Melt Shop Ventilation Upgrade

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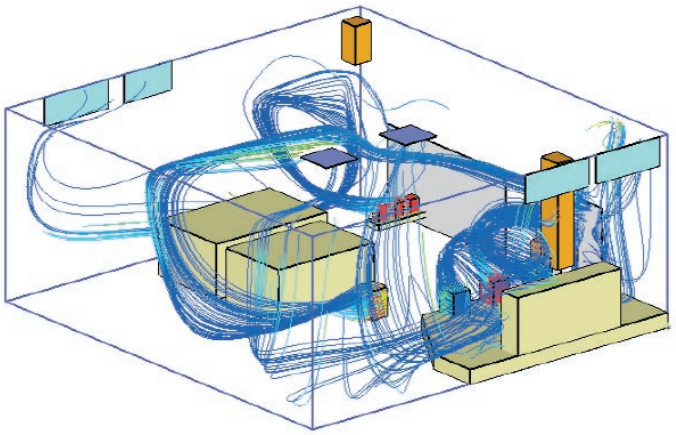
Improving air quality and environmental conditions in a foundry were the objectives for a recent project undertaken by the Industrial Hygiene and Safety Department at Wyman Gordon Company, a division of Precision Castparts Corporation and a leading manufacturer of metal forgings and castings for the aerospace and industrial gas turbine industries. Airpak, Fluent's airflow modeling software, was used to understand better the airflow patterns and resulting contaminant and temperature conditions generated by heat sources, exhaust fans, and replacement air systems. In subsequent simulations, it was used to evaluate several exhaust and supply options so that the best combination and configuration could be selected and tested without incurring costly trial and error expenses.

Worker exposure to metal oxide fumes was a problem in the melt shop when molten metal was poured into molds, even though more than 30,000 cfm of air was being exhausted through fans in the ceiling. Fresh air was supplied to the foundry primarily through a large door opening on one side of the shop and directly in-line with the mold pour area. This air entered at relatively high speed, disturbing the normally buoyant nature of the metal fumes by forcing them towards the workers' breathing zones. Also, a large volume of warm air built up above the workers. Over time, the exhaust fans expelled most of this warm contaminated air. However, a portion continued to recirculate into the occupied area, further deteriorating the working conditions.

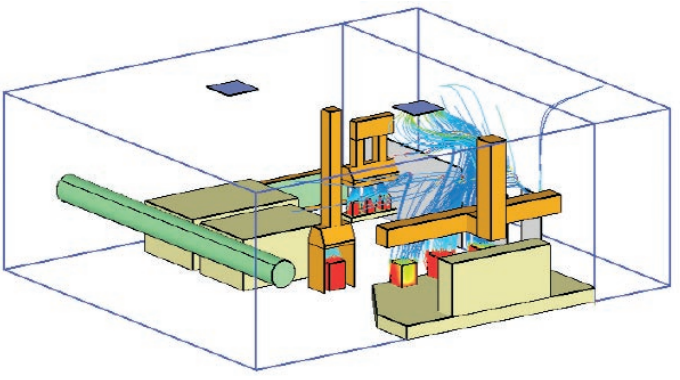
The initial analysis confirmed that heat from two gas-fired furnaces, three electric induction furnaces, and the hot molds was the key driving force for air currents in the shop. It also highlighted the need for considering alternatives to the existing replacement air system.

After the initial simulation, an Airpak model was developed to test whether such changes as increasing the total exhaust rate, relocating the ceiling fans, or extending passive vents from the roof down to the shop floor would be beneficial. The best configuration was found to capture the process fumes before they reach the workers' breathing zone and minimize the downward recirculation of hot air. This configuration consisted of three important components. Close-capture canopy hoods were designed for the pour station and the crucible heating station, one ceiling fan was relocated to directly remove furnace heat, and two new systems were designed to provide replacement air to the shop. The first replacement air system utilizes a perforated duct positioned over an aisle to provide 15,000 cfm on the opposite side of the shop from the pour area, and a second system consisting of a floor-level perforated plenum provides an additional 10,000 cfm near the pour station. Airpak results showed that the low-velocity discharges from these supply systems would not interfere with the local exhaust systems and would actually enhance a favorable airflow pattern in the shop.

To gauge year-round performance, models were run at ambient temperatures of 85°F for summer conditions and 40°F for winter. The results provided the basis for specifying ventilation schemes for each season. Installation is expected to occur in phases over the next year. Once again, as seen with previous Airpak projects at Wyman Gordon, a key benefit gained from using Airpak is the ability for management to visualize how proposed changes will impact existing conditions. For this project, Airpak results were instrumental in getting the necessary support to proceed with the project. In addition, using Airpak allowed plant management to choose a strategy that is in keeping with future plans for the department. ■



Pathlines originating from the heat sources show that airflow patterns in the original foundry design are dictated by buoyant plumes and by replacement air currents that enter the shop from the large door opening on the side (gray)



Pathlines originating from the heat sources show that the low velocity discharges from the replacement air systems on the side walls (green and gold) and other changes in the optimized melt-shop layout improve working conditions in the Melt Shop