Original Article

Alternative kilns and renewable fuel kilns

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Abstract

The current run up in the cost of oil has shown that using kilns that fire with fossil fuels or fuels derived from fossil fuels will become more and more expensive as the years go by and one day will not be possible.

Innovative thought about the fuel used, design, and firing of kilns is needed to continue making ceramic ware in the future. New materials and designs that make use of the advantages will help potters continue to advance studio ceramics. Renewable fuel sources, hybrid kilns, and efficient use of those fuels may be others.

The current run up in the cost of oil has shown that using kilns that fire with fossil fuels or fuels derived from fossil fuels will become more and more expensive as the years go by. In addition the concern over adding carbon to the atmosphere that was once locked in fossil fuels is another concern that caused me to think about alternatives to traditional oil and gas firing as well as electric firing where the electricity comes from the burning of fossil fuels.

In Washington State a cord of wood (128 cubic feet − 11.5 cubic meters) costs $135.00 split, stacked and delivered. Wood can be gleaned from factories that use wood in their production, from used shipping pallets, construction sites and from the forests (with the proper permits), which can be cost effective in monetary terms if not so cost effective in terms of time spent.

A case can be made for wood fired kilns that use scrap woods and wood from wood lots where trees are grown for heating or pulp production. In order for these kilns to be cost efficient in terms of money and labor the kilns must burn the fuel efficiently while producing the desired results. These kilns must use innovative designs to apply the maximum amount of heat to the ware and put less into the atmosphere. Particulate emissions are to be considered as well in a wood fired kiln.

The first kiln is one dubbed the Usogama (False or Lie kiln). It utilizes a firebox under the ware chamber with kiln shelves dividing the ware chamber from the firebox so that radiant heat as well as flames and hot gasses work to heat the ware in a shorter time than would other wise be the case. The chimney is above the fire mouth since the hot gasses and ash double back above the firebox. The Usogama was built in an urban setting causing a concern about smoke and particulate emissions.

This kiln built at the University of Puget Sound also used an “Afterburner” or “smoke eater” to burn the particulate that would normally make up the exhaust from a wood kiln. The Afterburner was separated from the ware chamber and the chimney by a pair of dampers. These dampers were adjusted during the firing. The afterburner employed a forced air gas burner during loading (to preheat the afterburner chamber and the brick work placed inside) and in the early part of the firing.

As the firing progresses the gas is turned back reaching zero at about cone 4 or 5 while the air is increased until the maximum possible is introduced by cone 1 or 2. The use of the afterburner provided a strong draft from the very beginning of the firing and greatly reduced the amount of smoke emitted by this kiln in an urban setting. A typical firing to about 1310 degrees Celsius took 24 to 26 hours and was accomplished with about 3 - 4 cubic meters of scrap wood.

The results from the Usogama were satisfactory and produced effects similar to a traditional wood kiln such as Bizen or Shigaraki. With a different firing schedule glazed ware can be fired to good effect. It was found that wood with the bark attached produced more ash and gave good results. This started a search for pruning s from yards and orchards that were saved, dried and cut to length for use.

A typical firing schedule was to reach cone 06 − 1000℃ − in about 2.5 hours then slowing the heat rise so that in the tenth hour cone 12 − 1326℃ − was reached. For the next 4 to 6 hours the kiln was stoked so that the temperature was maintained and ash was deposited on the ware. One could certainly lengthen the firing and achieve interesting results.

Fred Olsen developed a Fast Fire kiln with dual fireboxes that fires to cone 10 − 1305℃ − in a short time − about 7 hours − using a minimum of wood. Complete information on this kiln is in Mr. Frederick L. Olsen' s *A Kiln Book*, Keramos Books; [1st ed.] edition (1973). The Fast Fire kiln is of a typical sprung arch down draught form with a short chimney in the rear. It does not generate much in the way of ash deposits on the ware and therefore is intended to fire glazed ware. The glazed ware fired in the Fast Fire Kiln takes on a warm tone imparted by the ash that does reach the ware. Euan Craig of Mashiko built a similar kiln, Japan. Lee Love, also working in Mashiko has a version of the Craig kiln. Lee Love fires his kiln with scrap wood and fires to 1305 in about 20 〜 24 hours. Lee Love uses his kiln for glazed ware but has indicated that longer firings produce more ash deposits on the ware and that some areas are more prone to flashing from the flame.

In order to limit the increase of carbon that wood kilns put into the atmosphere trees must be planted to convert the atmospheric carbon into solid form. In Washington state there are lots of trees which have been planted for paper pulp which mature in 30 years and then the lot can be replanted starting the cycle again.

Hybrid kilns

Another avenue might be a hybrid kiln, that is a kiln that uses electricity and gas to achieve reduction fired ware. This type of kiln uses electricity to fire to bisque temperature then at bisque temperature − about 800 C to 850℃ − the elements are switched off and burner ports are opened so that a gas flame can be introduced. The atmosphere is maintained with less oxygen than will cause the gas to combust fully causing a reduction atmosphere. The reduction atmosphere is maintained until about cone 4 or 5 − 1186 ℃ to 1196 ℃ − at which time most feldspathic glazes are turning glassy. The materials in the glazes are reduced, as is the clay under the glaze and when the glaze gets glassy the materials will remain in a reduced state even if the atmosphere is returned to oxidation. At about 1200 C the burner ports are closed and the elements are then energized firing in oxidation until about cone 8 − 1263 ℃ − when the burners are again brought into action to fire the ware in reduction until the glazes are mature − cone 10,1305℃ − after which the kiln is closed tight and allowed to cool to room temperature.

The hybrid kiln takes advantage of the ability to fire reduction glazes while using a minimum of fossil fuel. If the source of the electricity is from hydropower then an absolute minimum of carbon is put into the atmosphere. The results may not be exactly the same as a fuel kiln but Celadon and Copper Red glazes can be produced with a hybrid kiln.

Increased efficiency

Space-age materials like ceramic fiber, heat reflective coatings, and instruments that detect the state of the atmosphere with great accuracy are avenues that artist/potters can use to limit expenses and limit the amount of fuel used. Today it is important for potters to look to science and industry for tools that will enable them to make their work with minimum expense and the best chance for good results.

It is my opinion that a new look at kilns and firing will enable potters to continue to make pots well into the future.

燃料の更新による窯の変化

(Alternative kilns and renewable fuel kilns：和文要約　劉 潤福)

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タコマ・コミュニティー・カレッジ, 陶芸講座主任

最近、石油価格の向上に伴い、陶磁器を焼成するコストも高くなる一方である。これからも石炭、薪、石油などの燃料がますます高騰し、これらを原料としての焼成が不可能になるかもしれない。

陶芸の更なる発展を遂げるために、大胆なデザイン、新しい原料の開発、窯のオリジナルデザイン、新燃料の選択等が必要であろう。新しい原料とデザインを用いることは陶芸研究室の建設にも有利である。そして、再生できる燃料及び各種燃料を混ぜながら、新しい焼成方法を研究することは陶芸を推進する原動力でもある。