White Paper Report

# Kiln Ventilation Facts and Figures

**Analysis of the effectiveness and energy efficiency of the methods used to remove and ventilate fumes, odors, and heat from ceramic kilns**

- Area Fan
- Downdraft
- Canopy Hood

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# The importance of kiln ventilation

### Removes hazardous fumes and noxious odors

The firing of clay and glazes can produce higher amounts of carbon monoxide (35 PPM) than what is acceptable by OSHA (Occupational Health & Safety Administration) standards.

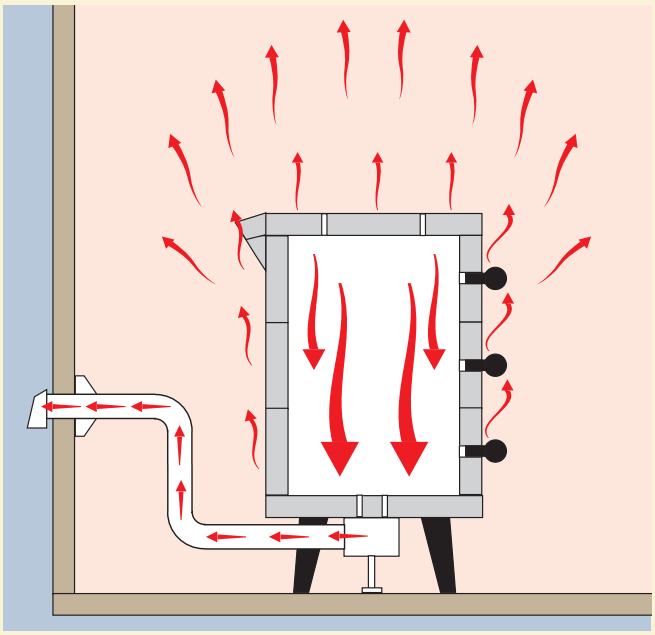
In addition, contaminants such as antimony, boron, cadmium, dioxin, selenium, zinc, and various metals can be released. These should be removed from the work area for the safety of students and workers.

### Removes excess heat from the firing room

Depending upon the ramp rate, the final temperature at Cone 6 ranges from 2165˚F to 2269˚F (1185˚C to 1243˚C). By design, a kiln is not air-tight and will release heat into the room. Excess heat not properly vented poses problems in the working area and contributes to higher operating costs.

- Uncomfortable or unbearable working environment - room temperatures ranging from 100˚F (38˚C) to 140˚F (60˚C) or higher
- Added energy usage and cost if the room needs to be air-conditioned
- Premature wear of electrical components in the kiln controller
- Excess heat may trigger the sprinkler system

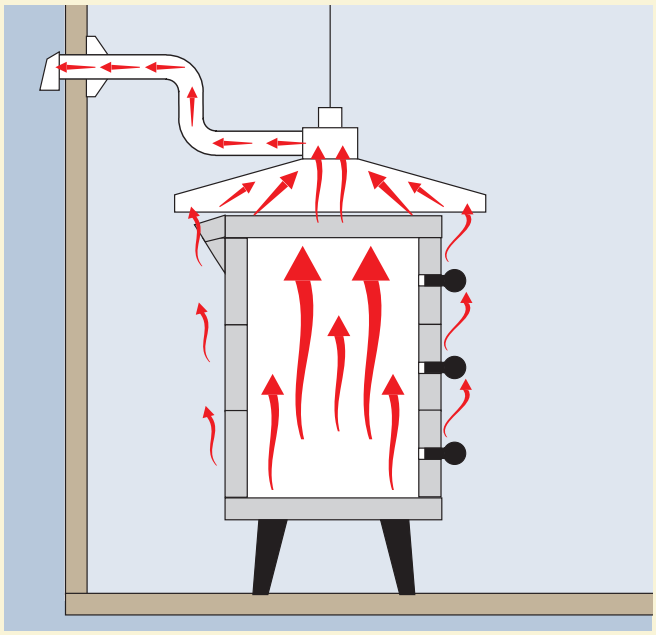
## Downdraft system



*Removes only heat and fumes from inside the kiln. It does not remove the heat and fumes escaping into the firing room and requires reheating to maintain consistent internal kiln temperature.*

- Although most fumes may be ventilated, peep holes and worn seals allow some fumes to escape into the room.
- Excess heat from both the interior and exterior of the kiln rises and can make the room unbearably hot.
- Air-conditioning can counter some of the excessive heat, but at a significant additional energy cost.
- Fan motor is not as energy-efficient and increases operating costs.

## Canopy-hood system



*Removes only heat and fumes escaping from the kiln. Helps maintain internal kiln temperature at a consistent level without reheating the kiln.*

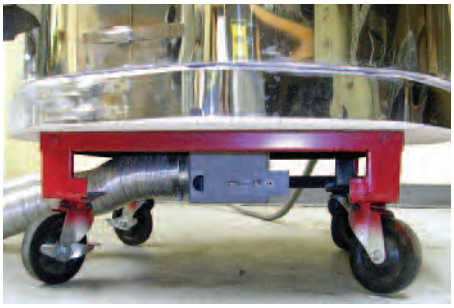
- Heat and fumes rise naturally and are captured immediately for proper venting before they can escape to the work area.
- Room temperature is moderate and more comfortable.
- No need to run expensive air conditioning to keep room cool.
- More efficient fan motor saves energy and reduces operating costs.

# Comparison of kiln ventilation methods

### Open window and fan

This is the historical way of venting kilns and is still used in some cases where the kiln is placed in a room separate from the work area. For many studios and schools, a kiln-dedicated room is inconvenient, impractical or too expensive to build and maintain. Whether in a separate room or the main area, traditional ventilation should be avoided for the following reasons:

- Inherently unsafe as the room is heavily contaminated with fumes and excess heat before being exhausted.
- Windows and doors are left open regardless of the weather, thereby incurring security risks.
- Expensive to run air conditioning when the room is too hot.
- Expensive to re-heat after the room has been vented. Noisy and expensive to run the fans.



### Downdraft system

Holes are drilled into the bottom of fire brick of the kiln. A plenum cup is attached to the kiln covering these holes. Flexible tubing connects the cup to a motor/blower mounted at the wall where the fumes are vented after creating a downdraft through the kiln. Although a downdraft system effectively ventilates emissions, it has these disadvantages:

- It takes longer to heat the kiln that uses a downdraft vent, so it is less energy efficient and more costly to operate.
- In addition, cool air drawn in passes over the heating elements, requiring costly re-heating with the potential for uneven firing.
- Kilns are not air-tight as fumes escape through peep holes (open or closed) as well as seals (especially when older and worn) between the fire bricks - fumes and odors still escape.
- Downdraft systems do not counteract physics - potentially dangerous and damaging heat and fumes will always rise and flow into the room.

### Canopy-hood system

A circular hood exceeding the diameter of the kiln is positioned above the kiln and connected to flexible hose with a motor/blower. Fumes and heat rising from the kiln are captured immediately under the hood, drawn through the tubing and vented properly.

A canopy-hood system provides several advantages:

- Does not require kiln modification (drilling into the fire bricks).
- Without a downdraft, it takes less time to heat up the kiln, so it is more energy efficient and less expensive to operate.
- Takes advantage of heat and emissions rising to be more effective overall.
- Does not upset the balance in the firing cycle.
- The motor is more efficient, resulting in significant energy and cost savings.
- Excess heat is removed, minimizing the hazards and temperature-control costs associated with an overheated work environment.

## Energy use and cost when firing at Cone 6*

Since downdraft ventilation systems remove heat from inside the kiln, more electricity is needed to maintain the kiln at the desired temperature. In addition, motors in a canopy-hood system have a higher blower capacity, but are more energy-efficient.

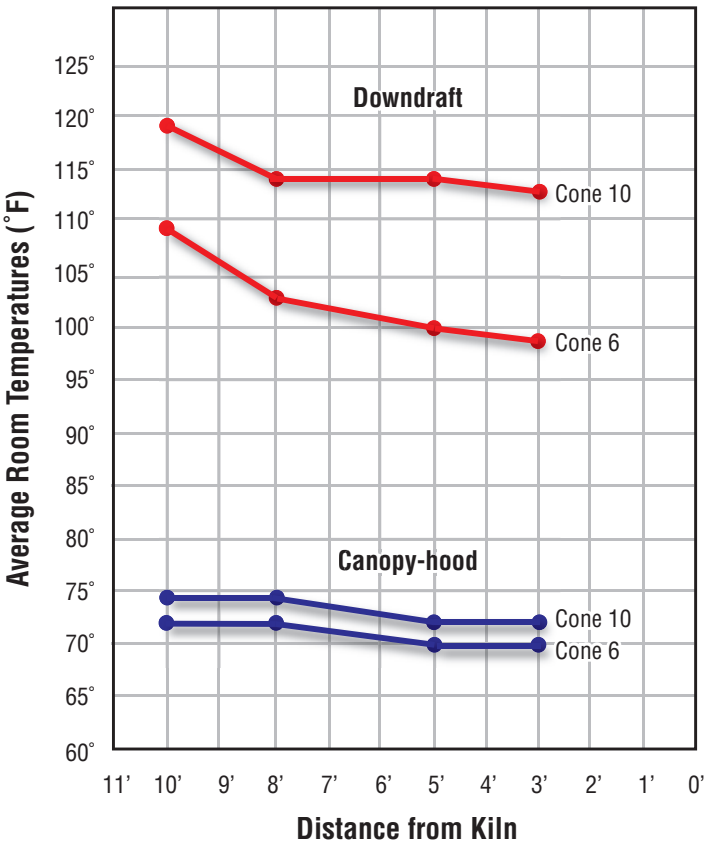
| System | Blower Capacity *(Cubic Feet/Minute)* | Energy Used *(kilowatts)* | Cost/Firing | Annual Cost |
|---|---|---|---|---|
| Downdraft | 130 CFM | 10.86 kw | $15.20 | $2,371.20 |
| Canopy-hood | 500 CFM | 10.27 kw | $14.38 | $2,243.28 |

- All tests conducted to reach and maintain Cone 6 for a total of 14 hours.
- Cost per firing based on USA average electricity rate of 10 cents per kilowatt hour.
- Annual cost estimate based on running a kiln three times per week for one year.

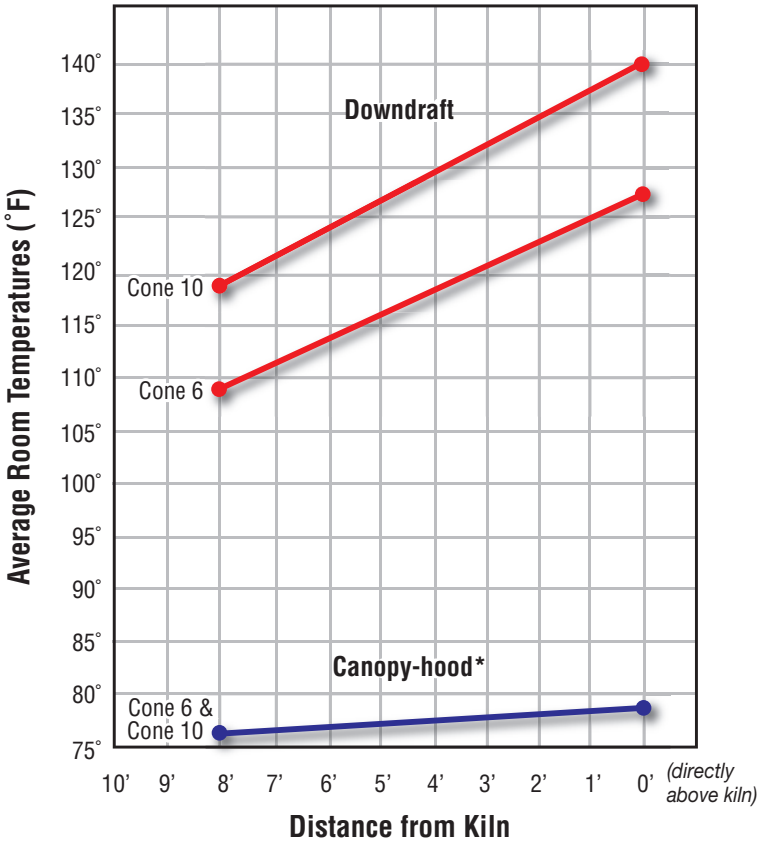
** Does not include additional energy costs to air-condition an over-heated room when using a kiln with a downdraft system.*

# Test Results of Room Heat Removal During Kiln Firing

### Room Temperatures at 5-ft. above floor




### Room Temperatures at 8-ft. above floor




** Temperatures recorded at 8-ft. (ceiling) height for Cone 6 and Cone 10 were identical with the canopy-hood system.*

## Conditions

- All tests conducted on an L&L E23T electric kiln
- Room size 19.5-ft. x 14.0-ft. x 8.0-ft. (ceiling height) - 2,184 cu.ft.
- Fast glaze to Cone 10: 2250˚F (1232˚C) and 2275˚F (1246˚C) internal kiln temperatures; hold at Cone 10 and measure temperatures at distances shown after 4, 5, and 6 hours
- Fast glaze to Cone 6: 2181˚F (1194˚C) and 2186˚F (1197˚C) internal kiln temperatures; hold at Cone 6 and measure temperatures at distances shown after 5 and 9 hours

| **Downdraft System** | **Cone 10** | **Cone 6** |
|---|---|---|
| Starting room temperature: | 55˚F (13˚C) | 51˚F (11˚C) |
| Kiln skin temperature: | 531˚F (277˚C) | 485˚F (252˚C) |
| **Canopy-hood System** | **Cone 10** | **Cone 6** |
| Starting room temperature: | 59˚F (15˚C) | 51˚F (11˚C) |
| Kiln skin temperature: | 505˚F (263˚C) | 449˚F (232˚C) |

## Summary

### Canopy-hood venting is OSHA-compliant

The canopy-hood method not only removes fumes and odors from the source of kiln emissions, it also removes excess heat, keeping the room environment safer and comfortable.

### Canopy-hood is the “green” choice

With superior fan motor efficiency and less need to run air conditioning, a canopy-hood system uses less energy and reduces overall operating costs.

*Vent-A-Kiln wishes to acknowledge the cooperation of Cone 5 Pottery, Buffalo, NY for its contributions to this report.*

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