KILNS AND THEIR FUEL AT THE KUMHARWARA

By

Urooj Mustafa
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This thesis is submitted in partial fulfillment of the requirements for the degree of Bachelor of Ceramic Design, from the Indus Valley School of Art and Architecture.

Internal advisor:  Arshad Farooqi

Sana Ghias

Sadia Salim

DEPARTMENT OF CERAMIC DESIGN
INDUS VALLEY SCHOOL OF ART AND ARCHITECTURE
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I would first like to thank my parents for their unconditional support, especially my father for finding the Kumbharwara and taking me there for the first time and introducing me to a potter.

I really am grateful to Aslam (potter) who allowed me to build a kiln in his work shop and provided me with as much assistance as he could.

Last but not the least I am really grateful to my teachers, Sadia salim and Sana Ghais who have been very encouraging and supportive throughout this whole process of dissertation in guiding me.
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ABSTRACT

This dissertation is an experimental research based on the problems of local potters. The research aims to provide correct and resolved knowledge from the existing practices to the local potters. The understanding of what type of kiln to use that would suit the climatic conditions of the region and a fuel that is sufficient and can help them cut down on their high cost of production and giving better firing results, minimizing the damage to the environment and their health.

This document will start with analysis of different kinds of kilns used commonly by the local potters all over Pakistan and specially Sind, in the light of the analysis the decision of which type of kiln is most suitable for Karachi will be constructed at the Kumbharwara. Then the research will move on to the different raw materials that can be used as fuel which are maximum eco-friendly, easily available to the potters and are most efficient. The materials used as fuel will be tested in a kiln that is built at the kumbharwara. Few alterations and firing techniques will be experimented so that better results can be achieved with low fuel consumption. There is some literature available on the different kinds of kilns used in Pakistan, but the main research and conclusion is on the basis of the experiments done at the kumbharwara which will determine the most efficient fuel for the local potters of Karachi that can minimize their cost of production and improve the quality of finished products.
INTRODUCTION

The Ceramic industry of Pakistan is a deprived industry at present. The very few successfully running factories are all in the private sector and the most affected are the local potters all over Pakistan. It is very unfortunate that a craft such as pottery making is dying so fast and nothing is being done to save such an ancient craft.

There are many problems which the local potters face. They are not supported by the government; they do not have a proper place to work, the main local potter’s area, commonly known as Kumbharwara is a low land area where living or working conditions are terrible especially during rain. The cost of production is much higher than what the potters get in return. The pots, they produce are of very low quality and sometimes even defected, which adds to their problems. It is important that the cost of production should be minimized and the quality of work produced should be upgraded in order to increase their sales and improve their working conditions.

During the field visits to different local potters in Interior Sind (Naserpur), Multan and Karachi, it is evident that the potters are greatly suffering due to the unavailability of proper resources. They gather waste material from here and there and burn them out to make fire to bisque their pieces and sometimes they run out of material during the process and face problems. Often their firing is not perfect due to lack of stock or inappropriate fuel.

The reason for choosing this topic is, so that a research could be carried out on the kind of fuels that can be used by our local potters and are easily available to them. Consideration of eco- friendly and low cost materials that can be used as fuel is of prime
importance in this context. If there are such materials, then are they affordable by the
local potters and also the kind of firing technique these fuels require and what are the
advantages and disadvantages. This research may help in introducing a new fuel or using
the existing fuels in a different way that is subsidized, efficient and sufficient.

The research encompasses the correct design of the kiln which suits the climatic
conditions of the region, firing techniques and the use of raw materials as fuels that can
cut down a section from the cost of production, it will also benefit in better firing results
and durable finished goods with minimal damage to the environment. The raw materials
which would become part of the research will be tested upon the economical grounds best
suitable for the local potters. The time factor and the quantity of fuel used would be of
consideration.

This dissertation begins from the secondary source of information which includes the
description of different types of kilns and the fuels used by the local potters in general; it
also includes the technique of loading the kiln, firing it, the fuels they use and their
considerations when they build a kiln in their respective regions. After understanding the
basic difference of kilns, firing techniques and fuel of each area, a kiln was built at the
Kumbharwara, New-Karachi.

In the following chapter, the construction of the kiln will be explained and selection of
materials to be used as fuel will be discussed.

In the next chapters, observation of firings, comparison of fuels and their results will be
compared so that the best and most efficient fuel can be determined in light of the
experiments.
The concluding chapter will include how the use of correct knowledge and research in order to save any craft can benefit the society and provide means of livelihood for the people.
In order to solve the issues of the local potters of Karachi it was important to first understand the nature of their problem and if it is only faced by the potters of Karachi or in all of Pakistan. After the initial field research it was evident that the main problem was of the high cost of production and low standard pottery which was due to shortage of fuel.

Saraswati Baidyanath (1978) talks about the different kind of kilns used in Pakistan. This includes three main types of firing; open firing, oven firing and kiln firing. These firings are generally similar but have slight local variations. In open firing with apical fire channel, pots are piled with their mouth inverted in circular fashion in three to four layers so that the pile takes the form of a dome. It is important that while the piling is being done, a hollow space is left in the center, which forms a vertical channel that opens on top of the dome when the pile is stacked. The fuel around the pile is connected to the apical channel. Entire pile is covered by the weathered grass or husk to be plastered with mud, but leaving the top hole open through which fire is kindled. When fuel in the apical channel is ignited, it gradually spreads through all the sections of the pile. The firing and cooling varies between 3 to 10 days, depending upon firing conditions and piling method. This firing produces less fumes, and cover a very large area but the number of successfully fired pots are almost 70 to 75 %, rest of them either chip off or have strange firing marks. Whereas, open firing with horizontal fire channel pots are piled in radial rows at the bottom within a circular base, allowing for a narrow passage in between every two rows which function as a fire channel and it runs straight across diametrically opposite. On both sides of the fire channel, stoke holes are prepared. Fire is kindled
through both the stoke holes simultaneously. Fire is low in the beginning, gradually flares up when it is stroked. It then spreads evenly due to good circulation of air within the pile of the pots. Fuel is arranged around the pots in the same fashion as in apical channel. The firing and cooling of this kiln is 12 to 24 hours. It is a slightly faster firing but the pots in the centre sometimes do not fire properly. In Open firing without any fire channel pots are bent on a flat or dug out hollow ground. Bottom of the pit is evenly filled with dry cattle dung or straw upon which the pots are arranged in circular fashion. The pile is then covered by split bamboo, withered samplings, pot shards, mud paste or any other think cover in order to prevent draughts of cool air and to conserve heat properly. The fire is kindled from all sides at once so that fire sets in. It is continuously fed more fuel until process is complete 1-3 hours duration. Rapid burning fuel such as cattle dung, straw, husk, dry leaves and wood is used. The fire kindles slowly in case of both fire channels; sometimes preliminary heating is done before they are fired intensely at 400 degrees centigrade to 700 degrees centigrade, this is the fastest firing but the temperature does not go high and therefore while unloading, the pieces mostly break and the consumption of fuel is also very high.

A much more practical type of kiln and firing is oven firing used by the local potters, in this type of firing pots are fired either in temporary or permanent oven made of bricks, clay or stone. Pots are piled up close to each other in the oven, which is with or without any enclosure. Pilling up of well-dried pots with their mouths inverted, starts from around the stoke hole in order to prevent heat striking directly on the ware. Dry cattle dung and strips of wood are stuffed into pots. Fuel is also stoked in with intervals. Fire gradually increases. Firing time is 2 to 3 hours.
From the Information gathered and the detail account of how the potters usually load a kiln and fire, the difference in loading and firing techniques, the understanding of the whole process becomes very clear. A huge difference can be seen in the results and cooling also becomes an integral part, the understanding of why a certain kind of kiln is being used by our Local Potters in Sind and specially Karachi was clear and it helped because I had to make a small kiln for my research and after reading this book was able to understand which kiln to built so that it would suit the firing and regional climatic conditions, consume energy and give better results. The Local Potters were of great help in what kind of kiln to make but the technical understanding was important and that I got from reading the book.

Rye S Oven and Evans Clifford (1976) talk about the different kinds of kilns used in Pakistan and gives detailed information about kiln and firings. This book had some information about some of the fuels and how it can be used in a specific kiln. It gave information about the different sizes of kilns and the consumption of each raw material in specific size. With the help of this information the choice of materials to be used as a fuel and how to combine two or more materials to make a fuel that is efficient and sufficient and can cut down the cost of production became slightly easy. This book also has information about different kinds of wood used as fuel and the difference in firing results. Also it gave a technical understanding of how and what process a pot undergoes in a kiln. This literature not only provided information related to the research but also added extra knowledge that could be very helpful to a clay artist.
Finch Joe (2006) talks about kiln construction of up-draught and down draught kilns. This book gives exactly the most detailed brick by brick means of construction of a kiln that can be used by gas, oil or wood. This book helped me greatly in constructing the kiln I wanted to make, a small compact one for my research. It was very important to know a few things before I made a kiln for myself:

1. What kind of pottery would I be firing?
2. What temperature would I be taking the kiln to? Maximum and minimum
3. What size would the kiln be and how often will it be fired?
4. What fuel will I be using?
5. Atmosphere and draught type?

This book has some very good step by step photographs of kiln construction which also were a great deal of help.

Bottererill Claire gives the most basic information about ceramics, from tools to, hand building, throwing on the wheel and types of kilns and firing. The types of kilns Claire talks about are the alternative kilns which can fire low temperature ware like red clay, after the initial bisque firing has been done. This idea of alternate firing appeals to my research as I plan not only to provide fuel for them but also improve the quality of products so that the pots could be sold at reasonable prices. If the potters start producing pots which have some decorative firings marks on them then there is a possibility that the market will be open for such goods too. The alternate firing kilns include, paper kiln and saw dust kiln (smoke firing) which would fire already bisqued pots and the alternate firing would give some decorative effects to the pot which are very appealing.
Pottery at the New-Karachi Kumbharwara (Dawood) is a closely related piece of literature to my research. It gives a very detailed description of the types of kilns used in New Karachi Kumbharwara few years ago. Now the kilns are slightly different but the use of fuel has not changed at all. Therefore, this raised question for the potters that if they are willing to bring change in the kiln construction so that more pots could be fired at a time with less breakage then why are they not willing to change the use of fuels and continue to risk their lives and using toxic materials for fuels.
The research methodology for the dissertation is based on primary and secondary sources of information. The secondary source is based on the literature review, Internet sources and some documentaries recently seen, which was based on a factory that is recycling material and making fuel for domestic use. www.samaa.tv is a local TV channel and in a program “innovation” they reported a factory where a Brazilian girl has introduced a way of using waste material. The group of people collects waste materials from the neighborhood every morning. Paper and saw dust or wood shavings and they mix it with water and press it and make cakes of it which are used by the locals as fuel cakes. Each cake size can vary but a good size, which potters use, is 4cm thick and 15 cm in diameter. Around 2000 cakes can fire 300 to 500 vessels of good size and compact piling. This documentary gives complete coverage of the process step by step, briefly shares the advantages and dis-advantages of such kind of fuel used. This helped in collecting more materials and to use it in the easiest possible manner.

This Information helped me in a way that I was able to understand the best way to store a huge quantity of fuel.

The primary source of data collection for the research is sub-divided in data gathering methodology (observation) and experimental data collection.
CONSIDERATIONS OF BUILDING A KILN AT THE KUMBHARAWARA

The commonly used kiln by the local potters are the open kilns as they are big and less fuel is consumed but the results are not satisfactory therefore after talking to few potters and reading up on kilns, it was obvious that the consideration of climate, material used as fuel, design and the fact that it should be up-draught or low draught was very important.

a. CLIMATIC CONDITIONS OF KARACHI

Karachi has a very dry, arid climate. It is located on the coast therefore some breeze makes the evenings mild. Precipitation level is low but humidity due to closeness to the coast remains high throughout the year. Karachi enjoys mild winters and very warm summers of around 30 to 35 degrees Celsius. It receives the tail end of the monsoon rains in July/August. Having these climatic conditions it is obvious that July and August provide fewer working days for the potters than the rest of the year. The dry, warm climate helps the potters in drying the pots in the open. The kiln constructed should be on a high land area so that even during rain, the water does not deposit and weaken the walls of the kiln. It was important to note that the structure of the kiln should be made of bricks with refractory fire clay filled in to save loss of heat.

b. MATERIALS

Research began with basic observation on study trips and other field trips where, the, way local potters (Kumhars) fire their pots were observed, the materials they use, the complete process of how they load the kiln which are usually huge ditches about two feet in depth and twenty to thirty feet wide. They fill the ditch with raw pots and cover them with trash material that includes all types of papers, plastic bags, rags, leather shoes, saw
dust and whatever that is available to them without spending money or spending as minimum as possible. They cover the ditch properly with the found trash and burn it for several hours until all the trash material finishes. Then after a day the ditch is cleaned and pots are taken out. These pots are mostly not perfectly fired; lots of them have cracks and those that survive have strange burnt marks on them. There are very few that survive and are in considerably better condition to be taken forward. One thing observed after firing was that around 10% of the material that is used for firing does not burn out, while materials like leather shoes and plastics create such bad environmental issues that it becomes difficult to bear.

After basic understanding of how they use this trash and why they use it, second step was to research on the alternative waste materials that can be used, making sure that it will not affect the cost of production for the local potters (kumhars) and would give them best possible firing results. Another factor observed was the lack of facilities and the basic problem was the open firing kiln that was wasting the fuel to great extent and destroying the environment too. Therefore, I decided to construct a kiln at the kumhar wara.

In order to construct the kiln, the first question was to what type of kiln to make that would full fill all the requirements of the research, it was important that the kiln is economical, fuel efficient, fits at least 100 pots and would have maximum successful pieces. The research on the different types of kilns was done with the help of secondary source of information which gave all the types of kilns and their details used by the potters.
c. DESIGN: UP-DRAUGHT KILNS/ DOWN-DRAUGHT KILNS

Kiln Firing: In a kiln draught is controlled and heat is introduced by means of muffing. Kiln firing is far better than oven firing or open firing because it conserves more heat and high temperature can be reached faster.

There are different kinds of kilns:

Up draught Kiln: Furnace is located at the bottom through which the fire enters the kiln, passes between the stacked ware and leaves through the flue and the chimney. The primitive field kilns were based on the same principle. These kilns were made of clay.

Down draught kiln: Fire rises from the furnace to the roof and returns to the floor and then leaves through the chimney or in case of a multiple store kiln, starts the next chamber.

Horizontal Draught kiln: Termed also as castle kilns, have the hearth located on the front. Short side of the kiln is separated from the chamber by a partition that prevents ashes and other impurities from entering the chamber and controls an even distribution of fire through the hearth. Flames pass horizontally between the stacked ware and ultimately reach the chimney.

A kiln design was chosen similar to the ones in Naserpur and Haala which was a down-draught Kiln. It was constructed at a local potter’s house/ workshop.

Simultaneously, environment friendly materials that can be used as a fuel was collected at the workshop. Assistance was taken from Afghani boys who collect and sort out trash material from the garbage dump, they were asked to collect all kinds of paper and
cartons. Textile factories were approached so that they could deposit their daily waste in large bags which would be picked up by the potters once a week, these were in huge quantities. Furniture shops were also approached and waste wood and wood shavings were collected on daily basis, cow dung from the local milk man, news papers were collected from neighbors and relatives but also a local news paper factory owner who was willing to give away the discarded papers (he also mentioned that the English news papers have better quality therefore those are recycled and used by some Urdu, low standard news papers). After recycling them twice or sometimes thrice, the paper loses its strength and that paper was totally useless for printing therefore they agreed to give that bundle as well.

The aim of this dissertation is to find out if there is any fuel that can be used by our local potters that will minimize the cost of production and will give better results. It is important that whichever material is most successful should be in abundant supply and easily available to the potters.

After talking to the potters and while collecting the material, I became aware of the fact that these materials have been used by the potters at some point but the potters complained that they burn out really fast and a huge amount of fuel is needed to reach 1000 degrees centigrade. Therefore, in my research, it was important to figure out alternative use of fuel.
KILN CONSTRUCTION

The main part of the experimental research began when the kiln was constructed. It was a four feet by 2 feet, and four feet high. The structure was made of bricks and cow dung was mixed with grass and coved on the inside and outside of the brick construction. The kiln was heated on very low temperature so that the moisture from the walls would be absorbent and the kiln could be ready to fire. It was important that the materials and technique used in the construction of the kiln would not include materials the potters cannot afford; therefore all locally available material was used. Another important factor was that the kiln should be made on slightly steep ground or some levels should be created so that when the kiln is fired, the heat should flow evenly from one end to the other, the best way is to build the kiln making sure the fire box is on lower level so that the air passing upwards would rotate the heat from bottom to top evenly distributing the temperature. So that using less fuel the heat would move up with the help of natural wind and it would also prevent reduction in the kiln, as reduction blackens the pots.

The pots in the kiln were made by the local potters with slight variation in thickness, they were asked to make the walls of the pots slightly thinner. It was important that they use their own red clay.
FIRING WITH SELECTED MATERIALS

a. Cow dung and saw dust cakes

The first experiment was done with cow dung and saw dust as the fuel. They were both mixed and circular discs were made of them. The discs were of 6 inches diameter, and 2 inches thick. The percentage of cow dung was 60% and sawdust 40%. They were dried properly under the sun for more than a week. The kiln was loaded with dried pots on top of one another to consume space and the fuel was stoked time to time, it took around 5-6 hours for the kiln to become red and around 1000 discs for the complete firing. There were no broken pots, only the pots which were directly hit by the flames were over fired but the result was better than there open firing kilns. The fuel cost them only rupees 200 for the entire firing as they only purchased saw dust from furniture market.

b. Wood shavings, paper pulp and cow dung.

The next fuel used was combination of paper, cow dung and wood shavings. Paper pulp was made in large quantities because, the paper itself had no strength and if used would burn out immediately. Therefore huge quantities of paper pulp was made and left to dry slightly, when little water was absorbed, wood shavings were added and mixed with it properly and balls were made. The balls were spread in the sun to dry completely. Once the balls which were of 2.5 inches-3 inches in radius were completely dry they were covered completely with a thick layer of cow dung. The layer varied from 1 inch to 2 inch in thickness. These balls were then left to dry further more. Later, the fuel balls were laid inside the kiln and pots were placed in between the circular fuel layer. The balls inside the kiln were slightly larger so that they could also provide cushion to the pots.
During the firing, balls were rolled in the fire box. This was a much easier method of stoking compared to the last one. The firing took 5 hours approximately and there was 100 result of pots. None broke, none had marks on them. The cost of this firing was also rupees 300, which included the wood shavings and helped from Afghani boys.

c. **Rags**

The third fuel used was rags from the textile industries. The rags were in long strips, different materials; cotton, linen and others. Initially it was a tiring task to separate all the different kinds of strips. Then knots were tied to them to the extent that they became like balls. These were laid inside the kiln and stoked throughout firing. The different materials fired in different ways and it was not possible to control the firing. The use of fuel was not balanced due to difference in material. The consumption of fuel was also much more. Around 5 bags of 10 kg each was used up and even then the pots were under fired.

d. **Recycled news paper and saw dust.**

The last experiment was done, using recycled news paper and saw dust. Paper pulp was made in large quantity and saw dust was mixed to it in the proportions; paper pulp 40% and saw dust 60%. The mixture was left to dry, disc of 3 inches thickness and 5 inches diameter were made and used as fuel in similar manner as above. This fuel was also not very successful because despite of thickness, 1500 discs were used. The main reason was that the news paper had no strength.

Every fuel used had some pros and cons. There was not too much variety in the materials that would be easily available for the potters in the future; therefore my research included the different ways the materials can be used to maximize the fuel consumption.
FINDINGS

Although, the potters have been using similar fuels in the past but using single material such as using only shoes, or only wood, or only hay, Just one material for the entire firing, which did not improve the quality of firing. Therefore my research was able to supply them with materials which are less hazardous to health compared to the plastic, rubber and leather shoes which are used as fuel currently by most of the potters. Due to many restrictions and limitations in place for the potters, I was forced to limit my use of material and the material used during this research has been used in past by the potters. But mixing of two or more materials and treating them in different ways brought better results and decreased the firing time as well as minimized the fuel consumption.
# OBSERVATIONS AND COMPARISON OF FIRINGS

<table>
<thead>
<tr>
<th>Fuel Used</th>
<th>Amount of fuel used</th>
<th>Duration of firing</th>
<th>Quality of firing</th>
<th>Type of firing</th>
<th>Cost of transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow dung and saw dust</td>
<td>1000 discs for complete firing</td>
<td>5-6 hours long firing</td>
<td>uneven firing. The distribution of stacking was uneven and also no fuel was kept inside the kiln, it was only stoked while firing.</td>
<td>Bisque firing. Reached around 900 degrees centigrade.</td>
<td>The saw dust and wood chips cost them 50 rupees per bag, 4 bags were used. There were no transportation charges as furniture markets are close by and potters have a push cart on which they bring the bags.</td>
</tr>
</tbody>
</table>

Table 1: Shows the details of firing done with the first fuel.
<table>
<thead>
<tr>
<th>Fuel</th>
<th>Amount of fuel used</th>
<th>Duration of firing</th>
<th>Quality of firing</th>
<th>Type of firing</th>
<th>Cost of transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood shavings, paper pulp and cow dung</td>
<td>Around 700 to 800 balls.</td>
<td>5 to 6 hours</td>
<td>Even and fast firing, no broken pots, none had marks on them. The fuel balls inside helped in heating the kiln faster and maintaining the temperature.</td>
<td>Bisque firing. The pot was almost vitrified</td>
<td>300 rupees in total. The saw dust and wood chips cost them 50 rupees per bag, 4 bags were used. And 100 rupees was given to the Afghan boy for his help.</td>
</tr>
</tbody>
</table>

Table 2: Shows the details of firing done with second fuel.
<table>
<thead>
<tr>
<th>Fuel</th>
<th>Amount of fuel used</th>
<th>Duration of firing</th>
<th>Quality of firing</th>
<th>Type of firing</th>
<th>Cost of transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rags from textile factories.</td>
<td>125 kilo grams</td>
<td>10 hours</td>
<td>Uneven firing, difficult to stoke the rags. The pots close to the fire box were fired to bisque but the pots on the other end were under fired.</td>
<td>Half of the pots were bisque and rests were under fired, the temperature was not able to flow in the kiln evenly.</td>
<td>The textile factories are in the cite area and the cost of transportation was 1000 rupees per Suzuki.</td>
</tr>
</tbody>
</table>

Table 3: Shows the details of firing done with third fuel.
<table>
<thead>
<tr>
<th>Fuel</th>
<th>Amount of fuel used</th>
<th>Duration of firing</th>
<th>Quality of firing</th>
<th>Type of firing</th>
<th>Cost of transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycled news paper and saw dust</td>
<td>1500 discs were used</td>
<td>7 to 8 hours</td>
<td>Even firing, but stoking had to be faster. Results were ok, no broken pots or marks on them.</td>
<td>Bisque firing, temperature reached to 950 degrees.</td>
<td>Assistance was taken from 5 Afghani boys to bring news paper from the factories, therefore rupees 100 were given to each boy.</td>
</tr>
</tbody>
</table>

Table 4: Shows the details of firing done with fourth fuel.
Figure 1: Bisque pot after firing it with first fuel.

Figure 1: Bisque pot after firing it with second fuel.

Figure 3: Bisque fired with third fuel.

Figure 4: Bisque fired pots with fourth fuel.
With the detailed report of the firings, it becomes easier to know what fuel worked the best. The type of kiln was same throughout, infact one single kiln was used. The details discussed earlier gives a detail account of how each material was used as fuel, Other than rags, none of the other materials were used alone, they were all treated to an extent. Throughout the process, the factor under strict consideration was that a major change cannot be brought about in the material to be as used as fuel because then the potters will not be able to get them in future and secondly the firing method and type of kiln should be such which suits the potters work and is easily made.

With reference to the above report the decision of best fuel amongst the ones tried can be achieved.
MATERIALS USED AS FUEL FOR FIRING AT KUMBHARWARA

Figure 5: Saw dust

Figure 5: Cow dung cakes mixed with dry grass and saw dust left for drying.

Figure 6: Cow dung cakes mixed with saw dust and paper pulp left for drying.

Figure 7: Rags from textile factories.
DISCUSSIONS

After analyzing the report of firing, it was necessary to also see what material was easily available and how much extra time would it take for the potters to actually prepare the fuel. Currently the potters use shoes, which are readily available to them and they just need to buy them and stoke them.

Following are some of classification done with the consent of potters in order to figure what suits them most.

DETERMINING THE BEST FUEL

Sufficient Availability of Material

The four types of material used for this experiment are news paper, cow/cattle dung, textile waste and wood shavings/saw dust.

a) News paper is a source of raw material which will be available to the potters on a daily basis because the circulation of both English and Urdu news papers is on a daily basis therefore, availability is of no issues.

b) Cow Dung as a source of fuel was also not such a great deal to find as almost all the potters have animals of their own, if not at the workshop then at their homes. Since cow dung is the most commonly and successfully used raw material compared to other materials large quantities of cow dung needs to be available. Upon talking to the potters they said that cow dung can be collected on weekly basis.

c) Textile waste was slightly costly because the factories are far away.
d) Wood shavings and saw dust was easily available because there is a huge furniture market on the way towards kumbharwara. A large amount can be collected on alternate days.

**Minimum cost of transportation**

a) News paper has little cost of transportation as assistance is taken from Afghani boys who collect paper and charge 100 for each visit. Many kabari wala’s are also found on the way to kumbharwara and they are willing to give news papers to the potters and charge them according to weight.

b) Cow dung transportation has minimal cost for the rent of push cart that is 50 rupees rent for one day. The potters rent these carts and stack the cow dung from their homes and bring them to the workshop.

c) Textile waste has a high transportation cost, the nearest factory is in site and one trip of Suzuki takes minimum 500 rupees and the ones which are far go up to 1000 rupees.

d) Wood shavings and saw dust have the same transportation cost as cow dung, here also, the potters can rent the cart and bring wood to the work shop.

**Maximum Environment Friendly Fuels/minimum time of firing**

a) News paper in form of pulp burns down slowly and does not create too much smoke; the little that comes out is also white in color. The firing duration of this material was 7 to 8 hours.

b) Cow dung when used as fuel in dry form burns like grass, it burns fast and no black smoke comes out of chimney. It is slightly gray in color. Firing duration of Cow dung is 5-6 hours.
c) Textile waste is the least environmentally friendly fuel compared to the other materials. It burns down in a very unstable manner, the textile rags have nylon, cotton, wool, linen and different types of rags which make the firing very uneven, some time the rags take very long to burn and some time they burn out immediately. The smoke also changes with the difference in material stoked in the fire box. The duration of this firing is 10 hours.

d) Wood shavings and saw dust also changes with the kind of wood that is available. Partal and teak wood gives lighter smoke but thin wood commonly known as chara gives very dark color fumes. The time duration of firing varies from 4-6 hours, depending on the kind of wood stoke. Saw dust gives more smoke when fired alone but mixed with cow dung is more environmental friendly.

**Minimum Consumption of Fuel and Easy To Use**

a) News paper as a material is used in large quantity, because when the pulp is made of news paper then it becomes less in quantity, therefore large numbers of news paper are required to make pulp. If compared to readily available raw material, then there is little hard work required to make pulp because first news paper needs to be shred and mixed in boiling water so that pulp is made, then the pulp needs to be dried.

b) Cow dung becomes the most integral part of the fuel, therefore it is better to have larger quantities for faster and better firing results. Treating the cow dung is a difficult and dirty job but women in villagers are use to treating and drying cow dung so it is not an impossible task.
c) Sorting the textile waste was time consuming but tying knots was faster. Stoking the textile waste was difficult as it has no volume.

d) Wood shavings saw dust needs no treating and can be stoked easily.

During the visits to Kumbharwara, one thing that I noticed was that there are no female potters. The women stay at home and do house chores and are free rest of the day. Therefore, with the help of the potters, women were asked to help their husbands make fuel at home with which ever from the above material was easily available to them. For most of them, cow dung, wood shavings, saw dust and paper was easily available. Therefore, the potters fire the kiln once in a week or sometimes larger kilns once a month and the women at home prepare fuel in large quantities.

Apart from bisque firings which our potters do, there are certain firings which include smoke firing, paper kiln firings and sager firings. These are low temperature firings, done in temporary kilns and they last for two to three hours maximum, it produce no smoke and gives very dramatic affects.

In order to promote the potters work and increase their sales it is important that they produce a small quantity of different type of work therefore it was decided that the potters will also be doing these second firings of the pots which are slightly defected or under fired so that even they could be sold on lower rates and improve in the income. These firings can be done after the bisque firing as the temperature in this firing reaches up to only 400 degrees to 500 degrees centigrade. A test firing took place only so that the process could be explained. Although this was not part of the dissertation but was a small way to improve the income of the potters and an idea which costs nothing. These types of
firings are not done regularly; potters can keep on collecting work and fire once a month and sell these pots in weekly market.
CONCLUSION

In the light of the research done which was completely experimental. I have concluded that the potters no doubt have knowledge and expertise from their fore-fathers but the realization of the fact that things have changed is not found amongst them. The fact of global warming which was not of such a big concern fifteen twenty years ago is now one of the biggest problems the people are facing but local potters are oblivious to this. Therefore after an in depth research, it is visible that although potters have no support from the government but they themselves are also not utilizing the available resources due to lack of knowledge and lazyness. If the correct steps are taken, then there is great possibility that the craft of pottery making will revive again.

When I started this research I was told repeatedly that the potters are more experienced and I will not be able to find any new fuel to help them revive the pottery craft. But this whole journey has been extremely knowledgeable for me as I was able to find out about different kinds of kilns and also the different fuel used. I have based my dissertation on experiment because I feel that these experiments will help me understand the nature of each material, which I will use as a fuel. And by experimenting with individual materials I was able to compare the results easily and such kind of research cannot be done only on the basis of secondary data. Therefore, I feel, my chosen way of experimenting in depth primary research is the most effective way from which I have been able to reach to the closest possible result of finding out if there is any alternative fuel that our local potters can use.

The materials which some of the potters have started using after my research are the ones which were already existing but were not used for this purpose. After this research, the
potters can use these materials by mixing them and creating a new fuel for themselves which is cheaper in cost, easily available and produces better firing results compared to the shoes they burn which also affects the environment. The treated fuels and the means of transporting them to the potters work shop has been the integral part of the dissertation as I was aware that a one time experiment will not do any good for potters therefore it was necessary to use material which has long term availability and to convince the factory owners to contribute towards the revival of this craft.

Just by bringing minor alterations to the existing material I have been able to provide a source of raw material to the potters which can produce better results and cut down on their cost of production. It is hoped that this will contribute towards the revival of the craft in Pakistan.
BIBLIOGRAPHY


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<table>
<thead>
<tr>
<th>Glossary</th>
<th>Definition</th>
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<tr>
<td>Bisque:</td>
<td>Preliminary firing of the ware to 1000 degrees centigrade</td>
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<tr>
<td>Chara:</td>
<td>A very thin strip of wood, usually used for packing material</td>
</tr>
<tr>
<td>Cooling:</td>
<td>When the temperature of the kiln starts to decrease</td>
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<tr>
<td>Kiln:</td>
<td>A large oven for firing, pots</td>
</tr>
<tr>
<td>Kumbharwara:</td>
<td>A place where a lot of kumhars work in different groups</td>
</tr>
<tr>
<td>Kumhars:</td>
<td>Potter</td>
</tr>
<tr>
<td>Partal:</td>
<td>Type of a wood</td>
</tr>
<tr>
<td>Refractory:</td>
<td>Term used for material with high temperature. Term usually used for fire clays</td>
</tr>
<tr>
<td>Stoke:</td>
<td>When fuel is thrown inside the kiln</td>
</tr>
<tr>
<td>Teak:</td>
<td>Wood</td>
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