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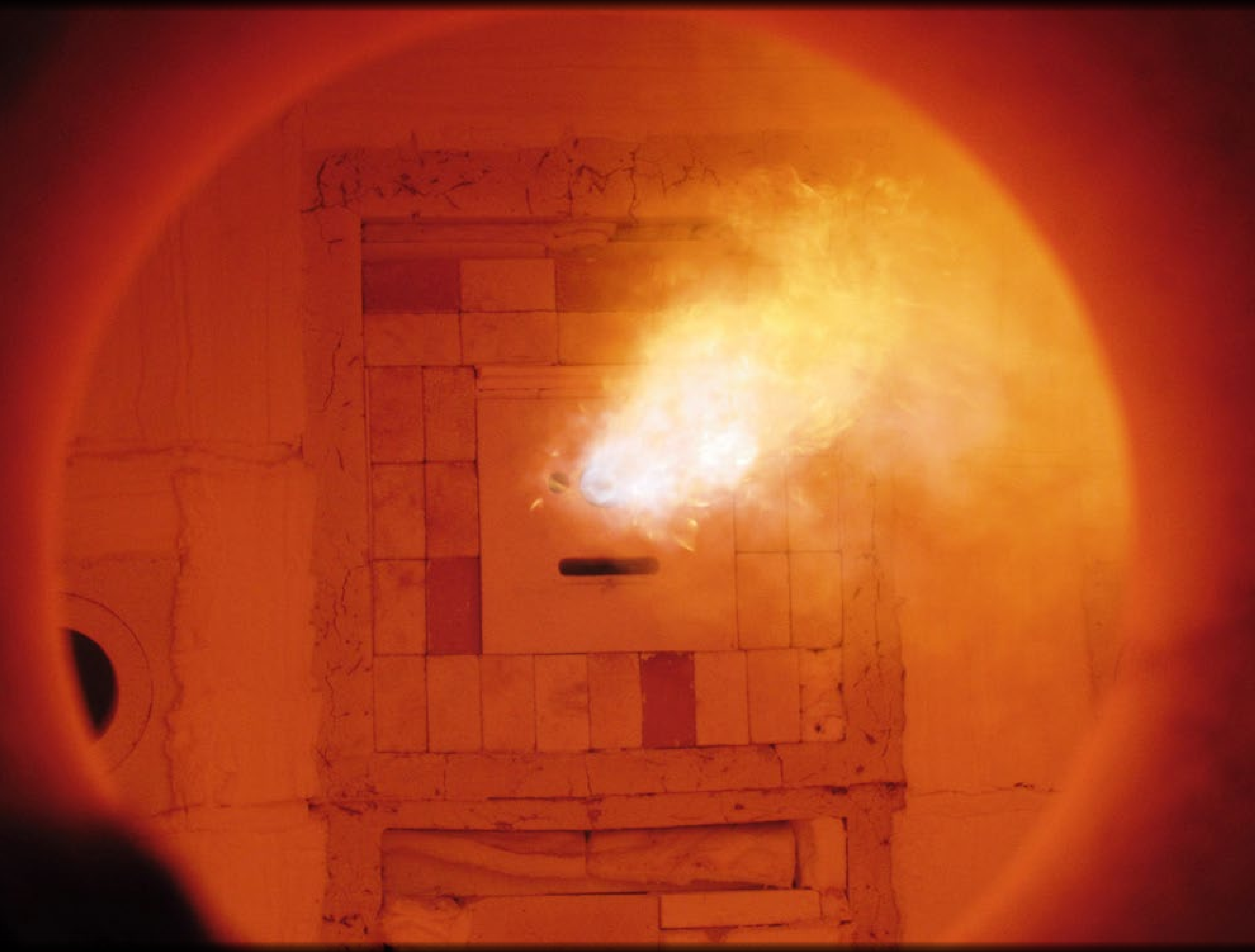

• Novel Oxy-Fuel Boost Burner Reverb Retrofit

Reverberatory furnace at Sapa fitted with adjustable heat release oxy-fuel burners.

Customized Combustion Solution Yields Productivity Improvement for Aluminum Extruder

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Aluminum demand in the U.S. and Canada increased 5% in 2014,[1] and continued growth is expected in the coming years across many key markets, primarily due to the increased aluminum use in automotive applications. Aluminum sheet, die casting, and extrusion producers are set to benefit from this trend. Many integrated aluminum plants will see their casthouses becoming a bottleneck as demand increases. In order to increase melting capacity, companies can invest in a new facility; add additional melting furnaces; purchase billets, ingots, etc. from the market; or upgrade their existing melting furnaces.

Investing in a new facility is the most expensive and time consuming option due to equipment and construction costs, permitting, and hiring a new workforce. While adding melting furnaces to an existing facility is an option, space is often limited, especially for an older plant that has already undergone numerous expansions. In a majority of cases, the most cost-effective solution is to optimize the existing melting furnaces to increase production. This method allows casthouses to fully utilize existing fixed cost assets, such as charging equipment, casting equipment, and trained workforce, to generate incremental pounds at a low cost.

Retrofitting existing furnaces has its challenges because there are often constraints based on the furnace layout, upstream and downstream operations, environmental regulations, and in many cases, extremely limited space. For this reason, most projects are fairly customized. In fact, it is quite common for a site to have four or five furnaces with two or three different designs, so the ideal retrofit solution for one furnace may not be the best solution for the furnace right next to it.

Project Overview

In 2014, aluminum extrusion consumption increased for the fifth consecutive year, rising 7.6% due to growth in building and construction, and transportation markets.[2] The rise in aluminum demand required Sapa—the world leader in aluminum extrusions—to explore options to increase the melting capacity at their Cressona, PA, facility. Given Air Products' long-standing relationship with Sapa at several other locations, the two companies saw this as another opportunity to work together to leverage each other's strengths. Sapa had excess casting capacity available to make extrusion billet, but was limited by the melt rate of the furnaces feeding the caster. The project's objective was to increase the production of a 65,000 lb reverb furnace equipped with a regenerative burner system by 15%.

Optimizing Existing Furnaces with Oxy-Fuel Combustion Systems

Sapa and Air Products evaluated several different oxy-fuel technologies during the initial phase of the project: boost burners, air-oxy-fuel burners, and full oxy-fuel burners.[3] A full oxy-fuel conversion, where the air-fuel burners are removed and oxy-fuel burners are installed, was not warranted given that the existing regenerative burner system was relatively new and efficient, natural gas prices were low, and the perceived risk and downtime of a conversion of this type was not attractive. Retrofitting air-fuel burners with oxy-fuel burners or oxygen lances was another option, where natural gas can be combusted with air, oxygen, or a combination of both within the same burner housing. This has been done on several other reverb melting furnaces to successfully boost production.[4] However, this methodology is most effective when retrofitting air-fuel burners that do not have regenerative or recuperative technology. Replacing the existing burners with air-oxy-fuel burners was also considered but this required more capital and downtime in comparison to the boosting option.

A collaborative study conducted by the two companies during the design phase led to the conclusion that using small oxy-fuel burners as 'boost burners' and strategically placing them in the furnace would be the most cost-effective option in this case. In this configuration, both the regenerative and oxy-fuel burners fire at the same time. Boost burners have been routinely used in the glass industry to increase production and ensure uniform heat transfer. Additionally, installation of boost burners requires minimal downtime and modifications to the furnace.

Project Design Phase: The Sapa casthouse operators and engineers provided Air Products with relevant furnace drawings and operating data. Engineers performed on-site audits to confer with the operators to better understand the charging practices, charge mix, and tending routines. For instance, Sapa personnel routinely had to stir the metal because there were still solids along the back wall after metal in the front of the furnaces was melted.

With this information, a computational fluid dynamics (CFD) model of the existing furnace and combustion system was created by Air Products research engineers. The results of this model confirmed that the back of the furnace was not receiving sufficient heat from the existing regenerative burner system. Increasing the firing rate of the regenerative system was not viable due to burner limitations.

After the base case, different test cases were modeled of oxy-fuel burners at various locations (Figures 1-2). Each case yielded different temperature profiles within the furnace due to the flame interactions between the regenerative burners and the oxy-fuel burners. The objective of the modeling was to select the burner type, position, and heat input rate that optimized temperature uniformity while operating within the normal furnace parameters. The Air Products oxy-fuel burner system with an adjustable heat release profile was deemed a good fit for this boosting application (Figure 3). The computer model confirmed the operators' observations that the back portion of the furnace was colder than the front.

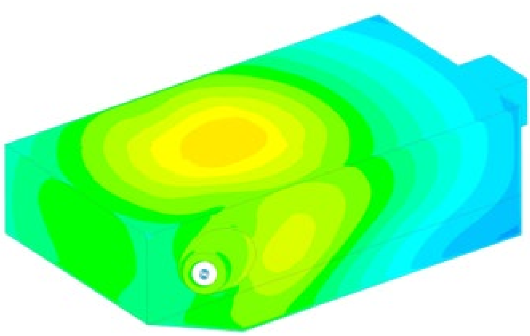

Figure 1. Computer model temperature profile of base case with regenerative burners.

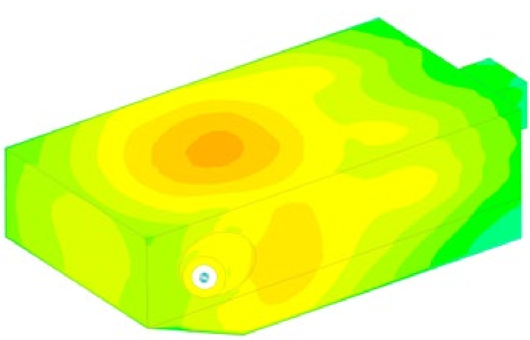

Figure 2. Computer model temperature profile of oxy-fuel boost case with regenerative burners and oxy-fuel burners.

Figure 3. Adjustable heat release oxy-fuel burner.

The computational modeling helped determine the type of oxy-fuel burner best suited for this application, as well as the range of firing rates that would be required during normal operation. The Air Products Advanced Clean Energy Laboratory in Allentown, PA (Figure 4) provided Sapa the opportunity to see the oxy-fuel burners firing at various set-points to help the team visualize how the burners would perform within their melting furnace under various conditions.

Figure 4. Air Products Advanced Clean Energy Laboratory.

Equipment and Installation: In order to minimize cost, Air Products provided a temporary oxygen storage tank and oxy-fuel combustion flow control skid while Sapa trialed the new combustion system. Most of the installation, such as the oxygen piping, natural gas piping, and flow control skid, was completed while the furnace was in operation, which minimized downtime. The refractory blocks for the oxy-fuel burners were installed during a planned maintenance outage (Figure 5).

Matching Energy Input with Energy Demand: Direct-charged reverb furnaces require the most energy immediately after charging. This is due to heat losses experienced while the door has been opened for a prolonged period of time. Also, the charge material is normally at room temperature and therefore acts as a heat sink once it comes into contact with the refractory. After charging is completed, combustion systems generally operate in their high-fire setting until the furnace reaches its set-point temperature. The set-point represents a desired temperature reading from the stack, roof, and/or bath thermocouple.

The oxy-fuel burners at Sapa reduced the amount of time it takes to heat the furnace to the desired set-point.

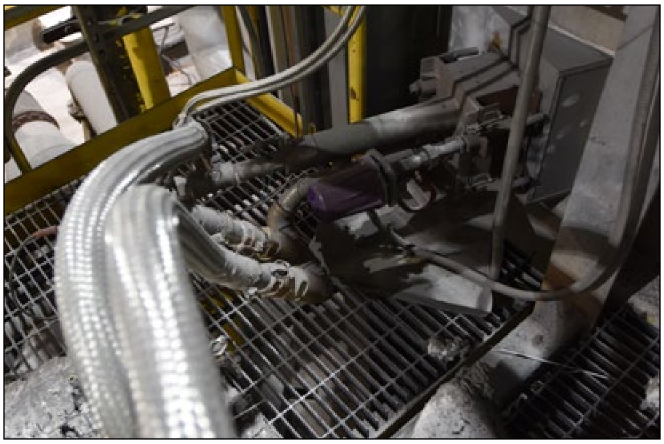

Figure 5. Adjustable heat release oxy-fuel burner installed in Sapa's 65,000 lb reverberatory furnace.

Once the target temperature is reached, the furnace firing rate is turned down using a proprietary heat modulation algorithm to avoid overheating the refractory. The advanced control logic maintains the optimal furnace temperature profile, while minimizing oxygen and fuel usage. By controlling the energy input in this manner, there have been no noticeable changes to refractory life since the burners were installed over a year ago.

Remote Monitoring System: In addition to data collected on-site during the commissioning of the system, a remote monitoring system was installed within the control panel of the flow control skid. This system allowed the controls engineers to track the performance of the oxy-fuel system and optimize the process from Allentown. Performance reports were generated daily and sent to the key members of the project teams.

Summary

Each melting furnace presents unique characteristics from both a design (side well, direct charge, burner system, etc.) and an operational (charge mix, charging equipment, alloying/refining practices, etc.) standpoint. These dynamics require casthouses to thoroughly review all aspects of their process before moving forward with any productivity improvement project. The collaborative efforts between Sapa and Air Products resulted in a custom-designed combustion solution that increased production by 15% on one of their melting furnaces and improved the profitability of the Cressona casthouse.

References

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