



Oven Air Management

In a recent article, we wrote on combustion air flow and we heard from our readers that there is interest in oven exhaust and its relationship with air pressure in the oven baking chamber. In this article, we will share our understanding of the importance and implications of air pressure for oven operation and the relationship of air pressure and air flow throughout the bakery. A proper understanding and evaluation of air pressure and flow throughout the bakery is critical.

Air Management

The primary reason for oven exhaust is to remove products of baking and combustion from the oven which include moisture, VOCs and products of combustion. These materials are exhausted to the atmosphere with or without secondary conditioning for environmental and energy conservation purposes. Within the baking process the oven air flow is guided by a rate of exhaust such that the bake chamber is maintained in a negative condition relative to the atmospheric pressure in the bakery. This is to prevent out-gassing of the baking by-products and ensure an adequate and controlled air flow through the oven to compliment the baking process.

Air Management Challenges

When operating the oven there are many variables to consider that impact the demands on the oven exhaust. Ultimately this is all influenced by the recipes of the various product(s) being baked. The recipes will dictate the amount of moisture, VOCs, products of combustion, oven speed (bake time), temperature requirements and through-put of product. These in turn will define the necessary rate of oven exhaust. This rate of exhaust is influenced by the other operating conditions in the bakery and they must be considered to ensure the desired product quality is met and maintained.

Another contributor to effective air management is outside air conditions. The outside air temperature and humidity influence the air conditions and air flow in the bakery. This clearly can be a greater or lesser challenge depending on the bakery location but in the end it does generally impact all bakeries and their ovens wherever the bakery is located. In northern climates cold temperatures place demands on the bakery to increase and control ambient air temperatures and generally experience drier conditions throughout the bakery that impact the performance of the ovens and the bake. In the southern regions high levels of humidity and higher temperatures become the challenge. And whether you are in a cold or hot climate neither is immune from the complications caused by seasonal changes impacting operational performance daily or monthly.

Thus, air management in older bakeries is critical and more challenging but can be managed if production and maintenance personnel are aware and sensitive to the air flow needs of the oven.

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In the case of new bakeries, the baker has the unique opportunity to work closely with their architect or designer to incorporate the correct configuration of air management equipment to ensure proper air flow throughout the bakery and most particularly for the oven.

Plant Environment - Negative Air Pressure

In the absence of a comprehensive plant air make-up air system, typically building supply air is available through passive openings in the building envelope or induced by mechanical exhaust (fans, etc.).

Exhaust fans may be running in other parts of the bakery for heat relief or to remove stale air to maintain a healthy work environment. In the absence of a properly designed and operated make-up air system that maintains a consistent atmospheric pressure in the area of the oven, the pressure in the bake chamber can vary from negative to positive and vice versa. Other building conditions such as temperature gradients can further influence this phenomenon. Negative building pressure means that air is drawn randomly and uncontrolled into the building to replace the air removed by exhaust systems.

Negative building pressure creates many potential problems:

- Uncontrolled drafts at the floor level
- Back drafting down furnace stacks
- Cold spots and wind chills in working areas
- Exhaust fans operating at reduced capacities and inefficiency
- Strong air inrush when a door is opened

This uncontrolled inrush of air brings with it the outside climate. If left unattended, all of these conditions have a profound and variable effect on the performance of your oven.

Make-up air systems and curtains can be used to control and stabilize air currents in the bakery. They also work to counteract the negative air pressure created by exhaust systems and other building conditions. It should also be noted that process generated heat in addition to the oven that can be used by the make-up air system which is normally wasted.

Oven Exhaust System

The individual product(s) being baked along with through-put dictates the necessary amount of air that flows through the oven and that air flow is controlled by the exhaust fans and associated dampers. Effective management and control of these systems has a direct impact on the quality of the products baked. The interconnectedness of these systems are directed from the recipes by product which specify the various ingredients, moisture content, bake times, heat and more developed by the baker to achieve the quality standards by product. Thus this emphasizes the importance of having sufficient air flow in the oven to capture and exhaust the products of baking and combustion.

To do this in a controlled way, the bake chamber needs to be in a negative air pressure condition relative to the atmosphere outside of the oven. Stated another way, the bakery atmosphere needs to be positive relative to the bake chamber. For example if the bakery atmosphere is -1 then the bake chamber will need to be -2. If this is not the case and the bake chamber is positive relative to the bakery the bake chamber will outgas through openings in the bake chamber and this out gassing of moisture and VOCs will condense in the insulation, and on other cool oven components, all of which impair the performance of the oven.

When considering influences on the air pressure in the bake chamber the following often are considerations:

- Oven and other rates of exhaust
- Outside conditions
 - Temperature
 - Humidity
 - Wind direction
- Other activities in the bakery

Given all these variables how can the bakery manage these dynamics to achieve the bake performance and product quality required to meet the established product specifications? Certainly a complex question and one point of focus in all of this are the dampers in the ovens and their influence on positive baking results. It is important to understand the function of all oven related dampers. Some oven related dampers should be adjusted and remain fixed, while others need to be adjusted in response to the various recipes and the current atmospheric conditions surrounding the oven. As conditions change the damper(s) may need to be opened or closed to maintain proper air flow. Typically this has been done manually by the oven operators based on experience and historical tracking by product or recipe. This is all fine if conditions stay steady state however as we pointed out earlier changing atmospheric conditions clearly change the conditions and challenges within the bakery.

So the baker must contend with more air flow or less air flow as conditions dictate. The damper cannot stay stagnant. The baker needs to rebalance regularly for changing recipes and atmospheric conditions. In addition, the baker needs to be aware that the inlet and discharge openings of the oven influence the distribution of the heat in the oven.

The numerical values in the following table are intended to illustrate the pressure relationship between the bakery and the oven chamber. Note that the oven chamber is always more negative than the bakery.

Location	Air Pressure	Location	Air Pressure
Bakery	+1	Oven Chamber	0
Bakery	0	Oven Chamber	-1
Bakery	-1	Oven Chamber	-2

The differential that is established for each set of baking conditions needs to be maintained by the oven operator. It's important to recognize and accept that one size does not fit all bakeries, recipes or conditions. The amount of air flow is dependent on the recipe. If recipe B has more moisture per pound of dough than recipe A then the air flow must be increased to take out the additional moisture if the specification and quality are to be met. So result is that baker may in fact vary/change his recipe when the real issue is the oven exhaust. This differential is what is important to creating the proper air flow.

If the baker is adding steam to enhance the crust then discussions on exhaust gets even more complex and important but necessary to maintain product quality. Steam at the entry point of the oven must be exhausted in the steam zone and not allowed to travel within the oven.

Another consideration in all of this beyond the actual performance of the oven is the sensitivity to safety. Managing the air flow, products of combustion and other particulate matter from the bakery as they are exhausted can accumulate either in or around the oven and in exhaust stacks

which can lead to fires. As a preventative measure, bakery maintenance should schedule regular inspections and cleaning as needed.

Air Management Summary

The rate of oven exhaust must be managed and generally gauged by maintaining a negative pressure in the oven relative to the bakery atmosphere. It is important to control and minimize random air infiltration, such as burner observation ports. It also must be recognized that bakery atmospheric pressure varies and the oven exhaust must be adjusted accordingly. All of these considerations are often overlooked by the baker and leads to changes in other parts of the process (for example recipe changes) that in fact would not be necessary if the air flow was managed correctly.

If we haven't covered a topic that is of interest to you, please e-mail us at info@banner-day.com with your suggested topic or question and we will consider it for a future newsletter.

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