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ID

Distr.
LIMITED
ID/WG.89/20
1 September 1971

United Nations Industrial Development Organization

ORIGINAL: ENGLISH

Interregional Seminar on the
Industrial Processing of Rice

USE OF INERT MEDIA (SAND AND PADDY HUSK POWDER) IN SIMULTANEOUS PARBOILING AND DRYING OF PADDY [1]

by

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id.71-6890

1. Parboiling is a process, wherein water is introduced into paddy kernel under controlled conditions by a process of soaking - cold or hot - and heat is applied (usually by steaming) to achieve the hardening and toughening of the kernel to give a product which can be easily shelled and milled with minimum breakage. There are a number of subsidiary effects, mainly biochemical, on which plenty of work has been done in all rice producing countries. It need not be pointed out that the mode and extent of the penetration of water during soaking and the subsequent hardening of the kernel during steaming are all important. Usually, in the trade, open steaming is employed. To a certain extent this causes the opening of the paddy and discolouration in certain zones due to localized over-heating in places where the direct impingement of steam occurs. Drying of parboiled paddy is a laborious and lengthy process. In modern rice mills which use oil fired mechanical dryers, it is a costly process which greatly affects the economy of the process.

2. In their search for a quicker drying method, the authors felt that if the surface of the drying medium were increased extensively, and the drying medium kept in very close contact with the parboiled paddy, drying would be quicker, more uniform and better. If the medium used were an inert one with low moisture retention capacity, drying would be quite fast at higher temperatures. It is essential that the inert medium should not combine chemically in any way with the paddy being dried, thereby introducing deleterious changes in taste, colour or odour which might have an adverse effect upon marketability. It should also act as a good medium for conveying and transferring heat, be readily available and cheap. The authors felt that sand would be cheapest material for parboiling and drying and paddy husk would be the cheapest source of heat in a paddy growing area. Use of hot sand for processing of various grains and for roasting has been a very old practice in India. For centuries it has been used to roast steeped pulses, including peas, and as the first step in preparing beaten rice (Aval). It is even reported to be used in preparing Sela Basmati type of rice in Saharampur District of Utter Pradesh.

3. Alternative inert media for rural areas in Southern India would be lime-stone, clay, laterite, and powdered paddy husk. The main advantage of lime-stone and sand is that they are inert materials which do not combine with the constituents of paddy kernel nor do they interfere with the taste or smell of the finished rice. Particles of the correct size offer a huge surface which, in close contact with the paddy assures absorption of moisture and transfer of heat. The media remain unchanged by moisture they extract, which is subsequently evaporated. When a desired level of dryness is reached, they do not stick to the paddy and can be easily sieved off.

4. The other inert media have certain shortcomings where this particular requirement is concerned. Clay and laterite, sufficiently subdivided, offer a comparatively larger surface and even a greater moisture reducing capacity. However, they have a tendency to stick to the paddy husk, particularly after heating, and are difficult to dislodge. Lime-stone powder works very well but is costly compared with sand. It is difficult to obtain in certain areas, particularly in the deltas where paddy is mainly grown. Powdered paddy husk is possibly the most promising material as there can be no objection to its use because it is an integral part of the paddy It is readily available in paddy growing areas. When powdered, it offers an enormous surface both for imparting heat and for absorbing moisture. When th paddy being treated is sufficiently dry, the husk powder can be easily sieved off. Its main defects seem to be the necessity to powder it fine, its tendency to retain moisture, its tendency to char and the possibility of its igniting, particularly in a finely powdered condition at the high temperatures employed.

5. In the first series of experiments conducted, wet paddy with a moisture content of 20 - 29 per cent was used. The sand employed was sieved to remove all larger particles; particles passing through 20 mesh (894 MCS) but remaining on 30 mesh (500 MCS) were used. The sand/paddy ratio used was 1.5 : 2.0 by wt. The sand was heated to 120 - 150°C, whereupon paddy was added and quickly stirred to attain a good mix. The hot sand offered an enormous inert surface at an elevated temperature. The hot particles surrounded practically every individual grain and thus offered a heating medium in very close contact with a good degree of temperature control. The vaporization of the grain moisture was rapid and accompanied by a rapid heating of the grain. Sand, being non absorptive where moisture is concerned, acts as a heating agent. Whatever moisture comes out of the paddy and wets the sand particle is not retained by the sand, but escapes upon agitation. This quick release and evaporation of moisture occurs simultaneously with heating. At this stage the sand was seived off. Usually when moist paddy was added, the sand temperature dropped to 80°C, whereafter it was raised and maintained at 100°C for 10 minutes; in some cases, 15 minutes was necessary. After this the sand was separated, the paddy was laid in a through-flow air current or spread out under a fan for about 30 minutes. After a period of tempering the paddy could be milled directly. At this stage it was also observed that by placing the paddy in a through-flow air current of 60 - 80°C (which can be produced by drawing air through tubes heated in paddy husk fired furnace) the moisture content dropped to below 16 per cent in about 10 minutes. The sand can be repeatedly used, thereby saving some heating

effort. The authors changed the sand after about a dozen treatments as it usually acquires a brownish tinge due to carbonization of organic particles in the chaff. However, if the sand is heated to about 300°C the undesirable brown colour can be removed.

6. While conducting experiments on the drying of freshly harvested wet paddy, the authors noticed that at a moisture content level of 20 - 29 per cent most of the grains were parboiled. Thus they proposed to exploit this phenomenon. Paddy was soaked in hot water maintained at 70 - 80°C for a period of 2 hours or given a normal cold soaking for 48 hours followed by sand treatment. The sand was initially heated to 150°C and soaked paddy was added, mixed and stirred for 15 minutes, until the husk lost its moisture and changed from dull brown to bright yellow. Usually during this period, the temperature dropped to about 80°C. The paddy was then sieved free of sand and spread out for cooling under shade; once cooled, it could be milled. The residual moisture was about 15 per cent, and the rice was perfectly parboiled. It was found that treatment with 4 per cent brine prior to sand treatment facilitated drying and parboiling considerably. The rice obtained was of good cooking quality and attractive in appearance, with very little browning.

7. The technique was applied successfully in the laboratory to the drying of salt parboiled and pressure parboiled paddy. The drying time was considerably reduced from 3.5 hours to approx. 20 minutes).

8. The authors successfully extended their work on sand treatment and the parboiling of paddy. It was found that when paddy is soaked for two hours in water raised to 100°C and maintained between 80 - 90°C and then treated in sand at 150°C for twenty minutes, simultaneous parboiling and drying occur. The authors conducted over a hundred experiments, using this method on a large number of paddy varieties common to Tanjore District including Co.25, ADT-27, ASD-11, Kichadi, Karuna and IR-8. It was found that excellent parboiling and drying can be done in one step. The moisture content of the paddy comes down to 16 per cent and, after a little aeration (spreading out under cover over night), the paddy can be milled quite easily. Details of drying rate are given in Appendix I.

9. On a laboratory scale the authors tested powdered paddy husk as a medium for parboiling and drying of cold soaked paddy. The experiment was very successful. The husk powder was heated to 100°C and paddy which had been soaked in cold water for 48 hours was added and vigorously agitated. The temperature was maintained at

100°C for 20 minutes. At the end of this period, the husk powder was sieved off and the paddy cooled under a fan for conditioning. At the end of this period, the paddy could be milled. The quality of rice produced was very satisfactory and the yield of head rice quite high (70 - 72 per cent). Details of the experiments are given in Appendix 2. Further work is in progress

10. The method as visualized by the authors for utilizing the sand treatment on a large scale as a village process is as follows:

(a) The sand can be stored in an overhead bin and fed a regulated rate through inclined cast iron or ceramic pipes into a paddy husk fired furnace (the same furnace can be used to heat the water for soaking, if parboiling is intended). The hot sand is then mixed with raw paddy (to be dried only) or soaked paddy (to be parboiled and dried), and the mixture is passed through a rotating drum provided with helical flanges to facilitate agitation. Baffles can be used instead of these flanges. The length of the drum can be adjusted to give a heat treatment of at least 15 - 20 minutes. Some of the flue gas from the furnace can be fed into a static outer drum on a counter current principle in order to maintain the heat level. Alternatively, the husk furnace can be used to heat air which can be sucked through cast iron or copper tubes with the help of a rotatory pump and fed as a counter current into the centre of the rotating drum particularly at the upper parboiling end. After the requisite period of treatment is over, the dried paddy passes over the last portion of the inclined rotating drum which is appropriately perforated for the sieving of the sand. The paddy travels along the rotating drum to drop into a funnel-shaped chute which empties on to a belt conveyer leading to a tempering bin.

(b) The paddy is fed from a manually filled overhead bin and the flow regulated by means of slide valves. A similar arrangement can be made for regulating the feed of hot sand. The sand and paddy are fed into a common tube at regulated speeds and into the rotating drum. The rate of movement during the parboiling-cum-drying operation can be regulated by adjusting the speed of the drum, and the proportions

of sand and paddy can be regulated by using slat valves adjusted to give the requisite mixture. The temperature of the sand can be adjusted by fixing the feed rate, the furnace temperature and the temperature and volume of the cross current air either in the outer drum of inside the rotating drum. If the temperature is too high, the hot air can be cut off and a current of cool air can be drawn to maintain proper temperature control. The sand heating pipe can be vertical or set at a steep angle so that the pipe can be kept permanently filled and sand hot.

(c) If the moisture content of the paddy is approx. 30 per cent as is common in freshly harvested wet paddy and in parboiled paddy, the proportion of hot sand can be raised to double that of the normal amount.

11. With intensive agricultural development, including short term crops of paddy (some of which have to be harvested right in the midst of the monsoon season), the drying of paddy has become a problem in many places. Treatment with hot sand can be used for quick drying. The sand treatment can be extended to achieve parboiling and drying in a single step. By this method the entire parboiling procedure can be reduced to about 2.5 - 3 hours and good quality parboiled rice without any acquired odour can be produced even at the village level at small cost.

APPENDIX I

Drying Rate During Sand Parboiling and Drying of Paddy

(1) IR-8 variety of paddy soaked in cold water for 48 hours. Moisture content of soaked paddy 28.5% and brown rice 29.1%.

(2) One lot of the above paddy parboiled and dried on sand heated to 150°C and maintained at 100°C after adding soaked paddy. Treatment for 20 minutes.

(3) One lot of soaked paddy parboiled and dried on sand heated to 120°C and maintained at 80°C with agitation after adding soaked paddy. Treatment for 20 minutes.

(4) Samples drawn at five minute intervals.

Moisutre Content of Brown Rice

Interval	Temp. original 150°C Maintained at 100°C	Temp. original 120°C Maintained at 80°C
5 Minutes	23.5%	25.1%
10 Minutes	18.5%	23.2%
15 Minutes	14.2% *	18.6% *
20 Minutes	9.1% *	13.5% *

In samples marked * distinct browning was observed on the kernel. This indicates that at 100°C, the drying time should not exceed 10 minutes.

APPENDIX II

Use of Husk Powder in Parboiling and Drying of Paddy - Experiment 1

(1) Paddy husk (1 kg.) powdered in a huller mill. The powder heated to 100°C.

(2) Paddy IR-8 variety soaked for 48 hours added to the hot husk powder, mixed thoroughly and maintained at 100°C for 20 minutes.

(3) Husk powder sieved off and the paddy cooled under a fan.

(4) Moisture content of paddy:

(a) As determined in moisture meter - 16.2%.

(b) As determined in hot air oven - 17.4%.

(5) Sample spreadout overnight under cover and milled. Milling performance is given below:

Paddy taken	850 grams
Brown rice yield	675 grams
Husk	175 grams
Percentage of polish given	5.9% (approx.)
Polished rice yield	635 grams
Bran yield	40 grams
Brokens	20 grams
Head rice	615 grams

Head rice %	72.3%
Brokens	3.1%

Moisture content of polished rice in universal moisture meter: 13.2%.

Rice produced was perfectly parboiled. No off-odour or off-colour. No browning. Paddy did not burst during heat treatment. Rice hard and tough. No white bellies. Indicates that under controlled conditions husk powder can be safely used as medium for parboiling and drying of paddy.

Experiment 2

(1) Paddy husk powder (1 kg.) produced in a huller mill heated to 100°C.

(2) Soaked paddy (soaked for 48 hours) added to the heated husk powder and mixed for 15 minutes with vigorous agitation. Samples drawn at 5 minute intervals and moisture content determined by oven drying method. At the end of the experiment the sample spread out and cooled for 2.75 hours at room temperature under a fan.

(3) Moisture content of paddy samples taken at 5 minute intervals:

Time	Moisture content in Paddy
10.20 hrs.	30.1%
10.25 hrs.	21.6%
10.30 hrs.	19.0%
10.35 hrs.	15.6%
Final sample after cooling under fan	Paddy 12.5% Rice 13.3%

(4) Milling performance:

Paddy taken	1,000 grams
Brown rice yield	790 grams
Husk	210 grams
Polished rice yield	755 grams (% polish 4.3%)
Bran	35 grams
Brokens	45 grams
Head rice yield	710 grams

Rice did not indicate any browning or any white bellies. Colour glistening white. Texture hard and tough. No smell of charred husk. Indicates that under controlled conditions husk powder can be used as an inert media for parboiling and drying paddy. There is no burning or charring of husk powder if properly agitated.

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