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Inexpensive Rod Mill for Grinding Rice Husk Ash.

Background

Rice husk ash is a pozzolana. A pozzolana is a natural cement. Rice husk ash is mostly silica. If rice husk is burnt at a temperature lower than 600° C, it is amorphous silica. This means that it is in a form that is soft and easy to grind. If burnt at a higher temperature it will be crystalline silica; hard and difficult to grind. When the ash is ground to a fine powder, it can be used to partially replace cement, or be combined with lime to form a cementitious binder. A mix of 70% Portland cement and 30% rice husk ash can have a 28 day strength as strong or stronger than 100% Portland cement. The 3 and 7-day strengths will be lower than 100% Portland cement. The major cost in producing rice husk ash cement is in grinding it. The grinder is expensive. This article focuses on the development of a small grinder called a rod mill. The original design for this mill was done at the Asian Institute of Technology. The design has been improved to make the ash easier to put in and get out of the grinder.

A field brick kiln fired with rice husks.

Most pozzolana grinders are of a ball mill design. That is they use many steel (or sometimes ceramic) balls to crush the ash. The balls and ash are placed in a large enclosed cylinder and the cylinder is turned. The balls are expensive.

The Pichai Rod Mill

The Pichai rod mill (named after Dr. Pichai Nimityongskul) uses smooth reinforcing bar to crush the ash. These rods are the same ones used to reinforce concrete in small buildings. The rods are cheap.

The Modified Pichai Mill with rods removed.

Pichai Rod Mill Specifications

Type:	Rod, tumbling	
Size:	Diameter: 600 mm	length: 900 mm
Capacity:	16 kg of raw rice husk ash	
Power usage:	0.87 kW	
Drum Speed:	107 rpm	

Grinding media:	Smooth steel reinforcing bar	diameter	length	weight per rod	Qty.	total weight
		5/8”	890 mm	1.10	51	56.1 kg
		1/2”	890 mm	.62	51	31.6 kg
		3/8”	890 mm	.35	52	18.2 kg
						105.9 kg

Grinding time to achieve 90% pass of a 0.050 opening sieve	30 min.

The Improved Pichai grinder includes a door on the end of the drum instead of in the middle. Doors in the middle of the drum usually leak a lot. A door on the end of the drum leaks only a little. A hand crank is used to position the door for loading and unloading. Lifting rods are inserted to raise the grinding rods so that the ash can be removed.

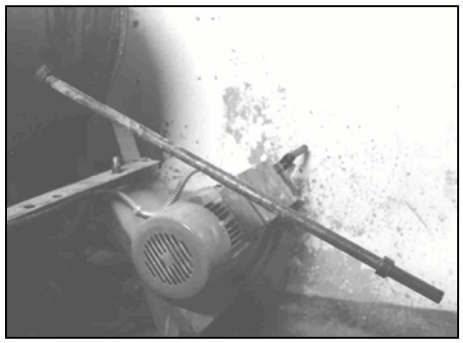
Lessons from Development

The results of this development are that secondary and final drives need to be chain drives. V-belt drives slip when the hand crank is used.

The wedge lock makes the end door easy to open and close.

The end door location does allow relatively easy loading and unloading of the drum. The door sealing mechanism works well. It has no threads to wear out and locks securely. It is easy to open and close. The lifting rods in the drum do allow the ground ash to be removed easily. Although, a significant amount of ash is raised with the grinding rods and cannot be removed. The hand crank does allow easy positioning of the door. With this method there is not much dust.

The hand crank is used to position the door.



The 2 lift rods are inserted in the side of the drum. Rotating the drum raises the grinding rods for easy ash removal.

The alternative to having an end door is having a door in the middle of the curved portion of the drum. There are 2 problems with a central door: it is very hard to get it to close tightly. A lot of dust comes out. It makes a cavity so that the rods do not grind against it efficiently. The advantages are that a portion of the ash can be easily removed. The grinder is run briefly with

the door open. This does cause a lot of dust but it is fairly quick and easy.

Future development needs include:

- an easy ash removal method
- a way to cope with the dust
- an easy way to remove brick chips from the ash before grinding
- a convenient way to handle and store ash from kilns
- a way to package ground ash or cement

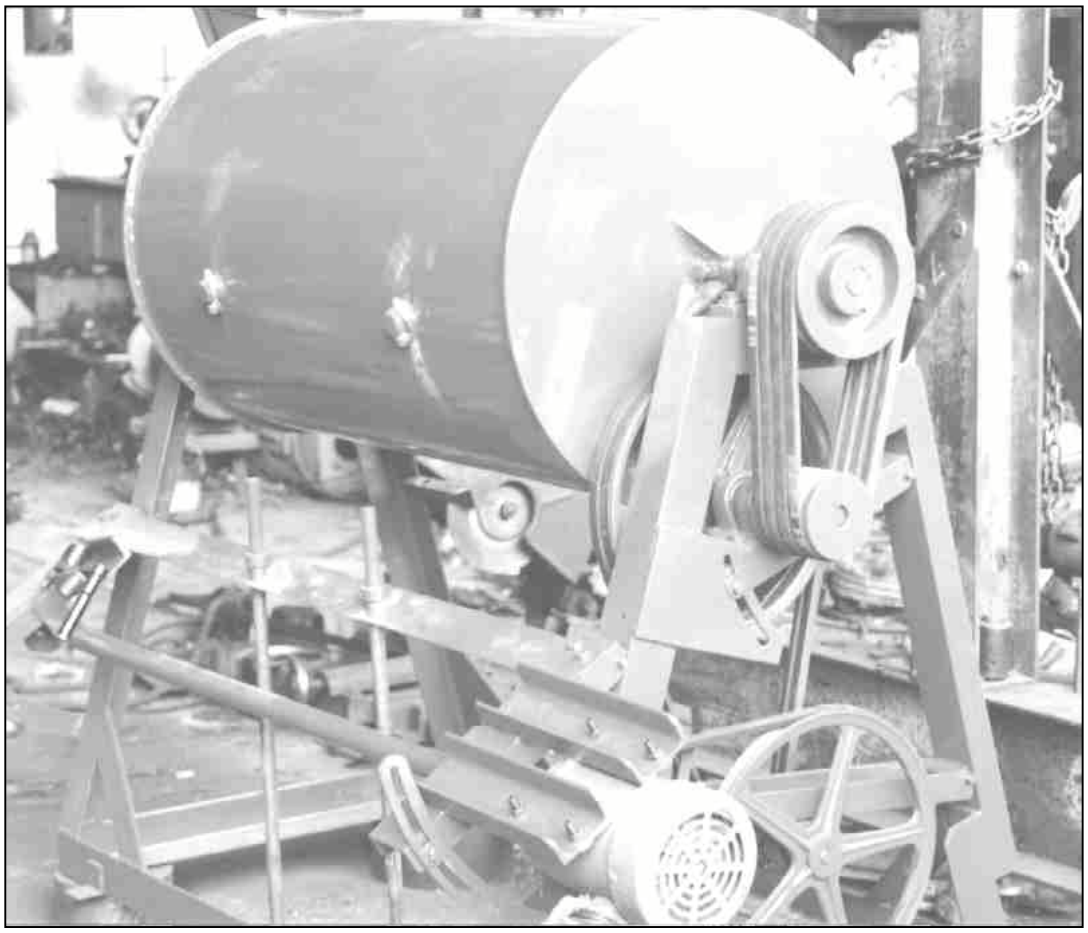
Materials and Fabrication

The drum is made from ¼" steel plate. The frame is made from angle iron welded together. Pillow block ball bearings are used for the shafts. The first attempt at the drive used V-belts. These did not work at low speeds. Chain drives are more appropriate for the intermediate and final drives. A metal fabrication shop with a steel plate roller is necessary to make this grinder.

Sifting brick chips out of the ash is a dusty job.

Limitations

This rod mill can handle a limited quantity of rice husk ash. The basic design can be expanded for larger mills (i.e., increased length and diameter).

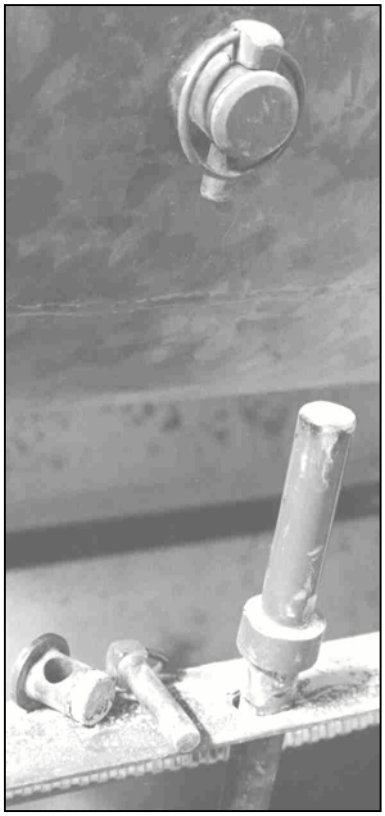


It is better to use chain drives in the secondary and final transmissions. This prototype belt drive slipped when using the hand crank.

Operation.

Put 16 kg of ash into the mill. Make sure it is spread about so that the rods do not become tangled. The rods will become tangled if too much ash is put into the grinder, or the grinder speed is too fast. The ash should be free from stone and brick pieces. Run the mill for 30 minutes then stop to remove the ash. It is a good idea to listen to the noise the grinder makes. If the sound becomes irregular, stop the grinder and check for tangled rods.

The grinder is moderately noisy. It is nice to be able to keep it in a separate room.



A clevis holds the lifting rods in place. Plugs with "O" rings are used when grinding.

Plans

Pichai Grinder design plans for use in making grinders locally are available. Plans are available from the CVBT. Please include $US 20.00 to cover postage and handling. Plans are also available from:

Regional Information Service Center for South East Asia on Appropriate Technology (RISE-AT)
Institute for Science and Technology Research and Development
PO Box 111 Chiang Mai University
Chiang Mai 50202 THAILAND
Phone 66-53-892189 FAX 66-53-892224
email Cnxnsmwn@chiangmai.ac.th

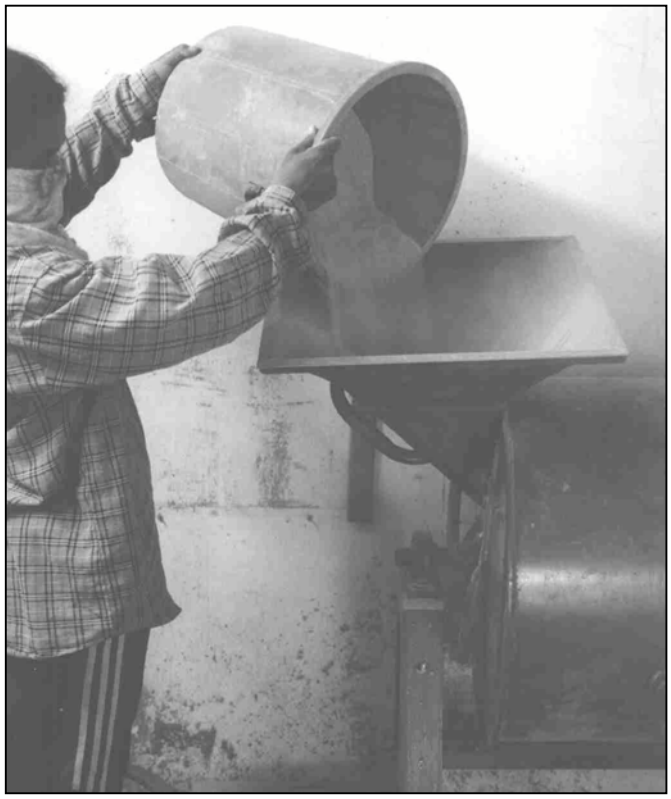
ISAT/GATE/GTZ
PO Box 5180
65726 Eschborn GERMANY
Phone (49 61 96) 79 31 85 FAX (49 61 96) 79 73 52
email gate-isat@gtz.de

Grinder Suppliers

CVBT
Pichai Rod mill Model PR-11 are available from the CVBT Price (excluding shipping) U.S.$800.00 Allow 6-12 weeks for delivery. Specify motor requirements (e.g., 220V single phase 50 Hz or 380V, 3 phase 50 Hz).

EcoTec
Schatzgutstr. 9
8750 Glarus, SWITZERLAND
Phone/FAX (41) 58 61 10 81

EcoTec markets a Cuban designed ball mill model MB-600. "The mill, with a body of 600x600 mm and a load of approximately 340 kgs of balls is capable of grinding 150 kgs of coarse material to powder (0.74 mm) per batch."



A removable chute allows easy loading.