# The Minimum Fluidization Velocity of Drying Corn in Fluidized Bed

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**Abstract.** Grains are agricultural products that often experience post-harvest damage, one of which is corn. Based on the standard SNI 014483–1998 quality requirements that must be met by corn is to have a moisture content of 14%. To maintain the quality and value of agricultural products, the drying method is used. In general, post-harvest drying is only done naturally by drying using heat from solar energy or commonly called conventional drying. In this study, the drying process used a fluidized bed dryer. The purpose of this study was to determine the minimum fluidization velocity of corn in fluidized bed drying. In this research the minimum fluidization velocity was 4.10 m/s.

**Keywords:** Fluidized · corn · drying

## 1 Introduction

Geographically, Indonesia is located on the equator and is one of the countries that has an area with extensive land availability, as well as abundant biodiversity supported by a tropical climate so that it has great potential for business development in the agricultural sector and makes it possible to cultivate crops throughout the year, thereby increasing agricultural yields. Indonesia is very abundant, one of which is corn. The corn production figure in West Nusa Tenggara Province has reached more than 1.6 million tons, corn production in NTB continues to increase every year, approaching the 2021 production target of 1.7 tons. Corn is one of the crops of Indonesian farmers that requires post-harvest drying. Good quality corn is produced to support the need for corn as food and a staple for the animal feed industry. So, it is necessary to guarantee the availability of good quality corn. The use of good raw materials is determined by the profitability process [1].

Drying is the process of reducing the water content of the material to a certain extent so that the biological reaction stops and microorganisms and insects cannot live in it using heat energy. In general, the process of drying agricultural products carried out by the community is drying in direct sunlight but still has many disadvantages. For this reason, it is necessary using technology in the form of mechanical devices such as fluidized bed drying [2]. There are some factors that affect drying, including air temperature,


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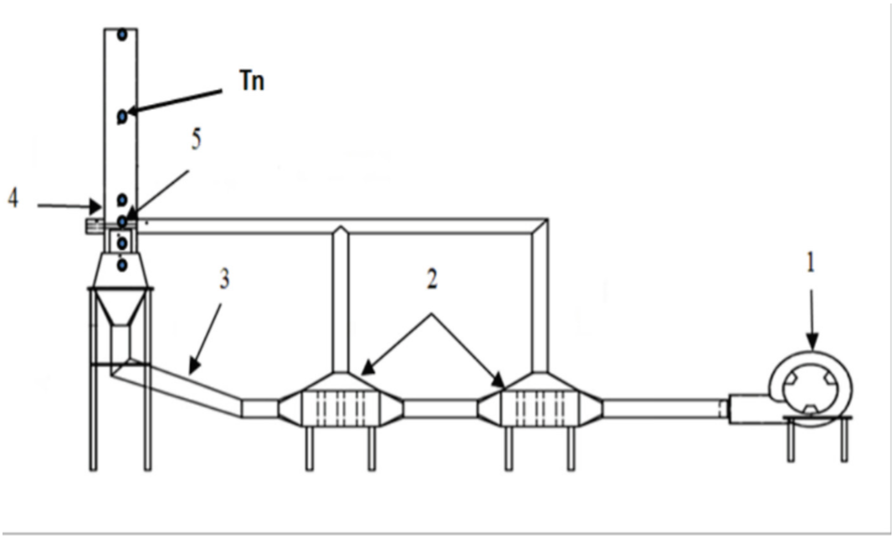


**Fig. 1.** Schematic of research equipment 1. Blower (centrifugal fan), 2. Heating element (heater), 3. Heating line (plenum), 4. Drying chamber (bed), 5. Heat exchanger pipe, Tn = thermocouple point

volumetric speed of the dryer and air humidity, the initial moisture content and the size of the material [2] and [3].

The working principle of the fluidization system dryer is blowing hot air by a blower fan through a channel to the top of the dryer tub. Fluidization dryers have several advantages, namely the heat and mass transfer rates are quite high because the contact between the hot air dryer and the material being dried is quite good, the temperature and moisture content are uniform, the construction is simple high drying capacity, high drying rate and easy to operate [4]. The drying temperature of corn affects the nutrition and quality of corn as animal feed [5]. The smallest speed for the fluidization process to occur in a system is one of the important parameters [6].

## 2 Materials and Experimental Set-Up

The material used in this experiment was corn kernels with an initial moisture content of 20%. This research was an experimental study with a scheme of research tools as shown in Fig. 1.

Before conducting the research, several preparations were made, namely preparing tools including gas stove, thermocouple, blower, anemometer, moisture meter, digital scale, stopwatch and ruler. Then prepare and weigh the corn material with an initial moisture content of 20% tolerance 0,5% weighing 0,7 kg. After the corn kernels are ready and according to research needs, the drying process is carried out by turning on the stove and blower by adjusting the temperature and speed of the air entering the drying chamber. Temperature variations used 45 °C, 50 °C, 55 °C and variations in air velocity used 4 m/s, 5 m/s, 6 m/s. Then the material is entered into the drying chamber

**Table 1.** The minimum velocity of fluidization

| Massa (kg) | $T_{in}$ (□ ) | $V_{in}$ (m/s) | $h_u$ (m) | $V_u$ ($m^3$) | □mf | $U_{mf}$ (m/s) |
|---|---|---|---|---|---|---|
| 0.7 | | 4 | 0.102 | 0.00147 | 0.43137 | 3.58147 |
| 0.7 | 45 | 5 | 0.113 | 0.00163 | 0.48673 | 3.80567 |
| 0.7 | | 6 | 0.124 | 0.00179 | 0.53226 | 3.98065 |
| 0.7 | | 4 | 0.104 | 0.00150 | 0.44231 | 3.65642 |
| 0.7 | 50 | 5 | 0.115 | 0.00166 | 0.49565 | 3.87136 |
| 0.7 | | 6 | 0.126 | 0.00181 | 0.53968 | 4.04167 |
| 0.7 | | 4 | 0.104 | 0.00150 | 0.44231 | 3.68637 |
| 0.7 | 55 | 5 | 0.117 | 0.00168 | 0.50427 | 3.93721 |
| 0.7 | | 6 | 0.128 | 0.00184 | 0.54688 | 4.10140 |

and the observation of the moisture content is carried out every 5 min until it reaches a maximum moisture content of 14%. Simultaneously, the velocity of the air leaving the drying chamber and the height of the bed, has been done in [7].

## 3 Results and Discussion

The minimum fluidization velocity of the corn with mass of 0.7 kg, temperature variation of 45 °C and an air flow speed of 4 m/s is calculated with the following data, particle diameter (dpr) = 0,008 m; particle density (ρ) = 745 kg/$m^3$; density of air (ρu) = 1,12189 kg/$m^3$; particle height (hp) = 5,8 cm = 0,058 m; bed height(hu) = 0,102 m. By using Eqs. (1) and (2) obtained the porosity of the bed (εmf) and the minimum fluidization velocity (Umf) = 3,581 m/s. Using the same calculation method, the calculation results are obtained for each variation of data as in Table 1:

Table 1 is the result of the minimum speed of fluidization. Fluidization is achieved when the airflow speed is greater than the minimum speed of fluidization. From the table, it can be seen that the minimum speed of fluidization is highest at a temperature variation of 55 °C with an air speed of 6 m/s which is 4.10 m/s, while the minimum speed of fluidization is the lowest occurs at a temperature variation of 45 °C with an air speed of 4 m/s which is 3.58 m/s. Low temperature and airspeed the value of the minimum speed of fluidization will decrease. This is due to the high temperature and airflow speed will accelerate the material to evaporate the moisture content and the material moves faster to release the moisture content from the material.

Figure 2 shows the increase in the minimum fluidization velocity for variations in air velocity. Where the graph shows that the higher the temperature and the varying air velocity, the greater the minimum fluidization velocity, on the contrary, the lower the variable temperature and air velocity, the smaller the minimum fluidization velocity. Because the temperature and high air flow speed will accelerate the material to evaporate

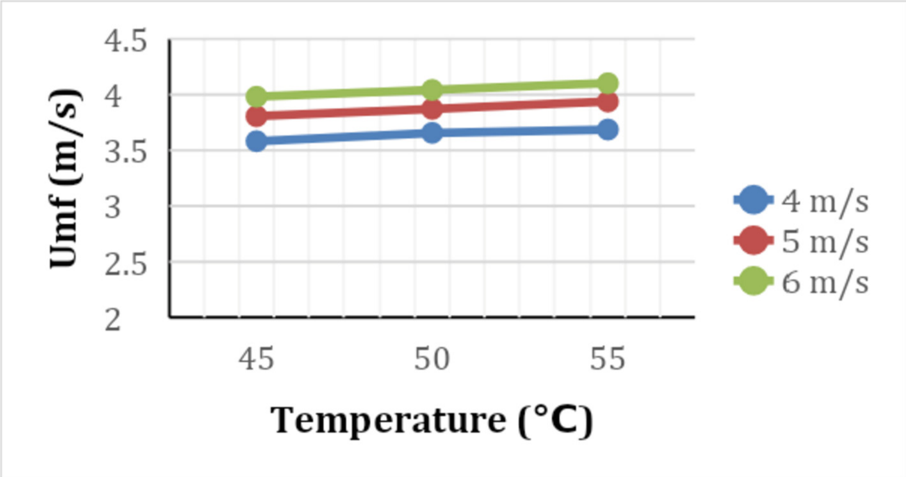


**Fig. 2.** Graph of the temperature variations and air velocity to the minimum fluidization velocity.

the moisture content and the material will move faster to release the moisture content from the material. In this study, the highest minimum fluidization velocity value occurred at a temperature variation of 55 °C and an air velocity of 6 m/s which was 4,10 m/s, while the lowest minimum fluidization velocity value occurred at a temperature variation of 45 °C and an air velocity of 4 m/s which is equal to 3,58 m/s.

## 4 Conclusion

Based on the data obtained, the following conclusions can be drawn: the highest minimum fluidization velocity value occurred at a temperature variation of 55 °C and an air velocity of 6 m/s which was 4,10 m/s, while the lowest minimum fluidization velocity value occurred at a temperature variation of 45 °C and an air velocity of 4 m/s which is equal to 3,58 m/s.

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