

The Manufacture of a Cement Extender from Rice-Husks using a Basket-Burner

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Ingredients

The only ingredient is rice-husks. However, to make a strong mortar, some additional calcium oxide (quick-lime) or Portland cement will be required.

Husk is obtained as a by-product of threshing **padi**. In fact, about 20% of the dry mass of harvested **padi** is husk. Of this residue, somewhere between 17% and 23% by weight is left as ash when the husk is burned. The ash is about 95% pure silica, and, if properly prepared, it is in an active form¹ which behaves very like cement.

The main problem in producing active silica from rice-husks is to burn them at a temperature below about 800°C to stop the silica forming inactive crystals. But it is also necessary to burn them for long enough so that all the cellulose burns away and leaves a white or grey-coloured ash.

The use of a simple basket-burner ensures that these conditions will occur.

Equipment

The basic equipment comprises two baskets - one large and one small. One alone will work but results are

more consistent if a small basket is placed concentrically inside the larger one. The reason is that the small basket allows for a more even combustion with sufficient access for air.

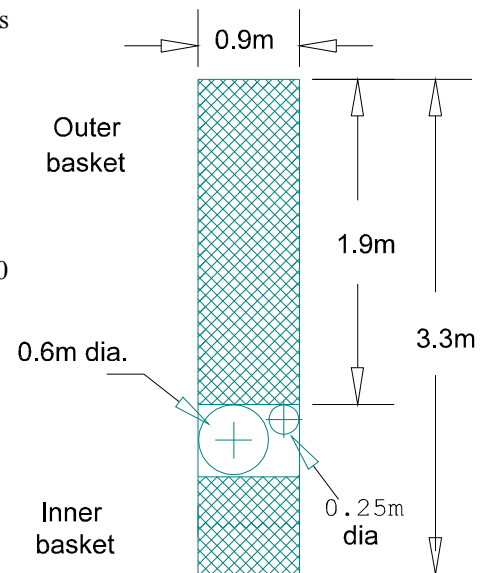
The larger basket should be about 600 mm in diameter and about 900 mm high. An inner basket of 250 mm diam and 750 mm depth should be positioned concentrically as shown in the sketch.

Both baskets are conveniently made from steel mesh having no fewer than four holes to the centimetre. (25 mesh/ins is very suitable).

The attached sketch shows how the mesh can be cut from a roll of mesh to minimise waste. There is no need for the mesh to be galvanised (coated with zinc) because this will burn off in the operation of the process.

However, using stainless-steel mesh is worthwhile if regular use is planned. This is because it can stand the high temperature, rain and some rough-handling without corrosion occurring. The basket should be supported with small pieces of brick or flat stone about 40 mm above the ground to let air get underneath it. Of course the ground should be level and free of plant growth for the same reason.

Because sudden rain showers can limit combustion and a wind



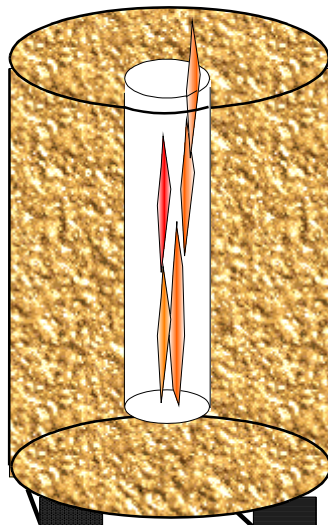
Cutting plan for wire mesh

blowing on the basket can increase the local temperature, the basket may have to be placed in a 200 litre drum and fitted with a cover.

The drum does not have to be new or even clean so long as it keeps wind and rain off the rice-husks in the basket. To ensure that sufficient air can get to the rice-husks in the basket, at least 10 holes of about 10 mm diameter should be drilled or punched in the base of the drum. It is also a good idea to put flat stones or bricks under the drum as well as under the basket.

Quantities

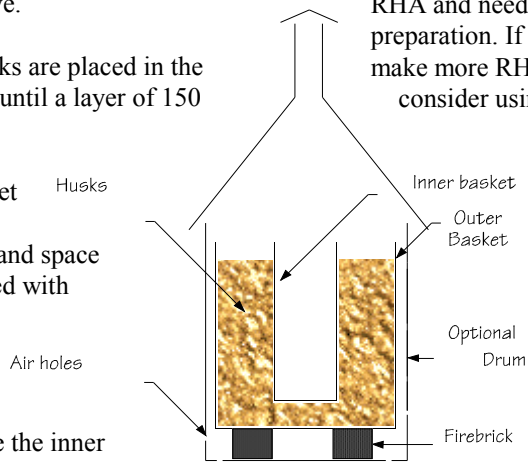
The basket described takes about 20 kg of rice-husks which occupy about 0.1 m³. Typically, one burning takes about 15 hours and produces 4 kg of Rice Husk Ash (RHA).



The Process

The basket should be positioned away from homes because it produces smoke. However, it can be placed under a roof provided that there is sufficient ventilation. If rain or winds are expected, the basket-burner should be under such a cover or inside a 200 litre drum as described in the Equipment Section above.

Dry rice-husks are placed in the large basket until a layer of 150 mm is formed. The smaller basket can then be put in place and space between filled with husks. There should be no husks placed inside the inner basket.



Ignition can be achieved by dropping a piece of burning paper or hot charcoal into the central basket. Alternatively, a piece of rag soaked in used engine oil and ignited can be dropped into the central basket.

YOU SHOULD NEVER USE PETROL TO IGNITE THE HUSKS !!

About 10 minutes after ignition you will probably see some flames. Then the burner should produce a little smoke (which keeps away flying insects but makes your eyes water!)

After about an hour, the side surfaces should be smouldering and turning black. This smouldering spreads slowly up the sides and the bed height reduces. There should be no flames produced at this stage although, as the husks collapse, there may be some sparks and a flame for a few moments.

If the process is started in the morning, the ash should be ready for removal on the following morning. However, it may still be hot enough to cause burns, melt plastic bags or

ignite paper bags **SO BE VERY CAREFUL**. The ash should be white or grey with only a little black char. If the ash is to be used as a cement-substitute or extender, it should be used as soon as possible because it loses its activity in moist air. Alternatively it could be stored in air-tight cans or double plastic bags. The basket is immediately available for making more RHA and needs no preparation. If your object is to make more RHA, you might consider using more baskets.

However, for full commercial operation, this is expensive. There are two alternatives:

1) In India and Pakistan, brick burners are used. They are built in

modules on a square base approximately 1 metre by 1 metre. The bricks are built into a wall but with some bricks omitted to allow air to enter. However, to stop husks spilling out, the modules are lined with mesh.

2) Two rolls of mesh can be unrolled and held upright with steel rods driven into the ground. The mesh provides the walls for a roughly circular path about 800 mm wide --- rather like a race-course. Rice-husks are loaded into the gap between the two walls for a distance of about 3 metres. The leading edge can then be ignited and more husks added to the cool face ahead of the burning. Husks can be added right around the circle to the opposite side. The next day, RHA can be removed until it gets too hot to handle and more husks added to the cool side to replace the ash removed. In this way, the fire is encouraged to go round the path continuously with husks added ahead of the fire and ash removed from behind it. Some sheets of corrugated iron can be used to build a shelter over the fire and rice-husks. This may be moved

around as needed or built into a permanent cover over the process site.

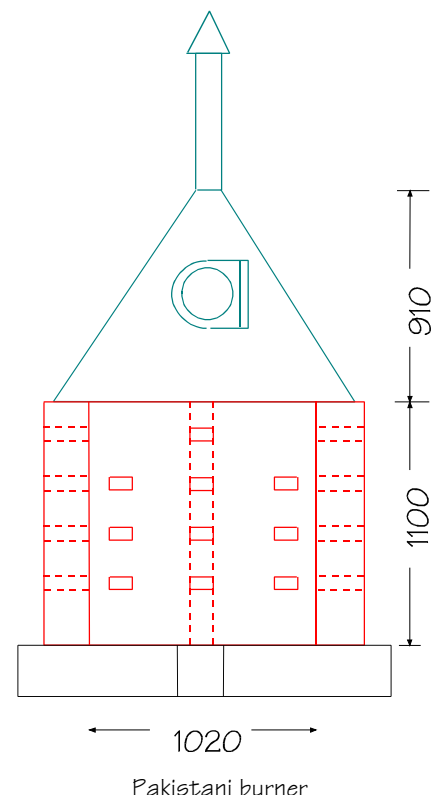
Making Cement

Rice-Husk Ash can either substitute for some of the cement in a mortar or it can be mixed with quicklime to make a hydraulic, cement-free mortar.

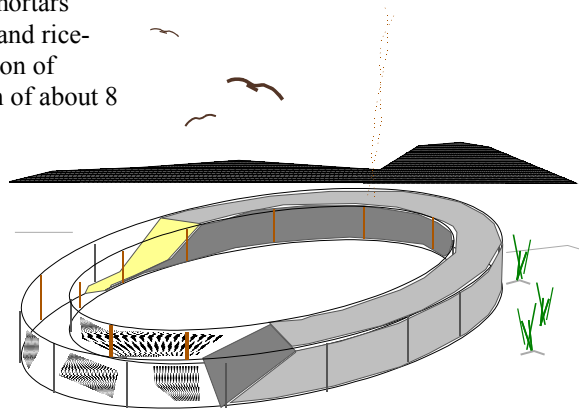
If you are interested in making such a material commercially or testing the properties of various mixes, you should consider grinding the rice-husk ash with cement (or calcium oxide) in a rod mill.

The accompanying sketch shows one made at the Asian Institute of Technology in Bangkok using a 200 litre drum mounted on a pair of car back-axes and driven by an electric motor. (Alternatively, the drum can be supported on rollers). The "rods" are from left-over pieces of reinforcing steel and should be slightly shorter than the drum so that they are free to move inside it.

You are also advised to obtain a book by Cook and Suwanvitaya² setting out the properties of various mixtures.



They have shown that mortars made from lime (CaO) and rice-husk ash in the proportion of 1:1.5 develop a strength of about 8 MPa after 28 days. And this is quite strong enough for some simple, non-load bearing structures. Cook and Suwanvitaya also showed that if increased strength is required, some of the lime may be substituted by cement.



bricks for use in making ceramic kilns and domestic cooking stoves.

References

- 1) Rice-Husk Ash Cements: United Nations Industrial Development Organization (with Govt. of Australia), Vienna (1984)
- 2) Cook, D.J. and Suwanvitaya, P. :Properties and behaviour of lime-rice husk ash. UNCIV Report R-208, University of New South Wales, Australia, 1983.
- 3) Mehta, P.K. :The chemistry and technology of cements made from rice-husk ash. Proc. UNIDO/ESCAP/RCTT Workshop on Rice-Husk Ash Cement, Peshawar, Pakistan, 113-122, 1979

Typically, a 1:1.5 cement:RHA mortar develops a 28 day strength of about 20 MPa and mixes containing cement:RHA greater than 1:0.67 actually show approximately the same 28 day strength as straight cement (i.e about 50 MPa)². Thus RHA may be used as a substitute for expensive cement to provide mortars possessing a range of strengths. The various possibilities are presented in Table 1 taken from the publication by Cook and Suwanvitaya². You should note that the highest strengths are only achieved if the RHA and cement are ground together for about two hours.

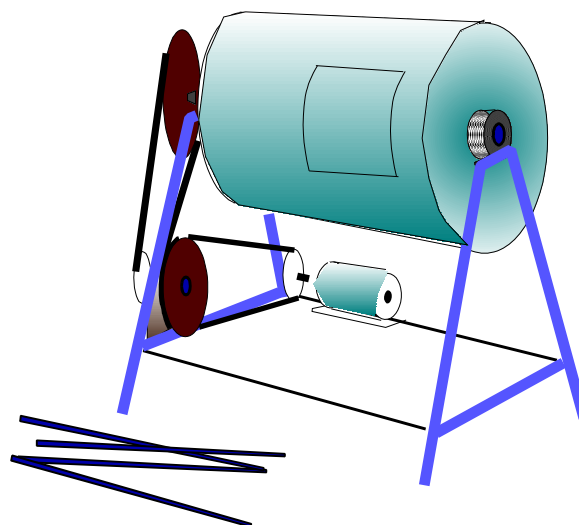
It could usefully form the basis for either undergraduate or post-graduate research at a University because the amorphous silica formed by the basket burner can be dissolved in sodium hydroxide to produce sodium silicate. Indeed, this process may be of value to an entrepreneur because sodium silicate is a high "value-added" chemical used in the slip-casting of ceramics and also as a multi-tonne inorganic adhesive for such products as corrugated card-board.

The incorporation of rice-husk ash into a mortar is reported to also confer extra resistance to acids³. Thus mortars made from RHA could be used to construct houses, rodent-proof rice stores, drains in acidic soils, bio-gas generators and milk-resistant floors in milking sheds.

Rice-husk ash has also been used as a low-cost sterile filler in plastics and soap. It has been shown to be biologically inactive and to make an excellent hydroponic matrix in which disease-free plants can be raised and seeds germinated. A 12:1 rice husk ash:cement mix has also been shown to form excellent castable insulating

Some other possibilities

This Project Outline will be of use to village co-operatives and rice-mills where excess husks are available during milling operations. This Outline may also be of use to schools as part of a building or fund-raising exercise. The process described also has some educational value in science classes.



AIT Rod-mill

Table 1

Compressive strength of cement-lime-ash mortar mixes

cement:lime:RHA	water:cement	Cube strength (MPa)				Fineness (cm ² /g)
		7 days	28 days	90 days	365 days	
100:0:0	0.49	29.3	43.0	47.2	44.0	3190
80:0:20	0.61	23.4	49.9	51.3	54.4	4640
60:20:20	0.61	22.3	36.2	38.9	41.3	7480
60:0:40	0.62	19.1	41.6	47.1	52.3	5860
40:40:20	0.67	11.2	18.3	20.8	21.8	11890
40:20:40	0.69	14.9	24.1	27.1	28.3	8320
40:0:60	0.74	13.2	17.8	19.4	19.9	10830
20:60:20	0.79	4.8	7.8	8.5	8.4	16360
20:40:40	0.74	7.9	11.3	12.7	14.6	14100
20:20:60	0.75	8.4	13.6	14.5	14.8	11560
20:0:80	0.82	4.8	6.2	7.1	7.6	10690
0:40:60	0.86	6.3	8.5	8.5	8.5	14180
0:20:80	0.89	6.4	6.7	6.9	6.8	12190

Source: Cook & Suwanvitaya²

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