DRYING&FIRING
QUESTIONS & ANSWERS

by **Cameron G. Harman Jr.**

Q *My small pottery business is doing well, and I need to purchase a larger kiln to keep up with the demand for my products. However, I've noticed that larger kilns are extremely expensive. Why do industrial kilns cost so much more than pottery kilns?*

A For many small pottery producers, deciding to upgrade to an industrial kiln can quickly lead to a sense of "sticker shock." Instead of the average $15,000 to $50,000 price of most periodic kilns purchased by potters, the initial cost of a typical gas-fired industrial periodic kiln can run as high as $150,000 or more. However, the "cost" of a kiln is more than just the sticker price—the real cost is the achieved cost per unit of ceramic.

Industrial companies are just as concerned about costs as individuals, so it can be helpful to observe the way larger industrial firms look at costs. For example, a refractory brick manufacturer was looking for a high-temperature kiln. It compared a modern downdraft periodic kiln with sealed burners to an updraft kiln with venturi burners (a common design found in pottery kilns), both from reputable American firms. The company found that the cost per ton of brick fired in the modern kiln—which had a selling price of at least twice as much as the other kiln—was much lower than in the venturi burner kiln, even including the amortized initial cost of the kilns. The cheaper kiln (selling price) was actually the more expensive kiln to own. Based on this information, the company purchased the modern periodic kiln.

Calculating the Savings

Given that an industrial kiln typically results in enough lower realized costs that it provides a fast payback, the question then becomes: Why is an industrial kiln often so much cheaper to own than a pottery kiln?

For one thing, an industrial kiln uses much less fuel. The sealed burners with individual combustion air blowers are much more efficient than the venturi burners, which have bases that are open to the firing atmosphere and are therefore much more difficult to control. Additionally, most industrial kilns are fiber-lined, while most pottery kilns are lined with insulating fire brick (IFB) or hard brick. Fiber lining weighs about $\frac{1}{8}$ as much as IFB, and IFB weighs about $\frac{1}{3}$ as much as hard brick. Since a kiln fires weight, the weight of the walls can greatly exceed the weight of the load. By reducing the wall weight, much less fuel is required.

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The faster firing cycles of industrial kilns can also provide significant fuel savings. Some pottery producers worry that they will lose the slow heating and/or cooling cycles required to fire their products. However, these slow rates are typically needed only because some pottery kilns are non-uniform, and it is difficult to ensure that all parts of the load are treated properly. In a modern downdraft kiln with side burners and multiple zones of control, the temperatures are so uniform that even difficult shapes, such as statuary, can typically be fired quickly without defects.

For potters working with crystalline glazes, the crystal formation requires a carefully controlled cooling curve to develop the desired effect. However, if the temperature in the kiln is uniform, the cooling cycle does not have to be as slow as one might think. Crystalline glazes have been developed on the surface of tile fired in a roller hearth kiln in very short times—sometimes less than one hour from cold to cold.

Additional cost savings are typically realized from reduced product losses when using an industrial kiln. Some pottery producers using venturi burner-fired kilns experience losses of around 10% or more—but this loss rate is unacceptable. The cost is tremendous when considering the amount of labor and materials required to make each piece before firing. I have seen cases where a reduction of just 5% in firing losses completely paid for a new tunnel kiln.

A large part of the initial cost of an industrial kiln is the control system. Industrial kilns divide the burners into groups—often referred to as "zones"—to deliver the heat more evenly inside the kiln. Many industrial kilns have burners both above and below the ware to allow a different heat input at the top and bottom of the kiln. It is also common to separate a kiln into horizontal sections—in some kilns, the center bottom, center top, bottom ends and top ends might comprise four different zones. All zones are fired to one time/temperature curve, which is dictated by the control system (and fully programmable by the kiln operator). This type of multi-zone control provides much greater temperature uniformity inside the kiln. If the zones are chosen properly and the kiln is a properly designed downdraft kiln, the temperature uniformity can be as good as ±2°F.

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In addition, a sealed burner can easily control the amount of air entering the kiln through the burner. It is possible to have a very small amount of cooling air enter the kiln when the burner valve is nearly shut, thus allowing slow cooling, even with fiber lining.* A considerably larger amount of air enters an updraft, venturi burner-fired kiln due to the relatively large opening of each burner. The high level of control in an industrial kiln enables it to be used even with products that previously seemed very sensitive to cooling rates. Of course, there are some instances where the kiln must still be fired down to achieve the desired effect, such as for developing certain crystal glazes or firing extremely large pieces, but even this extra firing is not a great disadvantage considering the overall cost savings provided by the kiln.

Additionally, a venturi burner typically has a very poor maximum-to-minimum spread (turndown ratio), with 3:1 being typical. A good sealed burner can have turndown ratios of 10:1 to 25:1 or more, and these higher ratios enable the kiln to be kept under control over a wide range of temperatures. This is especially important for firing porcelain, where very low temperature control is required to ensure high product quality.

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Exploring Payment Options

Despite the long-term savings in fuel and product losses that can be provided by an industrial kiln, there is still the question of how a small pottery producer can afford the kiln's high initial cost. Many pottery producers believe that they must either pay for everything in cash up front or go to the bank and borrow the money, and their balance sheet typically won't support such a large expense. However, larger companies often lease their equipment to avoid affecting their balance sheets, and smaller companies can do this as well.

For example, a kiln that costs $100,000 seems terribly expensive compared to a pottery kiln that sells for $50,000. Even though the industrial kiln could significantly lower the cost per fired piece and the extra amount would come back quickly, it is difficult for a potter to obtain the extra $50,000 to purchase the kiln. However, if the kiln were leased over a period of seven years at less than $1400 per month, the higher initial cost wouldn't seem so bad—especially since the monthly amount of the lease is generally tax-deductible. At the end of the lease, the pottery producer can typically exchange the equipment for a newer model, renew the lease for a specific period of time or purchase the leased equipment for a pre-negotiated amount, depending on the details of the lease contract.

A lease can typically be arranged through a local bank. Some kiln builders and suppliers have also begun offering this option through arrangements with leasing companies.

The Price is Right

An industrial kiln often looks more expensive than a typical pottery kiln because of its price tag, but it can actually be much cheaper in the long run—even at twice the initial price. If the kiln is designed correctly, fuel is often cheaper, losses are generally much lower and the level of control is typically much greater and more repeatable. Additionally, flexible payment options can often make industrial kilns affordable even for companies operating on a small budget.

*Because of its light weight, fiber lining tends to speed the cooling process.