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Techno-economical Up-gradationStrategies of Traditional Terracotta up-draught kilns

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Abstract:

Indian red clay-based pottery or terracotta has become a significant cottage industry in the past few decades. And it is one of the rural industrial sectors in our nation, thus many rural families rely on the sale of pottery as a source of income. For several generations. Potters are still using traditional processes for producing pottery. Due to the traditional age-old method, the manufacturing cost of pottery is also high as well as the potters are unable to maintain the same standard of quality, and to ensure productivity. As a result, this pottery is unable to compete with potteries available in the market due quality of the product. Accounting the demerits of Traditional age- old methods led to study the Techno- economical Up-gradation Strategies of Traditional Terracotta up-draught kilns. These kilns suffer higher fuel consumption, poor ware strength and extensive breakage. Smokes produced during firing will serious health problems to pottery workers and their family. Therefore, thermal studies on kilns are required to advise necessary modifications. This modification is suggesting for the new design of improved pottery kiln, which will be able to achieve uniform temperatures inside the kiln, decrease fuel consumption through better heat distribution and thermal insulation ofkiln walls.

Key words *: Red clay, Techno economical upgradation, ware strength, fuel consumption*

1. Introduction:

The Techno economical Up-gradation of rural industrial sector is the key to the development of our rural masses and for this, technical inputs are essential for reducing costs, increasing productivity, and raising the quality of output. The pottery industry uses a lot of energy, and most of thetraditional kilns used in rural areas to fire the pottery are relatively inefficient. The Pottery Cottage industry cannot afford the high efficiency white clay based pottery kilns utilized in the organized ceramic sector because of their high cost. The burning process in conventional kilns must be optimized to raise product quality while lowering production costs.

The main objective for this study is to overcome the limitation in the traditional kiln and improved pottery kiln by constructing an energy efficient kiln which helps to improve temperature distribution inside the kiln. The new, improved pottery kiln uses less fuel and maintains a more consistent temperature than older kilns. Itoffers potters a better working environment and fewer tendencies for spots on pots. Improved fire control results from longer gas residence times inside the kiln. Also contributes to reducing production costs and the construction of kiln is affordable to the villagers

2. Features of Indian terracotta Industry:

- The unit of production of Indian red clay pottery industry is of home scalelevel.
- Maximum older people whose age is above 45 years are continuing in the occupation. None of the respondents is willing that their children should learn this age-old traditional occupation.
- This occupation is not providing adequate employment for the respondents who are completely dependent on this occupation. On an average only 40 per cent families are continuing in this occupation, and the rest are engaged in other professions as an unskilled Labour. Some families who do not themselves produce pots prefer to purchase pottery products from other villages for the purpose of selling in their own villages to continue their caste tradition.
- Around 70 percent products are traditional, 20 percent is moderate and hardly 10 percent contemporary products are produced by the potters and they are either staying in the city or close to city.

- No modern technology and new techniques of production have been introduced.
- Villages nearer to forest are using firewood and others are using cow- dung cake as fuel for baking of product.
- Potters still using traditional technique of firing which is not suitable for high production and not suitable for quality of product.
- If potters have access to affordable scientific technology, they can maximize their profits while maintaining product quality.

Fig.1. Critical Scenario of Potter's community In India

Fig 1: Critical scenario potter's community in India.

3. Drawbacks in Traditional Kiln

i) The kilns are open without any walls except few with walls of small height (`2') resulting problem in loading of wares and non-uniformity in temperature due to movement of winds through kiln (through the cracks developed during firing in mud plaster).

ii) Plenty of heat energy is wasted, resulting lower thermal efficiency.

iii) Difficult to load the articles, being no regular platform as a result the articles are loaded generally in way which arrest the entry of adequate air-supply.

iv) Due to inadequate supply of air and irregular circulation of gases inside the kiln, the wares are generally produced non- uniform in colour and occasionally with black patches.

v) Without any controls devices in the traditional kilns, they are difficult to operate for controlled rise of temperature, resulting high rejection of goods.

vi) Finally, these kilns cannot be operated in rainy seasons.

4. Energy Budgeting of Traditional kiln

In a Traditional Kiln, The energy released by the combustion of fuel in a pottery kiln gets distributed with only a small fraction getting absorbed by the pottery. In traditional kilns, the walls are made very thick, which absorb a large part of the energy, which is essentially a loss. Also, the fuel is burnt directly on the floor, causing very high losses to the ground. A large part of the energy is lost due to high temperature of the flue gases exiting the kiln. Figure 2 gives the breakup of energy consumed in a traditional updraught kiln used at Kumharpara in Kondagaon, district Bastar, Chhattisgarh. Here highest loss is to the ground followed by the loss due to the energy stored in the kiln wall, which is 18" thick. Figure 2 gives the energy budget of another updraught kiln used in GramodaySangh at Bhadrawati, Maharashtra. This kiln had even thicker walls which stored 45% of the energy released during the operation of the kiln. The losses through the flue gases are nearly the same in both. Other losses include the convection and radiation losses from the wall exterior and the flames

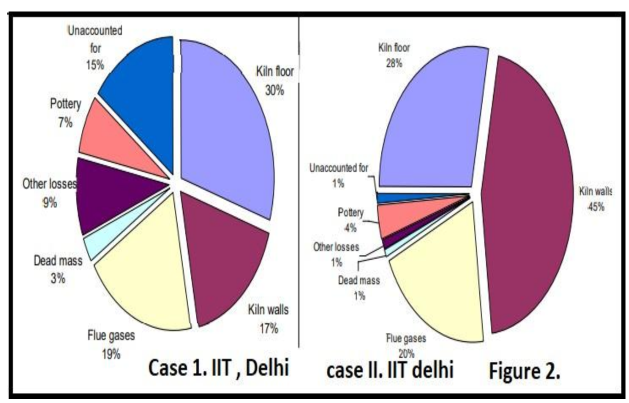

Fig 2: Energy Budgeting in kiln

The energy absorbed by the floor and the kiln walls is many folds higher than that absorbed by the pottery, because the walls and floor are several times heavier than the payload of pottery: The traditional Kondagaon kiln, for example, fires about 1000 kg of payload in a single firing, while the mass of the walls alone would be around 7500 kg of brickwork. A comparable mass of soil and bricks below the floor are also getting heated.

5. Non-availability of Techno-economical energy efficient low-cost kiln

Most of the potters in different regions are using the traditional kilns. In this kiln there is no provision to control the temperature and percentage of breakage is around 10 to 40 percent, which enhance the cost of finished product and reduces the profit margin. The fuel efficiency of these kilns is very poor.

The Mattikala board, Gujarat, has modified the traditional awa kiln and this has saved around 40 percent of fuel. But the survey with potters has revealed to be good only forbig pots like water pots. MGIRI, Wardha, has modified the up-draft kiln and reduced the fuel consumption around 33 percent. MGIRI, Wardha, had developed another energy efficient low-cost Cross- draught l gas kiln (1 cubic feet loading size) for value added terracotta products. But the size is good for studio potters. Still there is a need to develop different size of energy efficient, low-cost kilns. Lots of kilns are available in the market but these kilns are not affordable for small potters therefore there is need for development of energy efficient kiln.

In this study, further modification of the MGIRI's up-draught kiln is taken into consideration. The new, improved pottery kiln uses less fuel and maintains a more consistent temperature than older kilns. It offers potters a better working environment. Improved fire control results from longer gas residence times inside the kiln. Also contributes to reducing production costs and the construction of kiln is affordable to the villagers.

6. Adopted strategies / Features of New design Pottery kiln

I. Materials for construction are to be adopted, which are readily available with village potters and size/capacityof the kiln can be changed to suit the requirements.

II. The bottom ground, side walls and the top are insulated with a material, which is easily available and can be applied to kiln – Ceramic Fiber.

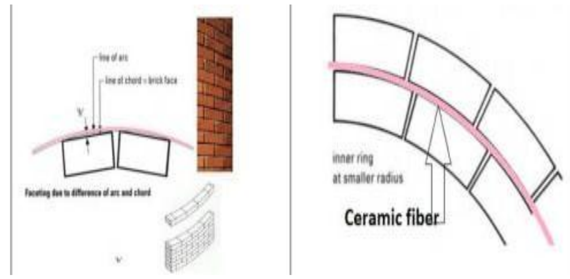

Fig 3: Ceramic Fiber insulation

III. The kiln is to be an enclosed cylindrical shape with chimney at the top resulting better retention of heat inside the kiln.

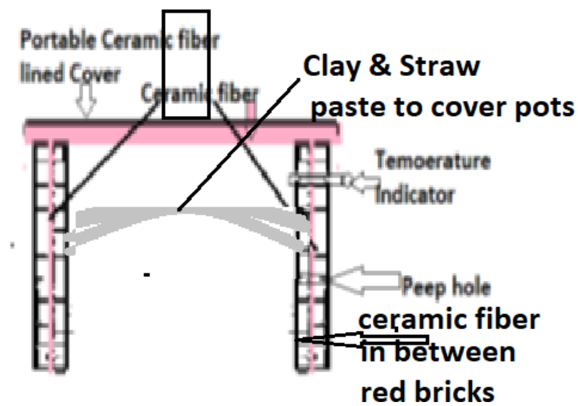

Fig 4: Ceramic fiber in between red bricks

Where, intermixing of gases generating from the bottom loading floor is provide so that the chimney can equalize the suction pressure from all the corners, middle of the kiln.

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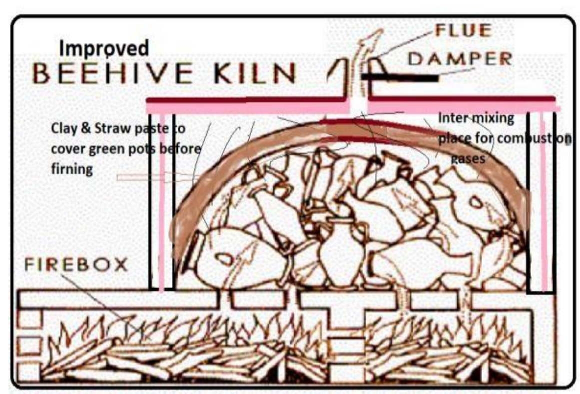

IV. Separate one or more fuel-feeding hole are to be provided, so that the entry of fuel can closely be regulated

V. Due to provision for separate fire grate with separate entries for air supply from bottom, the combustion efficiency of wood fuel is enhanced, resulting more efficient than traditional kilns and a temperature around 1050^{o}C can be attained.

VI. A Top loading and regular platform are to be provided for easy loadingof articles.

VII. Operation of kiln is to be designed very simple in view of the controls provided and the same can be operated by semi-skilled workers.

VIII. The kiln is to be free from threats of the fire accident and can be operated in rainy seasons.

IX. Temperature Uniformity inside the kiln is to be good and thus reproducible quality is assured.

7. Modifications in Energy efficient kiln

The kiln is cylindrical or rectangular in shape consisting of

(i) Fire grates.

(ii) Holes for air entry (3 Nos.)

(iii) Fire Box/Fire Chamber.

(iv) Fuel entry holes(3Nos.)

(v) Loading platform with holes for heat circulation.

(vi) Loading chamber.

(vii) Crown and,

(viii) Chimney centrally placed at the top of the kiln.

(ix) Air holes in side walls to control the secondary air, if required.

The combustion chamber provided separately with provision for supply of preheated air facilities for proper combustion of fuel. The top of the kiln is covered with a permanent dome with a centrally located Chimney. The dome helps to conserve the heat inside the kiln chamber and also ensures temperatures uniformity in different zones of the kiln.

The Chimney provided centrally at the top of the kiln is also fitted with a damper at the bottom and helps to improve draft in kiln. The draft is regulated with the help of damper. The dome is also provided with four flue gas holes to increase thetemperature as well as for rapid cooling.

The entry of fuel is regulated through fuelholes provided at equal distance apart. Thereare also 3 Nos. air – entry holes placed at equal distance apart beneath the fire grates. The platform provided for loading of articles has number of holes for the entry of hotgases and flames inside the kiln. Thenumber of holes on the kiln floor/platform depends on the size and capacity of the kiln. Articles are loaded in the kiln 5from top astraditionally. The kiln wall is tied up at twoplaces, (top and bottom) with the help of flatiron strip.

8. Operation of Kiln

The kiln was loaded with terracotta wares and covered with an Iron sheet dully fitted with Ceramic Fiber and a ceramic coating the kiln was lighted up with leaves and straws. The firing was slow (60^{o}C/hr. for about 6 hours) at the initial stage to allowthe wares to dry up slowly to avoid drying cracks. The slow firing was attained by regulating the air entry to the lower side as well as the fuel (viewing the length of flame on lower side). After attaining 360^{o}C the firing was slightly speeded up by increasing the entry of fuel and air. The fuel entry holes were closed immediately after charging of firewood to avoid the entry of cold air as well as to cut down the heat losses by radiation from the fire-boxes. The air entry was provided from bottom of the fire grate it got pre-heated before reaching to the combustion efficiency of fuel.

The temperature was measured with the helpof charomal-Alumel thermo-couple at different interval of time. The rate of rise of temperature was ascertained by plotting the time and temperature curve. During the firing the kiln was closed on completion of firing after 15 hours. All the holes in the kiln were properly closed and the kiln was allowed to cool under natural condition for 24 hrs. It was observed later on that the holes may be kept open for better colour development of terracotta wares.

9. Conclusion :

The above study provides a solution to the drawbacks of traditional kiln. These kilns suffer from higher fuel consumption, poor ware strength and extensive breakages. This paper helps to accounting the demerits of traditional kilns and upgrade the traditional kiln by technically and economically for small potters which led to the development of an energy efficient pottery kiln by modifying the parameters of traditional kiln and provide suitable insulated boundary to reduce the extensive breakages of kiln.

References

traditional pottery kiln for terracota wares Volume: 09 Issue: 08 | Aug 2022 irjet