The Post-Drying Paddy Rice
(Nur Komar)

DETERMINING THE CRACKING OF THE POST-DRYING PADDY RICE
Nur Komar

Abstract

Paddy rice is harvested and dried firstly, and it is consequently necessary to determine the extent of the cracking. Some drying parameters involving the cracking ratio of the paddy rice are: 1) level of the drying air velocity; 2) the depth of the drying paddy rice pile; 3) temperature of the drying air; 4) the relative humidity; and 5) duration of the drying process.

The aims of the study are to 1) determine the relation between the paddy rice cracking ratio, the air velocity and the pile depth, 2) find out the appropriate drying air velocity and the pile depth for drying.

From the study result of Yamaguchi et al. (1980) suggested that the cracking ratio caused by thermal stress is highly lower compared to that caused by moisture stress.

Water loss of the air velocity 0.4 m s\(^{-1}\) at 1 cm deep was 10.37 % ww after 2 hours of drying. The slower the air velocity and the deeper the pile, the lower the cracking constant. The lowest cracking constant was at \(v\) (air velocity) = 0.2 m/s and 5 cm deep, that is 3.6165936 \(\times 10^{-3}\) minute\(^{-1}\). The cracking ratio-calculation results post-drying is relevant to the experimental results, in which the lowest cracking rate was found at \(v = 0.2\) m/s and 5 cm deep, that is 4%. The cracking size form found in the present study was the circular cracking around the paddy rice. Supplying the drying air velocity of 0.2-0.4 m/s and 1-5 cm deep in this study give the lower final cracking rate, that is 4-9%.

INTRODUCTION

Background of the Study

The cracking ratio of the paddy rice that is proportion of the cracked paddy rice in the entirely paddy rice is the important factor influencing their quality and ability to the subsequent process. The cracked paddy rice tends to be ‘breakable during grinding so that the entire rice produced much less, it means reducing the grinded rice rendement.

Having been harvested, the paddy rice was firstly dried, and the drying process affects the extent of the cracking ratio. Several drying parameters affecting the cracking ratio are: 1) the given air velocity, 2) depth of the paddy rice pile, 3) temperature of the drying air, 4) relative humidity of the drying air, and 5) the length of the drying.

The study is crucial because the alternative drying devices is needed when the paddy rice yield is ample, in which the drying process by the aero-spatial drying is impossible to do because it require the large space. Besides, for the exporting efforts is required the rice quality that meet the specified standards.

The cracking study using the mikroskopis approach need the sophisticated technique because of the relative small seed size. This study only focuses the cracking characteristics on the paddy rice macroscopically, in which the technical data collected is expected can be applied to determine the ideal paddy rice drying condition.

The characteristics of the paddy rice cracking, is studied by calculating the cracking ratio post-drying, through the semi theoretical approach involving the mathematical equation describing the cracking establishment post-drying.

The Purposes of the Study

The purposes of the study are:

1. Determine the relation between the cracking and the air velocity and the pile depth of the paddy rice.

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2. Find out the appropriate air velocity and the pile depth for drying

STUDY OF REFERENCES

General

Rice plant (oryza sativa L) is one of the seasonal crop included into grass class. Paddy rice grains consist of the edible meat called as caryopsis, and the other is the outer skin structure called as husk. The husk take part 18 - 28% of the entire seed weight at water content of 13% (Tjiptadi and Nasution, 1976). Quantitative requirement of the rice by Bulog can be seen in the table 1.

Table 1. Quantitative requirement of the rice quality by Bulog (Hartono, 1984).

Caryopsis is entirely covered around by husk composed from lemma, palea, and the upper-end called as awn (De Datta, 1981). The surface of caryopsis has curve caused by lemma and palea.

The main components of rice seed are husk, caryopsis coat, endosperm, and germ (De Datta, 1981). Caryopsis is almost consisted of germ and endosperm, the surface contains some thin layer covering germ and endosperm.

2. The Paddy Rice Cracking

The rice have been cracked before and after harvesting prior to grinding is result of tropic weather in which the temperature and humidity fluctuation relatively high, besides, the frequently rain. These can result in the seed become swollen and shrunk in order and irreversible leading to the cracking (Ruiten, 1981).

The cracking during drying occurs because the presence of the arbitrary heating, the excessive heating, hitting, and putting down against the material. The arbitrary heat can occur when the weather is bad, the suddenly rain, the beginning of drying in the midday, and also the overhot treatment of using the drying tool (Boesono, 1986).

Komar (1998) suggested that the technical parameters determining the paddy rice cracking post-drying, according to the effect level are: 1) drying temperature, 2) air speed, 3) drying time, and 4) the pile depth.

In artificial drying with various drying temperature will influence rendement and quality of the final grinded rice. Drying at 43,3°C will provide the higher head rice and rendement (Hartono, 1984). In the other hand, Kamarudin (1981) said that the good grinding quality of flat bed dryer by 700 kg capacity (depth 0.33 m) was at 45.5°C (plenum temperature) with air rate 0.43 m³/second.

The cracking of the caryopsis occurs is cause by the high difference of water content between the central endosperm and the peripheral part, so that rise the local pressing and pulling. These crackings lead to the rice become broken during grinding (Araullo et al., 1976).

Miwa et al (1979) in their experiment to investigate the paddy rice cracking by using x-ray photograph during the drying process, concluded that the size of the paddy rice seed each line shows difference, in which the longer seeds have the higher cracking ratio.

Nishiyama et al. (1979) pointed out that the paddy rice cracking ratio in the early storing post-drying is very high but after 72 hours storing the given cracking ratio become stabil. So that the effect of the drying condition against the final cracking ratio can be evaluated at the time of 72 hours after storing.

Based on the study of Yamaguchi et al. (1980) is found that the cracking caused by thermal stress is highly less compared to that caused by moisture stress, so that can be concluded that during the drying process, the cracking occurs because of moisture stress.

This result of study of Yamaguchi et al. (1980) can be seen in table 2 and 3.

Table 2. The cracking ratio during the drying with T₁ = 35°C and RH = 63% (Yamaguchi et al., 1980)

Table 3. Number of the cracked paddy rice from the cold paddy rice sample injected with hot air T₁ = 35°C (Yamaguchi et al., 1980).
Matematic Model of Drying and the Cracking Post-Drying

Drying model of the thin layer of the seed can be divided into 3 models, those are: 1) theoretical model, 2) semi-theoretical model, and 3) empirical model (Brooker et al., 1974).

While in drying of the thick layer of the seed, Sharp (1982) classified into 3 models, the partial differential, balance, and logarithmic model. Bowden et al. (1983) recommended that there is four drying models for the thick layer, 1) reducing water content model, 2) logarithmic model, 3) balance model, and 4) the model of Ingram (1976).

The drying model of the thin layer is derived upon the movement mecanism of the heat and mass, as well as the heat and mass diffusion of the product. The aid of establishing the matematic model, in Figure 1.

\[
F = 1 - \exp\left[-(\theta - \theta_o)^m\right] \quad \text{(2)}
\]

Substitution \( F = \frac{M - M_e}{M_o - M_e} \), drying equation can also be expressed as follows (Over Halts et al., 1973):

\[
\frac{M - M_e}{M_o - M_e} = \exp\left[-(kt)^m\right] \quad \text{(3)}
\]

THE EXPERIMENTAL METHOD

Place and Time

The study was conducted in the agricultural product processing technique laboratory, agricultural technique department, agricultural technology faculty, Brawijaya University from September to November 1998.

The Material and Equipment

The materials used were the field dried paddy rice of IR 64 variety derived from Merjosari Village, Malang. The equipments employed are:

1. Drying machine unit type batch model CSIRO
2. Glass termometer, with temperature range -5 - 150°C.
3. Higrometer, the wet and dry ball termometer, with range -5 - 50°C.
4. Windmeter
5. Balance, capacity 1 - 10 kg
6. Three-digit digital balance, capacity 0 - 10 grams.
7. Oven, temperature 0 - 150°C  
8. Moisturemeter  
9. Desikator  
10. Micromanometer model MK 5  
11. Thermocouple, ranging -5 - 150°C  
12. Psychrometric chart

The Experimental Method

Measurement of technical parameters was held on some drying air velocities and the pile depth, arranged in the following experimental set:

V1 = air velocity of 0.64 - 0.67 m/s, V2 = air velocity of 0.53 - 0.55 m/s, V3 = air velocity 0.44 - 0.45 m/s

T1 = the pile of 1 cm deep, T2 = the pile of 2 cm deep, T3 = the pile of 3 cm deep, T4 = the pile of 4 cm deep, T5 = the pile of 5 cm deep.

Table 1. The cracking constant

<table>
<thead>
<tr>
<th>V (m/dt)</th>
<th>Layer</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
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<td>3.618168 × 10⁻³</td>
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<td>3.620277 × 10⁻³</td>
<td>3.620040 × 10⁻³</td>
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<td>3.618426 × 10⁻³</td>
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<td>3.619725 × 10⁻³</td>
<td>3.618750 × 10⁻³</td>
<td>3.617778 × 10⁻³</td>
<td>3.6165936 × 10⁻³</td>
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ad.

T1 = 1 cm  T3 = 3 cm  T5 = 5 cm
T2 = 2 cm  T4 = 4 cm

The Implementation and Observation

The Implementation

Steps implemented in this study includes:
1. Preparation of equipment and materials
2. Installment of the measuring tool and regulation of temperature and drying air velocity based on the planned treatments.
3. Measurement of the initial water content.
4. The paddy rice is put into the drying bucket with the determined depth.
5. Balancing the initial paddy rice weight
6. The paddy rice put into the drying bucket is balanced, the obtained values is then substracted by the discharged drying bucket.
7. Measurement of the orificial upstream and downstream static pressure.
8. Drying machine is run for 2 hours
9. Measurement of the technical parameters each one hour.
10. Storage of the paddy rice in desicator for 72 hours
11. Calculation of the cracked paddy rice percentage, by opening husk using hand.

THE RESULTS AND DISCUSSION

After the drying process for 2 hours drying, the water content just reached 18.69%
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ww at \( v = 0.4 \text{ m/s} \), 19.35% ww at \( v = 0.3 \text{ m/s} \), and 19.12% at \( v = 0.2 \text{ m/s} \). Furthermore, drying for 6-9 hours thereafter can reach the final water content of 13-14%.

The Cracking Constant

This cracking constant is equivalent to the drying constant, so that the more the drying constant, the more the cracking ratio.

It was found that the lower the air velocity, the less the cracking constant. For example, in depth of 2 cm, the average cracking constant at \( v = 0.4 \text{ m/s} \) was \( 3.620277 \times 10^{-3} \), and getting increasingly less at \( v = 0.2 \text{ m/s} \), that is \( 3.619725 \times 10^{-3} \).

The deeper the pile, the less the cracking constant. At \( v = 0.4 \text{ m/s} \) the cracking constant with the pile of 1 cm deep was \( 3.620724 \times 10^{-3} \), this value was getting increasingly less at the pile of 5 cm deep, that is \( 3.619448 \times 10^{-3} \).

From the table below can also be concluded that the cracking ratio is becoming increasingly less at the lower air velocity and the deeper pile, in which the least cracking ratio was found at \( v = 0.2 \text{ m/s} \) with 5 cm deep, that is 4%.

<table>
<thead>
<tr>
<th>Air velocity, m/s</th>
<th>The cracking constant, menit(^{-1})</th>
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<tbody>
<tr>
<td>0.2</td>
<td>( 3.619725 \times 10^{-3} )</td>
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<td>0.3</td>
<td>( 3.620130 \times 10^{-3} )</td>
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<td>0.4</td>
<td>( 3.620277 \times 10^{-3} )</td>
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</table>

Figure 2. Air velocity and cracking constant 2 cm drying of paddy rice
The depth of rice drying, cm | cracking constant, menit$^{-1}$
---|---
1 | 3.620274 \times 10^{-3}
2 | 3.620277 \times 10^{-3}
3 | 3.620040 \times 10^{-3}
4 | 3.619608 \times 10^{-3}
5 | 3.619445 \times 10^{-3}

Figure 3. The depth drying of rice and cracking constant, $v = 0.4$ m/s
## Table 2. The cracking Percente of paddy rice post drying

<table>
<thead>
<tr>
<th>V (m/dt)</th>
<th>Layer</th>
<th>Percence cracked (%)</th>
<th>T₁</th>
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</table>

### The Form of the Cracking Size

In this present study, the form of the cracking found is only circular around the seed. The cracking refers to vertical line throughout the paddy rice was not found, because the heating treatment held in lower temperatur. The form of the cracking size can be seen in photograph below.
Figure 4. a. The one-crack paddy rice seed, b. The two-crack paddy rice seed and c. The four-crack paddy rice seed.
CONCLUSION AND SUGGESTION

Conclusion
1. The loss of the water content at air velocity 0.4 m/s with the pile of 1 cm deep was 10.37% ww after 2 hours drying resulting in the number of the cracked paddy rice seed.
2. The slower the air velocity and the deeper the pile, the lower the cracking constant. the cracking constant at $v = 0.2$ m/s and the pile of 5 cm deep was $3.6165936 \times 10^{-3}$ minute$^{-1}$, the calculation results of the cracking post drying was 4%.
3. The cracking ratio at drying air velocity of 0.2 - 0.4 m/s and 1-5 cm deep was 4-9%.

Suggestion
It is necessary to hold the further study by using equation $M_c$ and $k$ from the various paddy rice variety.

REFERENCES


