furnace life and improve performance, we'll guide you through the essential facts and figures that demonstrate how optimized furnace operations can advance your business. In this article we provided tactics from practical improvements to cutting-edge solutions that could redefine the economics of your aluminum melting processes, making them leaner, greener, and more cost-effective than ever before.

STRATEGIC EXPENDITURES FOR MAXIMUM ROI

Identifying the most effective expenditures for aluminum furnaces can significantly enhance your ROI, prioritizing from fastest to slowest payback.

Optimal Furnace Design and Cost-Effective Materials

- Furnace Designed for Efficient Cleaning: Large central melt furnaces, exceeding 50,000 to 60,000 pounds capacity, challenge manual cleaning due to their size. Utilizing mechanized cleaning methods such as fork trucks is advisable. Traditional single-end clean-out doors restrict access, creating hidden corners and complicating the cleaning. This leads to oxide build-up which necessitates premature relining. A solution is to use full-width double-end doors allowing better access and easier cleaning and prolonging the lining's life
- Factors in selecting refractory lining: Investing in high-quality furnace linings is crucial. Modern central melt furnaces use 80% to 90% alumina non-wetting hot face linings, which are easier to clean and maintain, especially around critical areas like the belly-band. For those considering cost-saving on linings, a 70% to 85% alumina phos-bonded plastic refractory may offer better durability compared to lower-quality alternatives.

Super Insulation of Furnace Linings

Implementing advanced insulation materials like micro-porous silica can drastically reduce energy loss. This insulation maintains essential thermal dynamics such as the "freeze plane" while adding about $18.00 per square foot to the lining cost, with an average ROI period of 16 to 20 months.

SOW Pre-heat Hearths

Pre-heating half of the aluminum input (assuming a 50/50 mix of new metal and scrap) for about 30 minutes can reduce the energy needed by 12% to 15%. This practice usually achieves an ROI in 20 to 24 months, considering a typical operational schedule. (Based on 5,200 hours of melting per year.)

Molten Metal Circulation

Enhancing the circulation within the furnace can save an additional 9% to 12% of energy. Advancements in molten metal pump technology have reduced maintenance needs significantly through more rapid melting and reducing sludging and convectively maintaining a homogenous bath temperature. Enhancing circulation through circulation pumps and transfer pumps produces an ROI in 24 to 28 months. Overflow pumps are extremely efficient and provide less turbulent transfer into the transfer ladle.

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Regenerative Combustion Systems

Regenerative burners are paired burners that use exhaust from burner A to preheat air for combustion in burner B, and back to A in a preheating cycle. Harnessing heat from combustion exhaust a paired heater draws in combustion air and preheats the air significantly, saving energy. Adding a regenerative combustion system to the enhancements mentioned in 1 thru 4 can lower energy consumption to between 900 and 1050 BTU per pound of melted aluminum in a fully utilized melter. The significant upfront cost can be offset within about 60 months, depending on operational capacity and energy prices.

NOTE: If the first four items above are furnished on a furnace, a fully utilized central melter will melt at about 1235 BTU/lb in a SGI radiant roof-fired reverb furnace, and at about 1,590 BTU/lb in a SGI high headroom wall-fired furnace. This is all being accomplished in a wet-bath reverb furnace, which absolutely provides the aluminum foundry the lowest metal melt loss by several percentage points.

Recuperators

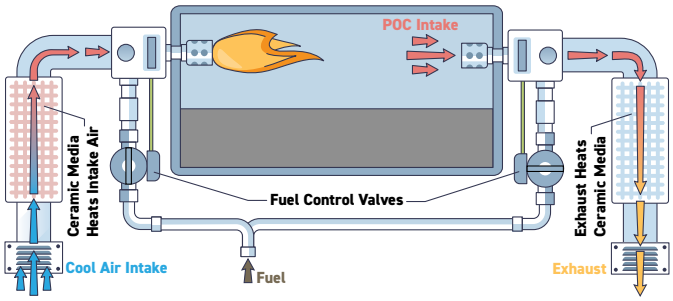
Installing recuperators can immediately save the BTUs needed to heat combustion air up to 700°F, often reducing fuel use by 19% to 25%, with an ROI averaging around 20 months. Placing covers on any wells not in use for over 30 minutes can prevent significant energy loss at high temperatures.

Well Covers

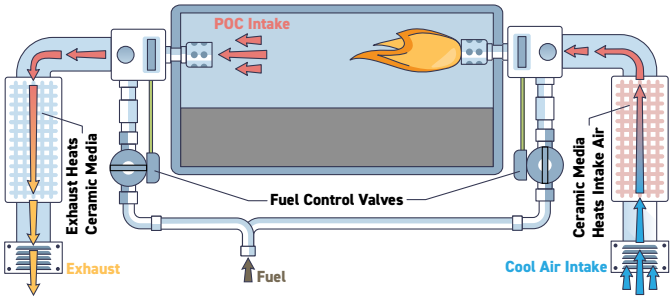
Well covers should be placed on any open well that will be out of production for more than 30 minutes. At higher temperatures 1400°F you lose approximately 7,800 BTU/square foot/hr of surface area off an open well with some dross on the surface. Since the average charge well on a large reverb is about 30 square feet, that is 234,000 BTU/hr off that well.

Calculating the return on investment shows that, while some items are significant investments, they are investments that will save money and produce better products while gaining efficiency in your shop.

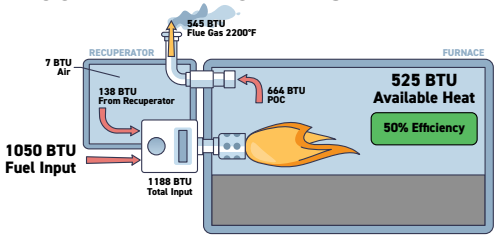
REGENERATIVE BURNERS CYCLE A



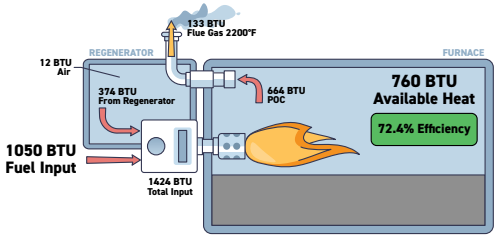
REGENERATIVE BURNERS CYCLE B



RECUPERATIVE BURNERS



REGENERATIVE BURNERS



HARD ENERGY USE NUMBERS

Gas-fired Furnaces
Combined, enhancements improve efficiency from 34% to 72%

- A well designed and fully utilized radiant roof fired melting furnace will operate between 1,500 and 1,600 BTU/lb. (34% efficiency. Based on 100% cold metal charging)
- Easy energy enhancements like lining super insulation, sow pre-heat hearth and metal circulation can improve efficiency to around 1,235 BTU/lb. (41% efficiency)
- Additionally improving the system with recuperation increases output to 1,095 BTU/lb. (50% efficiency)
- Layering in regenerative burners sees efficiency improve to 940 BTU/lb. (72% efficiency)

Electric Radiant-roof Furnaces
See a reduction from 0.24 kWh/lb to 0.18 kWh/lb with efficiency enhancements of 66.7% increased to 76.3%.

- Electric reverb operates at .23-.24 kWh/lb 784 BTU/lb. (67% efficiency)
- Add molten metal circulation 21-22 kWh/lb to 687 BTU/lb. (72.8% efficiency)
- Additionally, immersive element melter 18-19 kWh/lb to 655 BTU/lb. (76.3% efficiency)

Crucible Furnaces
Gas: Connect 3,000 BTU/lb of metal melted. Uses about 2,300 BTU/lb melted and is 32% efficient.
Electric: Connect 0.31 kW/lb of metal melted. Uses about 0.25-0.27 kW/lb of metal melted and is 48% efficient.

Tower or Stack Melters
Generally, connect about 1,800 BTU/lb of metal melted and use about 1,000 BTU/lb of metal melted when the stack is kept full, which puts them (depending on their fixed heat loss) into the 74% efficiency range.

ENERGY SOURCE VALUES

- **Natural gas:** 1,039 BTU per cubic foot
- **Propane:** 91,452 BTU per gallon
- **Motor gasoline:** 120,238 BTU per gallon
- **Diesel fuel or heating oil:** 137,381 BTU per gallon
- **Electricity:** 3,412 BTU per kWh

EXECUTIVE SUMMARY

It's crucial to understand and monitor your current energy usage to effectively manage and reduce costs in any foundry or die-casting facility. Following Peter Drucker's advice, "If you can't measure it, you can't manage it," remains as relevant today as ever. Know what your present melting and holding costs and take these measurable steps to see their financial benefits.

This article focuses on steps and their financial benefits to optimize furnace operations for efficiency and ROI.

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