



# WISCONSIN OVEN CORPORATION



**Increase Your Productivity with  
Better Age Oven Technology**

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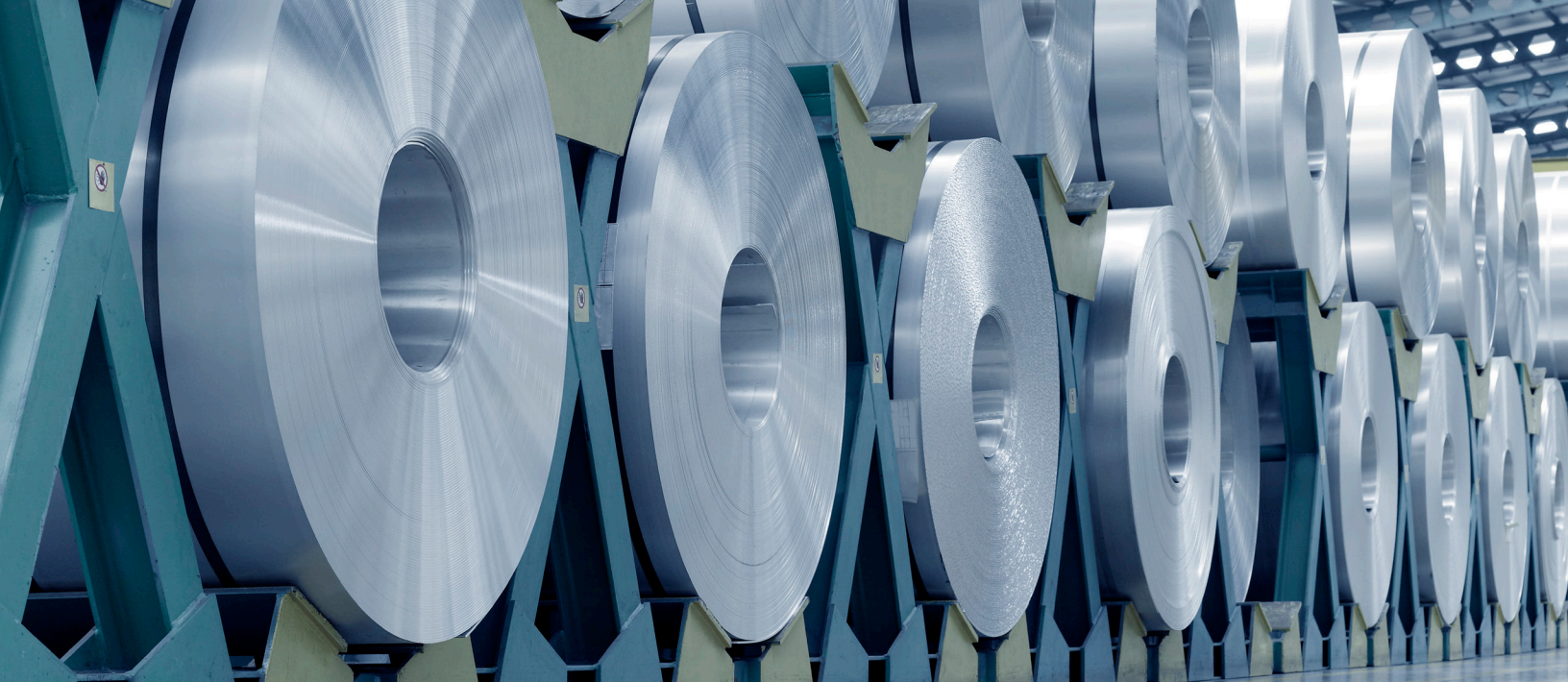
*In today's marketplace, it is critical to optimize the productivity of the equipment in your plant. This is especially challenging for aging ovens, which must also be energy-efficient, low maintenance, and provide consistent metallurgical results with varying parts.*

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**Wisconsin Oven Corporation**



## OVEN DESIGN FOR AGING

Many age ovens in use today are general-use equipment, not specifically designed for aluminum aging. This can cause problems, however, since aluminum aging has some unique requirements that differentiate it from other types of thermal processing. As will be discussed below, general-use ovens typically have insufficient

airflow volume for aluminum aging. This drawback costs money through reduced productivity, with the user often unaware that a problem exists. By designing heat processing equipment specifically for aging, cycle times can be reduced and productivity increased.

## ROBUST CONVECTION AIRFLOW IS THE KEY

Aluminum aging is a relatively low-temperature operation, performed under 500°F. The parts are heated using recirculated air and then held at temperature. Convection (forced air) is especially effective in aluminum processing because of the very high thermal conductivity (over 4 times that of steel) of aluminum. Aluminum will accept heat virtually as fast as it can be delivered via

the air that's been convected. By using increased convection and heat input, heat transfer to the parts will be optimized, reducing cycle time. The same principle applies during the cooling cycle. Hot aluminum will release heat extremely quickly when cooling air is sufficient and properly delivered, thereby reducing the cooling time.



# MORE AIRFLOW DELIVERS BETTER PERFORMANCE

The biggest factor in the design of age ovens, is the air recirculation rate, measured in CFM (cubic feet per minute) and often expressed in “air changes per minute” (CPM). This refers to the volume of air circulated within the oven by the recirculation blower. The CPM reflects the number of times per minute all the air is completely recirculated through the heating chamber. For example, if an oven work chamber is 8’ wide x 10’ long x 7’ high, its volume is 560 cubic feet. If the recirculation rate is 28,000 CFM, the CPM is 50 (=28,000/560).

A high-performance age oven should deliver approximately 30 to 50 CPM. This is in contrast to general-use ovens, which are often 5 CPM. Considering that an oven with 5 CPM oven operating at 350°F will circulate 82,300 pounds of air per hour, versus 8,230 pounds per hour for an oven with 5 CPM, it is understandable why airflow has such a big impact on oven performance.

In addition to the issue of production rate, part quality can be negatively impacted by insufficient airflow. In a densely loaded basket of aluminum parts with inadequate airflow, the parts on the outside edges of the basket will heat up quickly and begin the aging process, with the center of the load lagging by a period of time. If the parts on the outside of the basket heat up to temperature in ½ hour, for example, and the ones in the center take 4 hours, the outside parts will age 3½ hours longer than the ones in the center. Since the hardness of the aluminum is determined by the duration of the aging time, the parts on the outside of the basket, which have been aged longer, may be harder than the ones on the inside. This can be a problem.

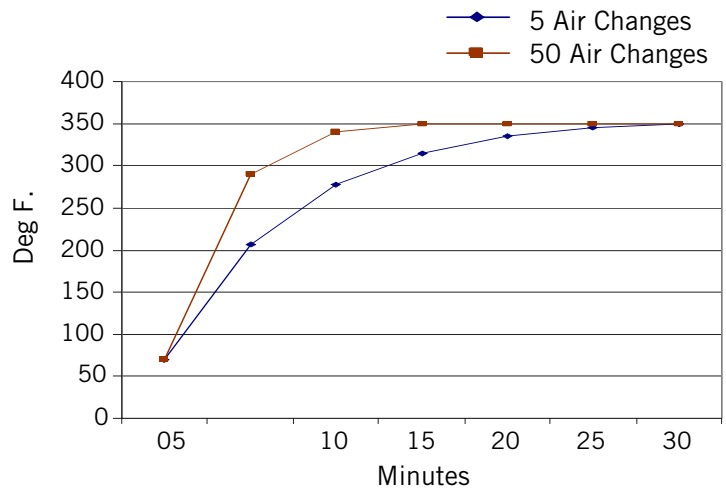


Figure 1 – Aluminum Heating with Different Air Recirculation Rates

|                         | 5 CPM | 50 CPM |
|-------------------------|-------|--------|
| <b>Heat-Up</b>          | 30    | 15     |
| <b>Soak</b>             | 120   | 120    |
| <b>Cool</b>             | 30    | 15     |
| <b>Total Cycle Time</b> | 180   | 150    |

Figure 2

Figure 1 shows the calculated heat-up rates of aluminum castings at both 5 and 50 CPM. The 50 CPM design heats the castings to 350° F in approximately 15 minutes, in contrast to 30 minutes for the 5 CPM design.

After aging is complete, the cooling cycle will compare similarly, with additional 15-minute savings for the 50 CPM design. This results in a total savings of 30 minutes over the entire cycle. If the soak time is 2 hours, for example, this savings translates into 20% higher efficiency over each aging cycle, as shown in figure 2. Therefore, the oven will process 20% more product using the higher recirculation rate, which will shorten the payback period and increase the productivity of the equipment by many thousands of dollars over its life.



# TEMPERATURE CONTROL FEATURES THAT ENHANCE THE AGING PROCESS

A unique feature that shortens the heat-up time for aluminum loads is a controlled heat head, also known as thermal overdrive. This consists of temporarily setting the oven recirculated air temperature above the desired part temperature by a preset amount, for a short period of time at the beginning of the heating cycle. This forces the load to heat more quickly than if the oven was set to the desired part temperature over the entire heating cycle (See figure 3). For example, to quickly reach the desired part temperature of 250°F the oven air temperature

is temporarily set to 300°F. The 50° difference between them is referred to as the thermal heat head. After the part temperature approaches the desired temperature of 250°F, the control system automatically reduces the oven set point to the desired part temperature, thus preventing the overshoot of the part temperature. This feature helps overcome the physical limitations of a dense part configuration, to allow faster heating rates and increased production throughput in a batch style oven.

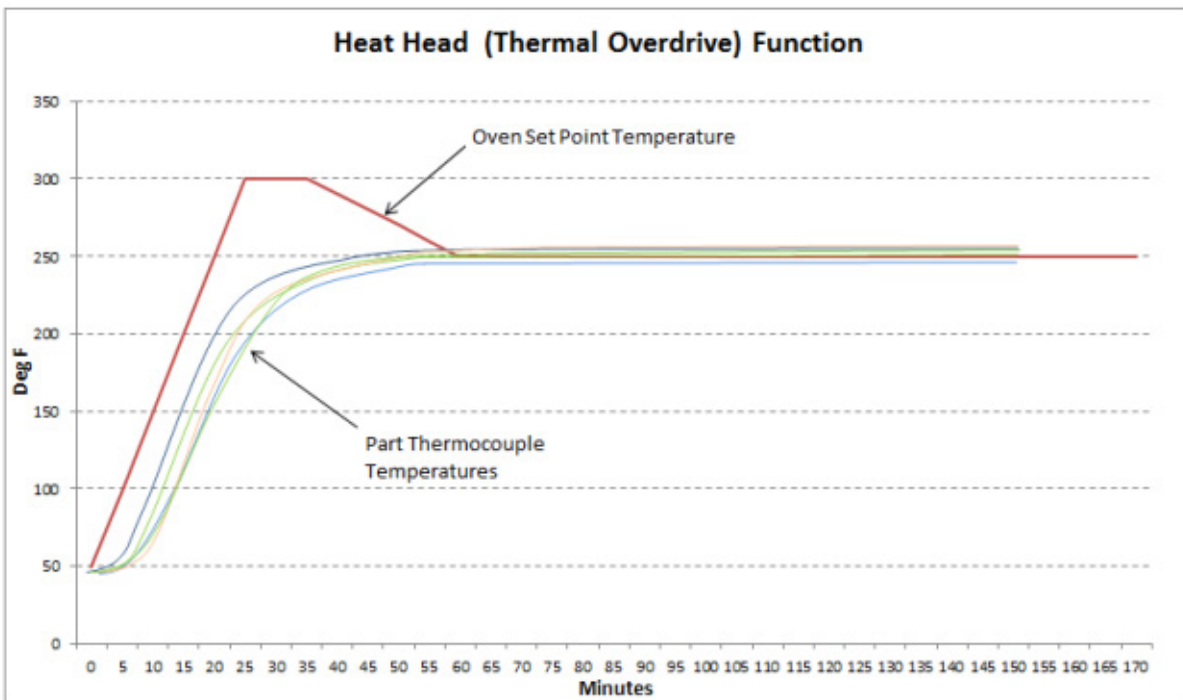


Figure 3 – Part heating rates using thermal overdrive

In order to use thermal overdrive, certain safeguards must be observed to avoid overheating the parts, since the oven air is temporarily hotter than the part target temperature. Part

thermocouples are embedded in the load prior to heating (Fig. 4) and wired to the control system that runs the overdrive function. This allows the system to monitor the part temperature during



the heat-up period, and reduce the oven set point temperature as the load temperature approaches its target temperature, ensuring overheating does not occur. The thermocouples must be carefully positioned both in the region of the part that is

anticipated to heat up first, as well as the region anticipated to heat up last. These will generally be the thinnest and thickest sections of the parts, respectively.

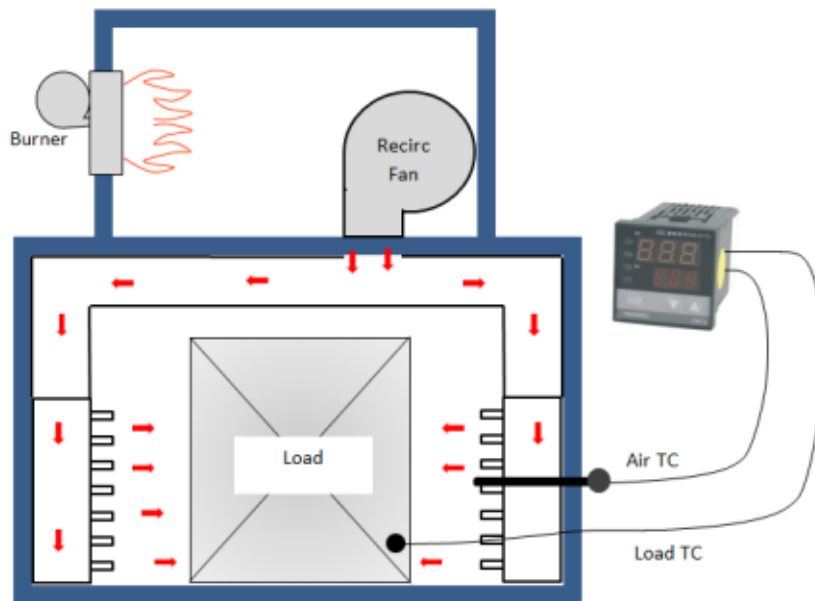


Figure 4 – Thermocouples imbedded in a load to allow the use of thermal overdrive

Multiple recipe controllers can be programmed to run different recipes for different parts, each with a different thermal overdrive program. The user can also set the maximum allowable load heating rate, the peak allowable load temperature and the ramp rate of the air temperature for each.

In conclusion: When shopping for an age oven, find a supplier that understands aluminum aging and can provide a high-performance unit designed specifically for aging. Pay attention to the airflow volume and control system. A properly designed age oven will provide better parts, faster payback and increased productivity than a general-use industrial oven.

