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Calcium granules drying using air flow through technic

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Abstract. The purpose of this research is to study and investigate the hot air flow fixed granular bed drying of calcium. The main disadvantage of the fluidized bed drying process is the fine dust particle's formation, resulting in the loss of product at the filters. Moreover, dangerous explosion can occur by scrubbing between the granules. Cleaning of the fluidized bed dryer is another difficult and time consuming. In this work, the effects of velocity and temperature of the hot air to the drying rate at the different size of granule are studied to determine the optimal condition of the drying process. In this drying process, the moisture on the surface and inside the calcium granules are different. Since the moisture of the top layer of the granule calcium is different than that of the bottom layer, the optimal thickness of the layer of the granule calcium needs to be determined before operating the drying process After the drying process at different condition was performed, the moisture of the granule was measured and compared with that of the convention fluidized bed process. It was evident that the proposed drying process had higher drying rate and less dust diffusion than that of the conventional process. Additionally, this drying process was productive when the thickness of the layer of the granule was appropriate. Therefore, the air flow through the dryer was an appropriate drying process for granule calcium.

1. Introduction

Medicine is important for life and health of human. Thus, pharmaceutical industry must be involves with the economics and social in term of quality and safety of the consumption. Rising of the medicine production is caused by the improvement of the efficiency of the machines and increase of the capacity. One of important processes in the medicine production is the drying process. Many drying methods has been studied and developed for pharmaceutical industry as seen literature. In this research, calcium is used as material for drying. Calcium is a relevant material which contain in the human body. Ninety percent of the calcium in the human body are bone and teeth, while the rest is inside the tissue and liquid. The function of the calcium in the body is to control the nerve system of muscle and heart by contracting the muscle and stimulating nerve. In blood system, the calcium is important element of the blood coagulation for pregnancy and breastfeeding of women. In the same way, calcium is essential in pharmaceuticals industry.

Normally, pharmaceutical industry uses fluidized-bed technique for drying process and decrease a moisture ratio of granule calcium referenced by following researches. Liu et al. [1] In this work, moist dibasic calcium phosphate anhydrous was dried using a commercial spray fluidized bed dryer/granulator. The experimental have classified size of materials into fines, medium and coarse using the sieving approach. The impacts of air flow and air temperature on the drying process were also investigated. Finally, the results indicate that if drying is carried out in a slow drying regime, where capillary flow is faster than evaporation, drying is dominated by the constant rate stage and the impact of particle size on drying is not significant. Several previous works about other drying technique related to granule drying processes, have been presented [2-8]. Pramjareun et al. [2] presented a drying kinetics of shrimp dried by fluidized bed technique using superheated steam and hot air. Using the high air temperatures in this work, the results revealed that the bilateral fluids were able to cook shrimp due to high temperature use and had a similar tendency to expedite the moisture reduction as drying temperature increased. Sutherland and Ghaly [3] had studied drying paddy by fluidization technique under tropical zone climate. Under the hot air temperatures from 40 to 90 Celsius degree the moisture of the paddy could be reduced from 24%w.b. decrease to 18%w.b. the quality of the paddy was preserved, However, the process needed to perform again to reduce moisture for fully dried paddy at 14%w.b. Keansup and wongwiset [4] had studied the drying pepper using the fluidized-bed dryer and fluidized-bed dryer with microwave oven. The pepper has the starting moisture at 12%d.b. with 5-5.5 millimeters diameter and air temperature are at 40-90 Celsius degree. From experiment has found that fluidized-bed with microwave oven at same amount of drying time has less moisture content. Keansup [5] had studied about drying pepper by using the fluidized-bed dryer with microwave and found that fluidized-bed dryer heated by the microwave oven yield the better quality of dried pepper than that of the conventional fluidized bed dryer. Likewise, many several works about the interesting drying techniques for the granule drying has been presented. Soponronnarit et al. [6] had studied drying paddy using spouted bed dryer for two dimensions. In the experiment, they used paddy rice with 19-21% (wet basis) and the moisture of the paddy was reduced to 13-14% (wet basis). The experiment was conducted at different drying temperatures of 100, 125, and 150, the results showed that the drying rate depends on air temperature. Zotarelli et al. [7] presented a convective multi-flash drying process (CMFD) to producing dehydrated and crisp fruits. In the drying process, the hot air at 60 °C was used and a vacuum pulse was applied, Dehydration by a combination of convective drying and flash evaporation could be achieved. The result is similar to that yielded by fluidized bed drying. Fu and Lien [8] had studied drying shrimp using a hot air dryer combined with infrared dryer. In their experiment, the different condition of air temperature and temperature of infrared heat sources were employed for drying process to determine the optimal condition. They found that the had drying time of a high temperature of infrared combined with a lower air temperature was less than that of a low temperature of infrared combined a high air temperature.

However, fluidized-bed technique has disadvantages. Loss of product from the following aspects such as filtering, traction of material that makes dust also material exploding, and long period of cleaning. Due to the disadvantages of the fluidized bed technique, in this research the air flow through drying technique was studied and developed for drying of granule calcium.

2. Experimental setup

2.1. Experimental method

Drying experiments were carried out to determine the effect of air temperature (120, 140 and 160 °C), air velocity (14, 17 and 20 m/s), size of granule calcium (1 mm, 3 mm and 6 mm) and mass of granule calcium in cup (50g, 75g, 100 g) on the drying curves. after drying, take dried Calcium to determine the

2.2. Materials preparation

Calcium (CALTAB) used in this drying is from The Millimed manufactures of pharmaceutical (Millimet Co., Ltd) The average moisture content is 25%db. The main ingredient is Starch 1500, which is partially pregelatinized corn starch mixed with the calcium powder that has been processed by the granule process. Average diameter of Size of granule calcium used in this drying is 1 mm, 3 mm and 6 mm

2.3. Equipment

The purpose of this research is to study and investigate the hot air flow fixed granular bed drying of calcium. In Figure 1. show the air flow through dryer process diagram. the granule calcium is contained in the cup with grate with the mesh size of 24 micron. This cup is located between the heater and the blower. Heater use 6 unit of electric heating coils. Each unit is 1800 watts, 3 in parallel, then two series. Arrange in a 4 inch of pipe. Air heated by heater around the end of air pipe. Hot air from heater will travel through air pipe by suction of 2.2 kW revert blower. The air from ambient flow from the top to the bottom through the first filter, and the air is heated before entering to the second filter. Then, the hot air passes through to the cup to dry the granule calcium. Next, the air passes to the third filter before entering the suction of the blower. Finally, the air is released to the ambient.

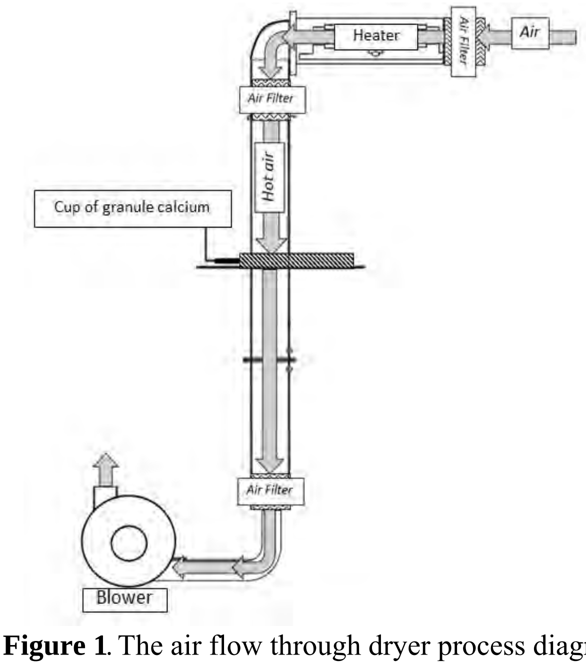

Figure 1. The air flow through dryer process diagram.

Figure 2. Cup of granule calcium.

Figure 3. Cup of granule calcium was installed

Figure 4. The air flow through dryer system.

2. Results and discussion

The drying characteristics of the granule calcium using air flow through technique dryer were studied. A total of 31 drying experiment were conducted for this work. The effect of velocity, temperature of hot air and size of granule were affect drying process. Typical drying curve for drying expressed as the average moisture content vs. drying time, at a specific (hot air velocity (V) for different air temperature (T), and drying rate vs average moisture content at a specific hot air velocity for different air temperature.

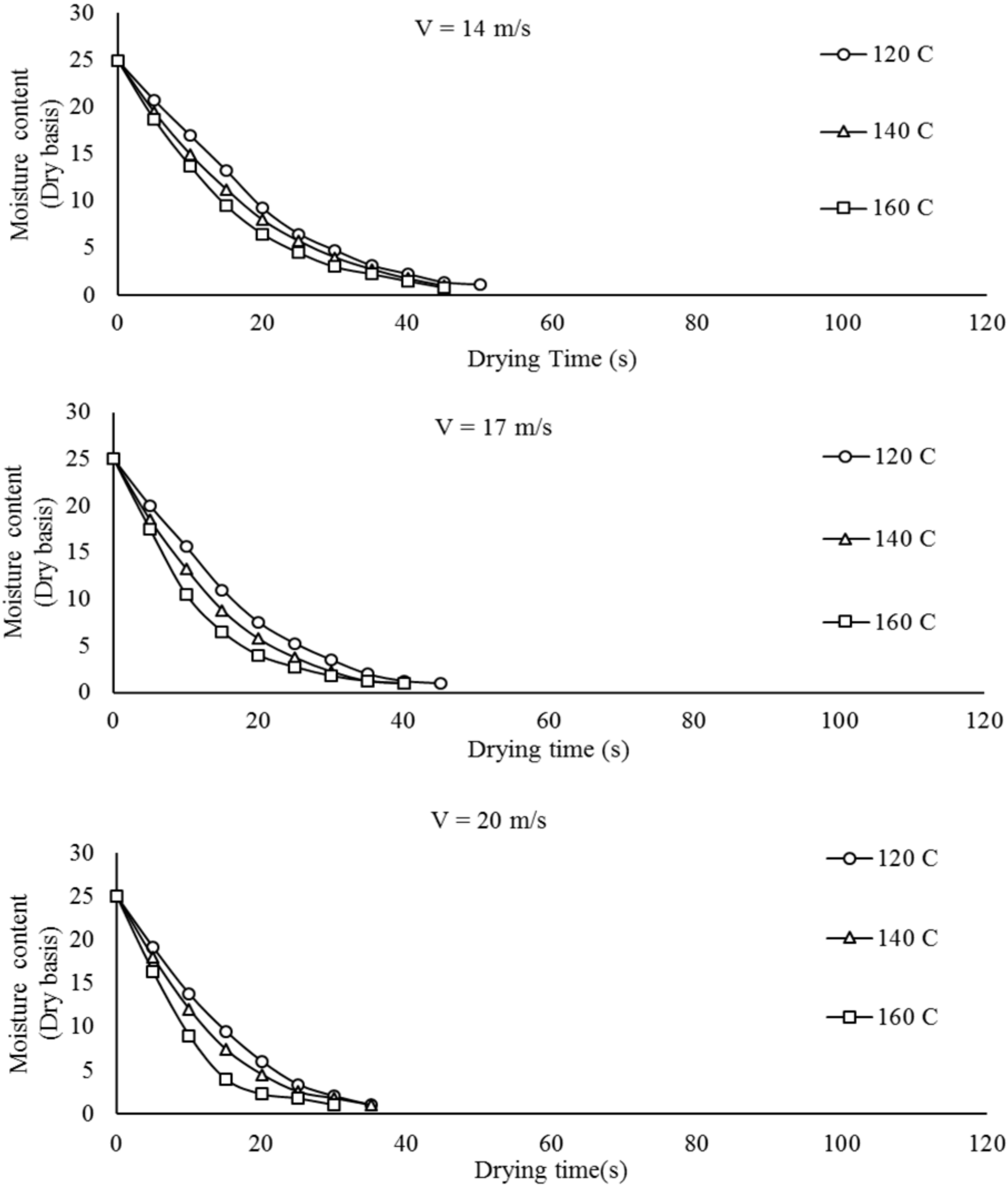

Figure 5. Variation of the average moisture content with drying time at a specific hot air velocity for different drying air temperature for granule calcium with the diameter of 1 mm.

The effect of drying air velocity on the moisture content is shown in Figure 5 and 6. At a specific air temperature, increase of air velocity caused the drying time to decrease. This mean that at the same required final moisture content of 1%(dry basis.), the higher air velocity gives a faster drying process.

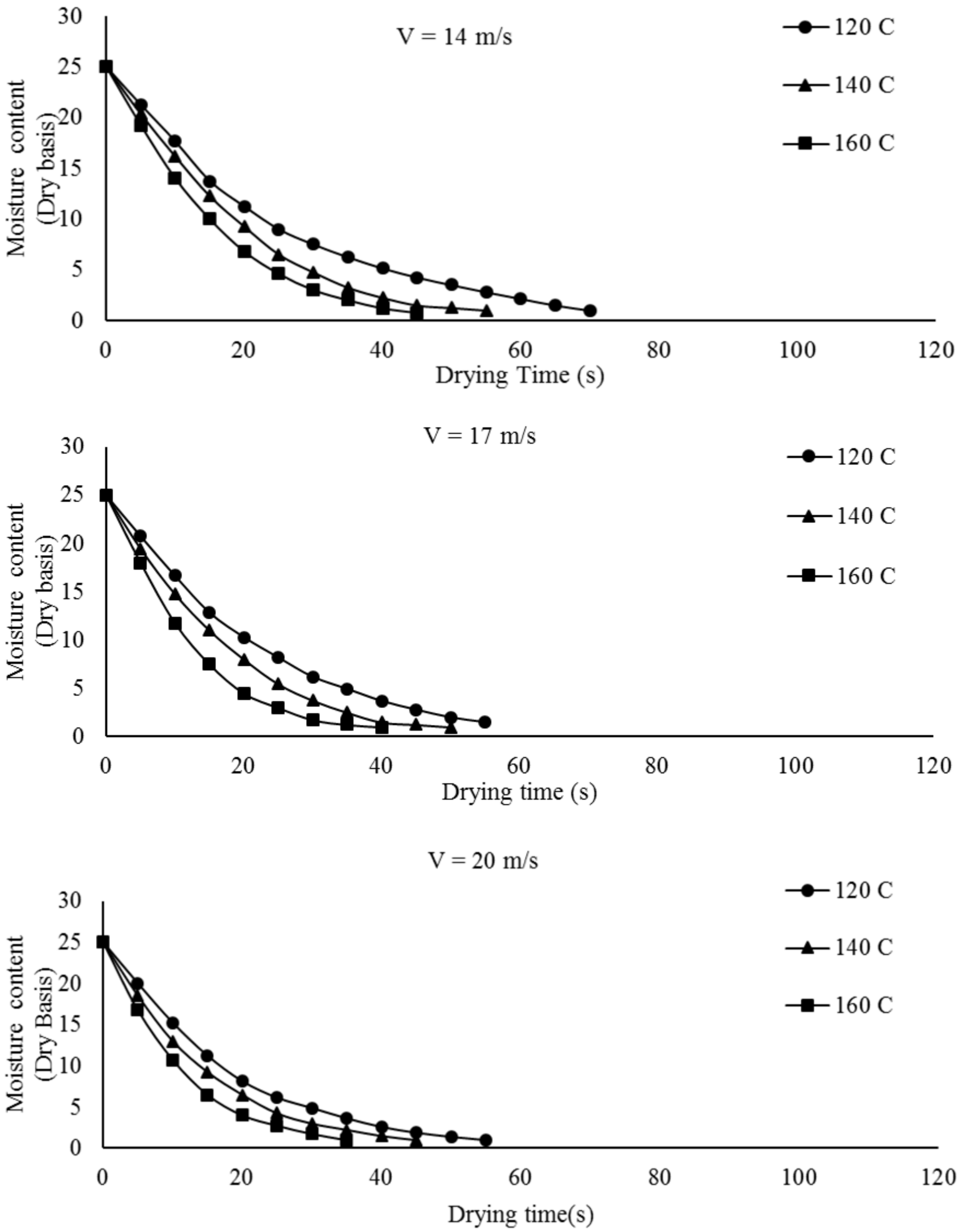

Figure 6. Variation of the average moisture content with drying time at a specific hot air velocity for different drying air temperature for granule calcium with the diameter of 3 mm.

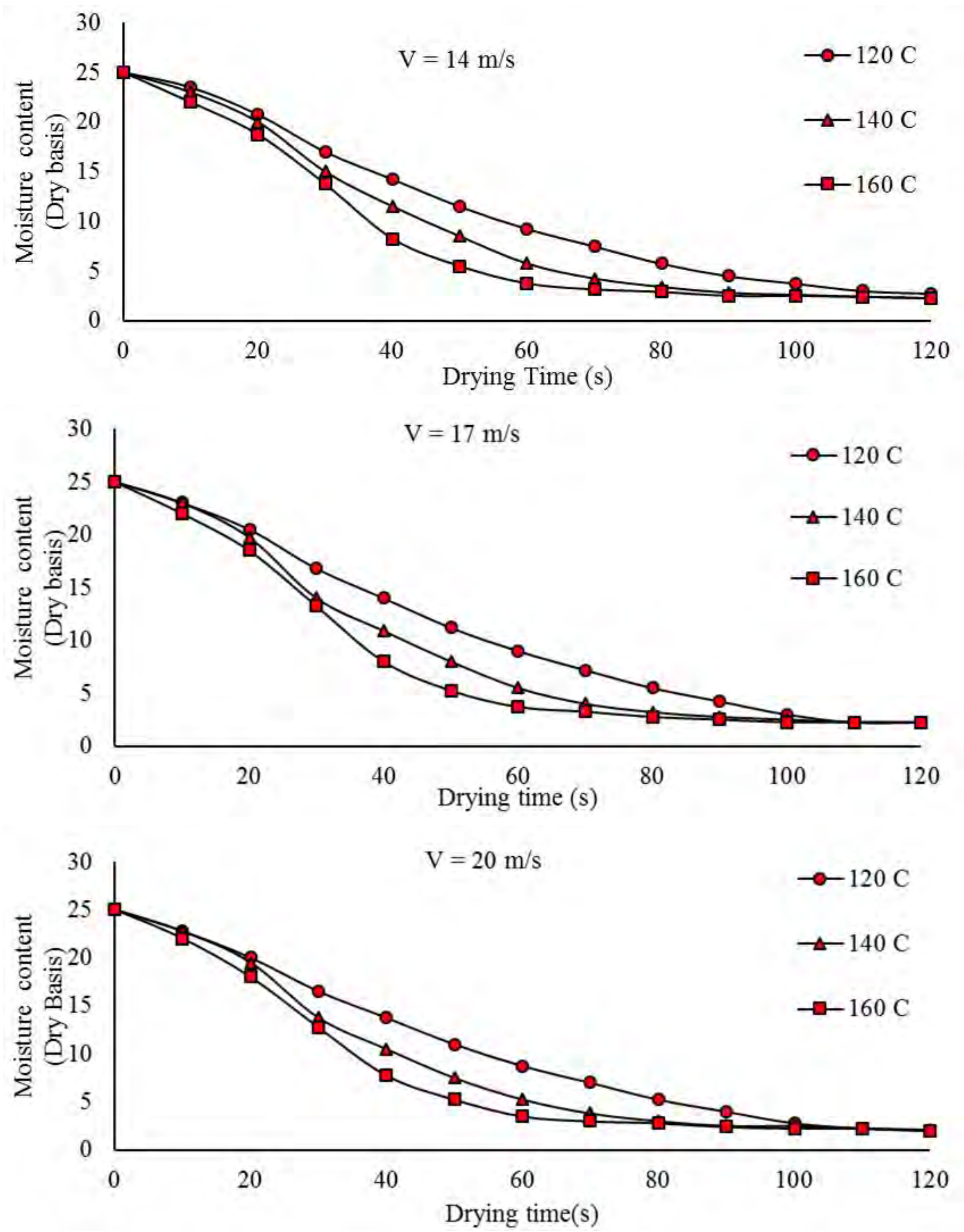

Figure 7. Variation of the average moisture content with drying time at a specific hot air velocity for different drying air temperature for granule calcium has 6 mm diameter.

The effect of drying air temperature on the moisture content is shown in Figure 5 and 6. At a specific hot air velocity, increase of air temperature causes the drying time to decrease. This mean that at the same required final moisture content of 1%(dry basis.), the higher air temperature gives a faster drying process. Figure 7 and Figure 10, show the different relationship between moisture content and drying time. The plot of the moisture versus drying time is from in Figure 7 for specific hot air velocity under the variation of temperature of drying air. However, the relationship in Figure 10 is moisture at the condition of specific air temperature under vary air velocities. Based on the results shown in these Figures, the variation of air temperature affects moisture content of granule Calcium more than that of air velocity. This can be seen clearer when size of granule is larger.

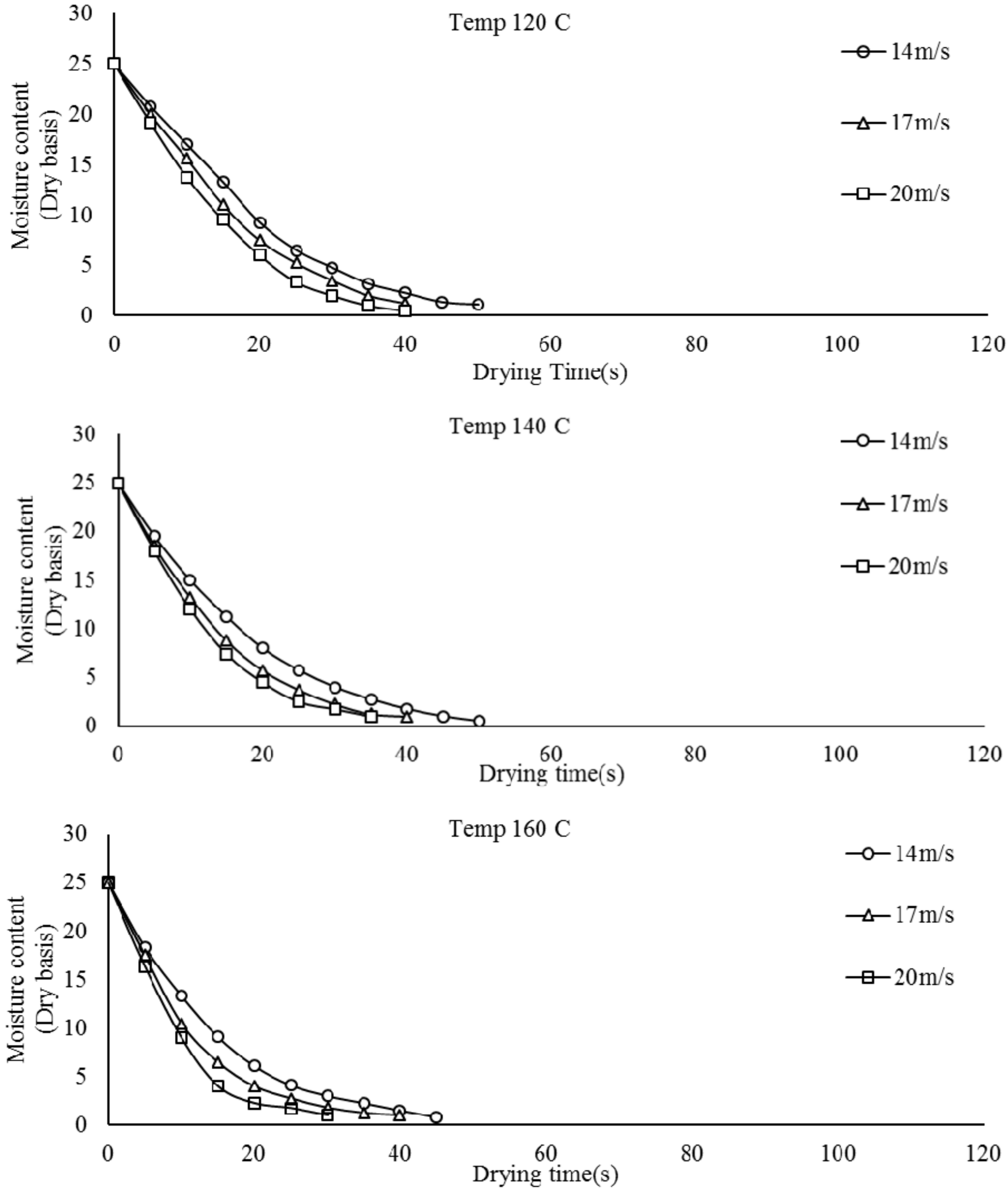

Figure 8. Variation of the average moisture content with drying time at a specific drying air temperature for different hot air velocities for granule calcium with the diameter of 1 mm.

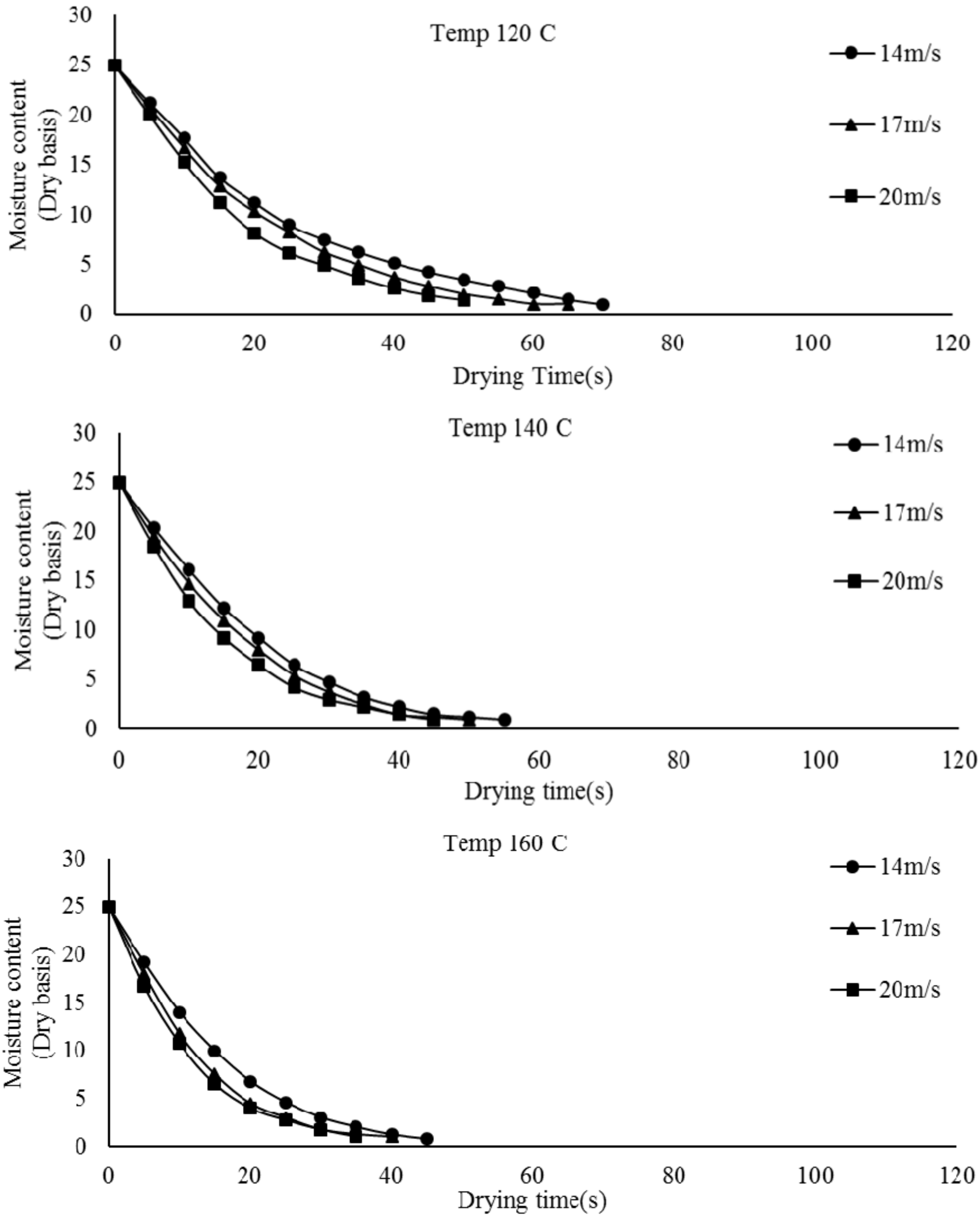

Figure 9. Variation of the average moisture content with drying time at a specific drying air temperature for different hot air velocities for granule calcium with the diameter of 3 mm.

The effect of size of granule calcium on the moisture content is shown in Figure 5, 6 and 7. At a specific hot air velocity and a specific of air temperature, an increase size of granule calcium causes the drying time to increase. This mean that at the same required final moisture content of 1%(dry basis.), the higher size of granule calcium leads to a slower drying process.

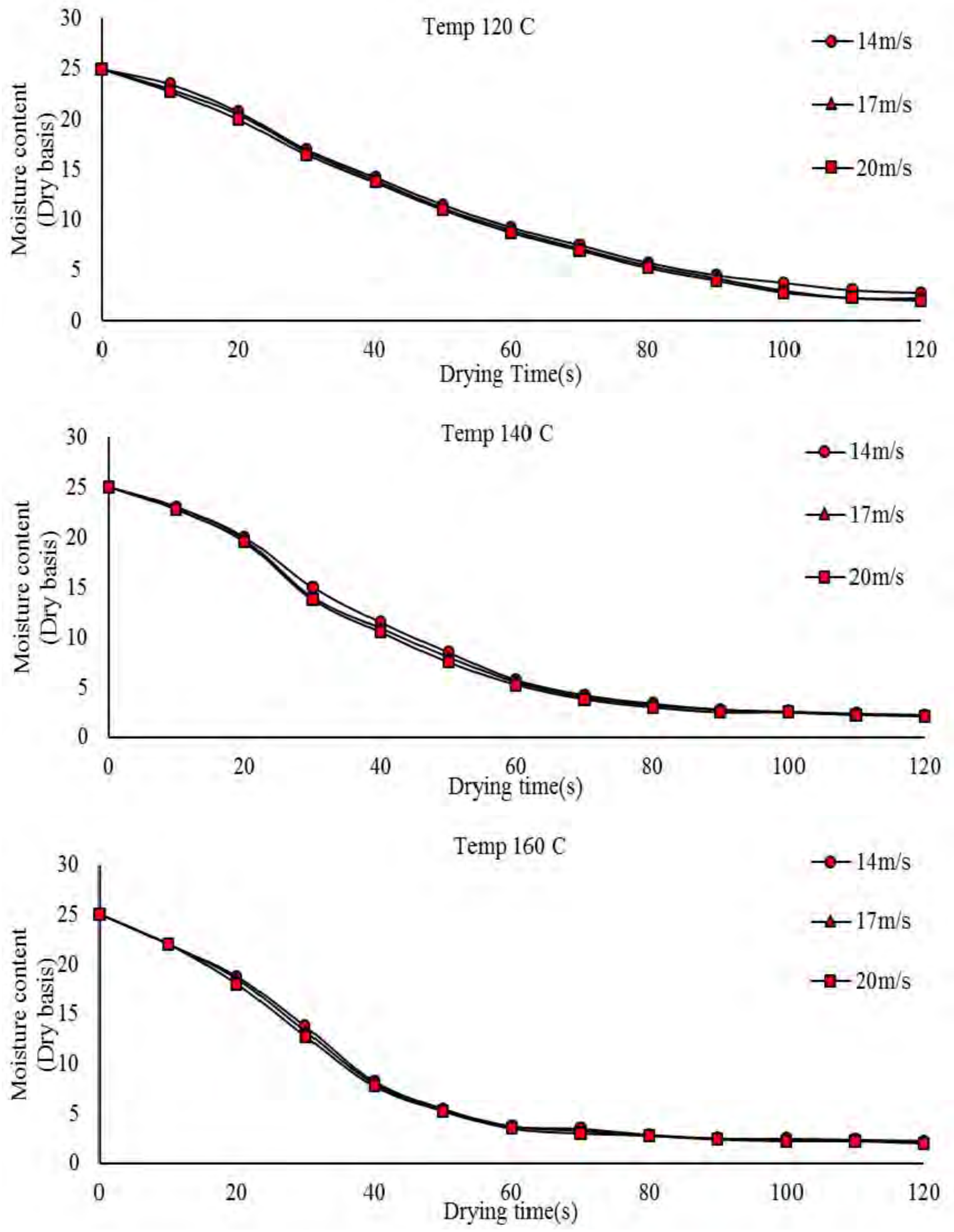

Figure 10. Variation of the average moisture content with drying time at a specific drying air temperature for different hot air velocities for granule calcium with the diameter of 6 mm.

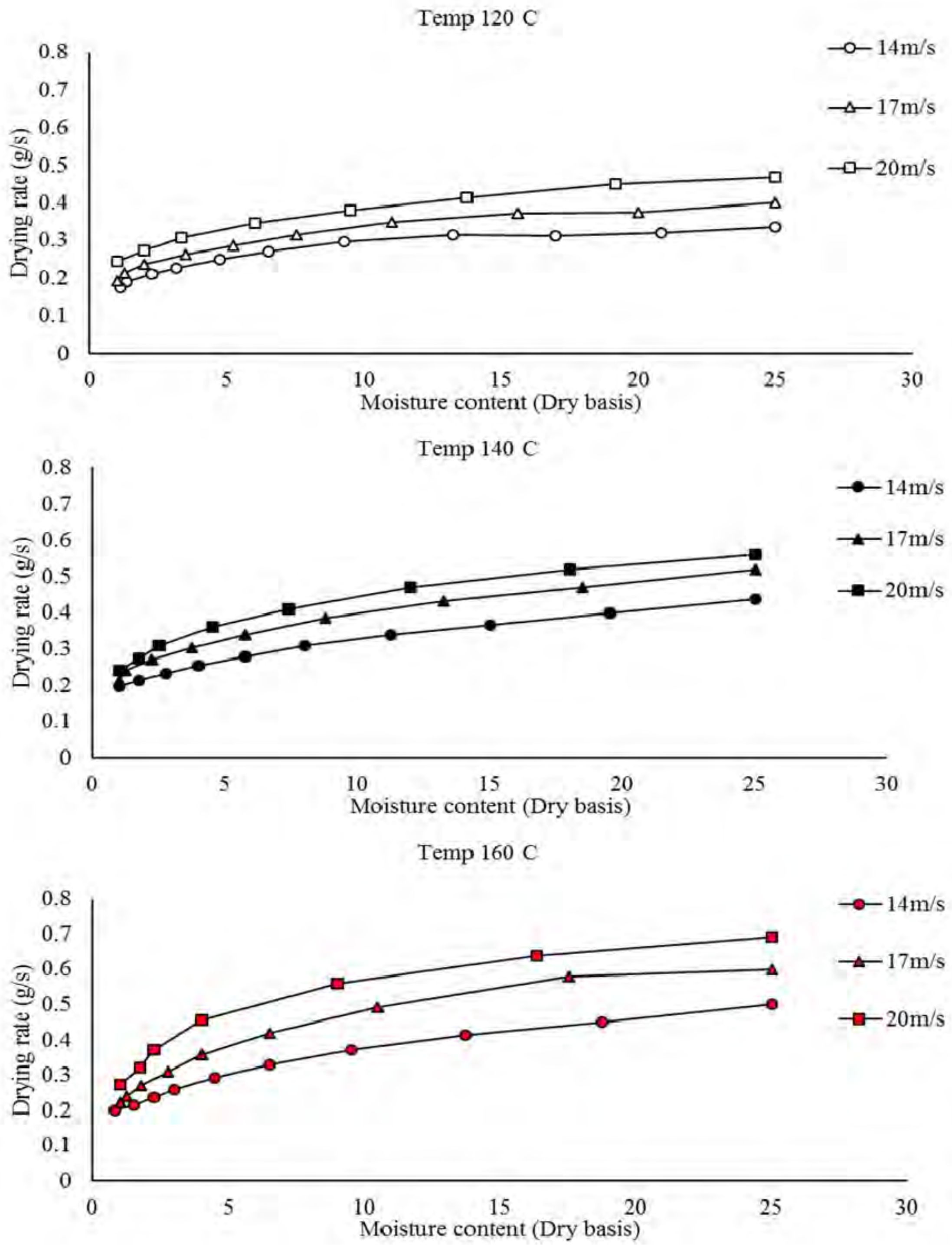

Figure 11. Variation of the drying rate with average moisture content at a specific drying air temperature for different hot air velocities for granule calcium with the diameter of 1 mm.

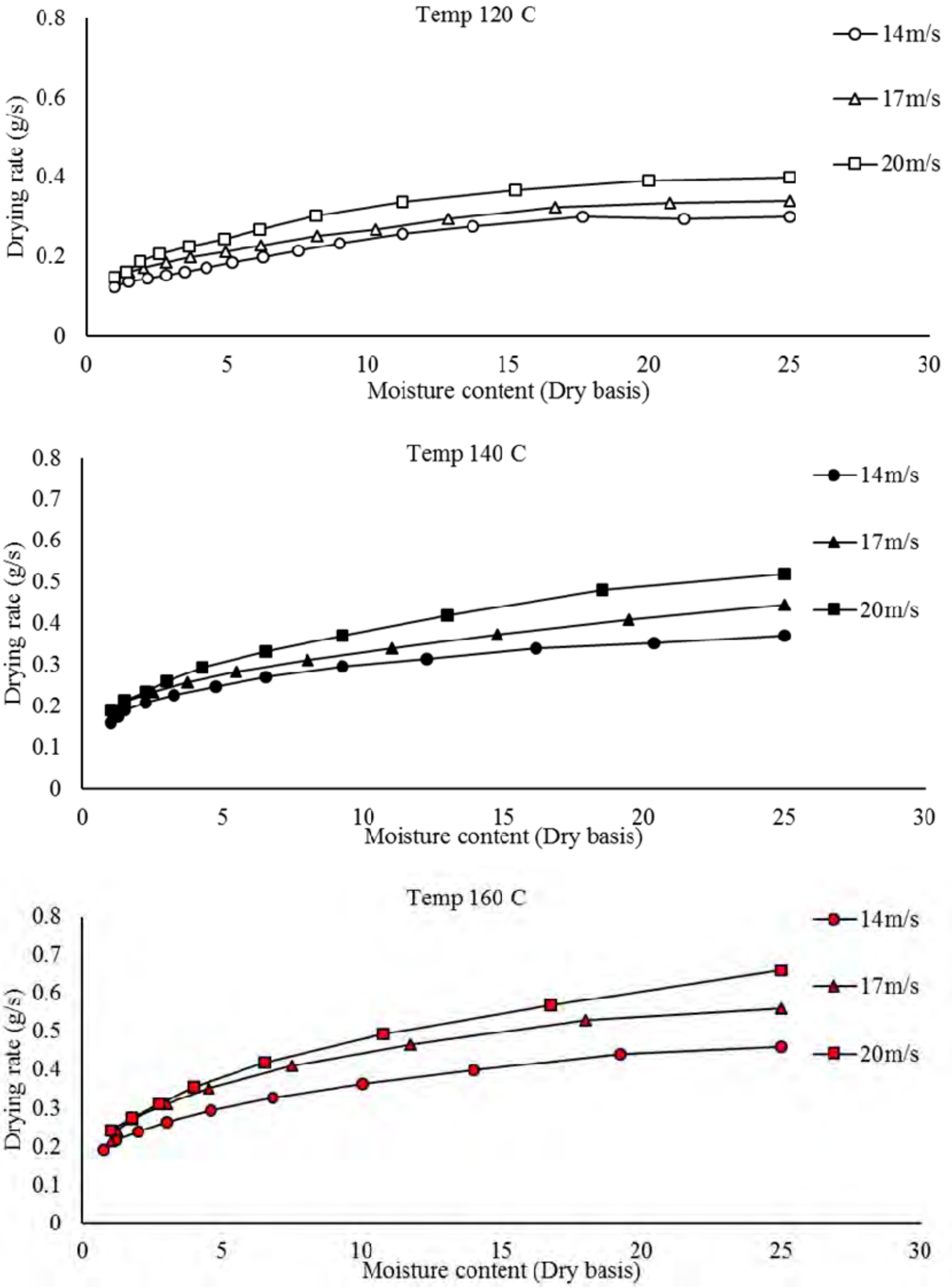

Figure 12. Variation of the drying rate with average moisture content at a specific drying air temperature for different hot air velocities for granule calcium with the diameter of 3 mm.

Figure 11 and Figure. 12 show the relationship between the drying rate and the average moisture content. In the drying curve, the slope of the higher air temperature line is greater that of a lower one. In a similar way, at a specific drying air temperature, an increase of air velocity enables the drying time to decrease.

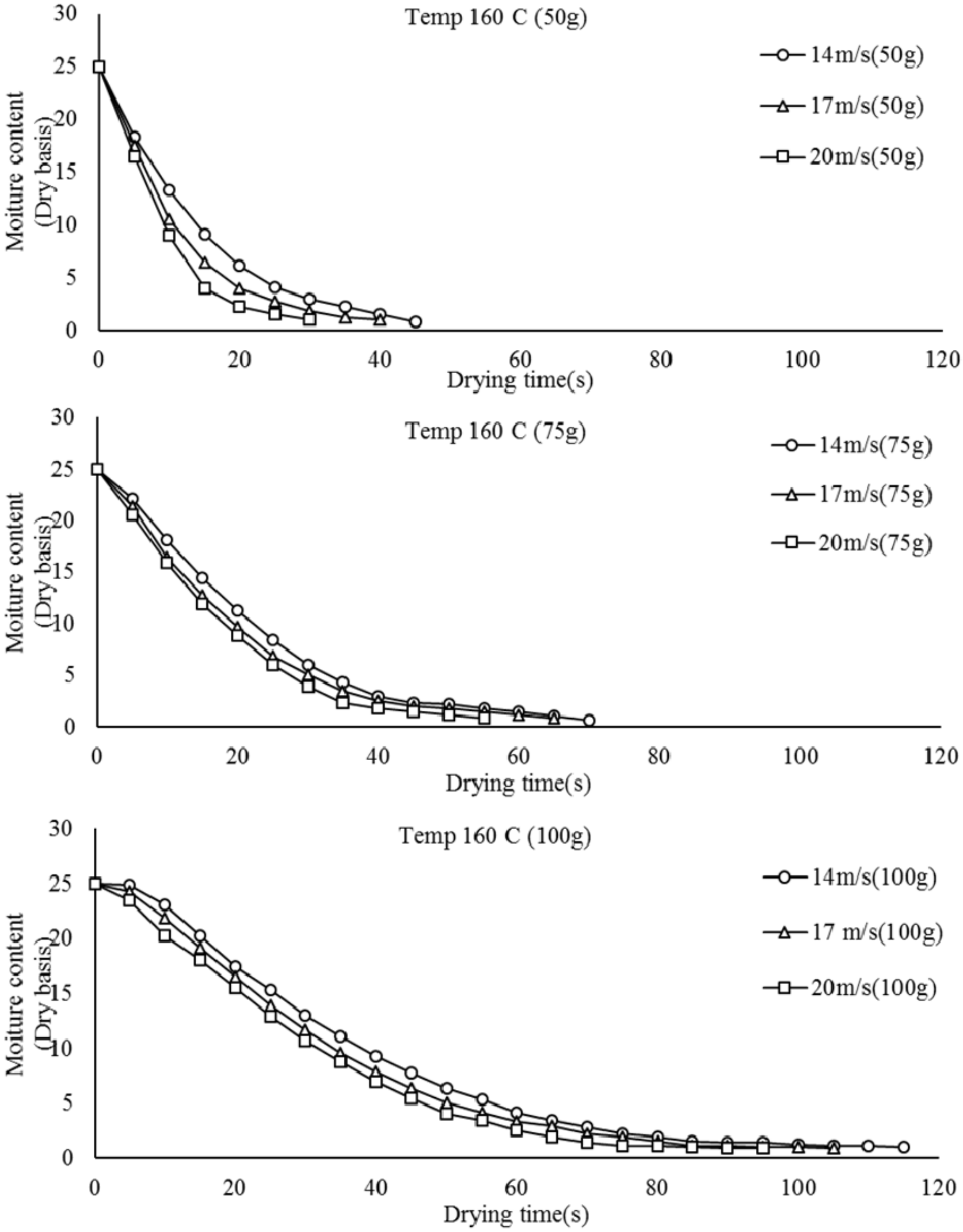

Figure 13. Variation of the average moisture content with drying time at a specific air temperature (160 C) for different drying hot air velocities for granule calcium with the diameter of 1 mm for the different weight of 50g, 75g and 100g.

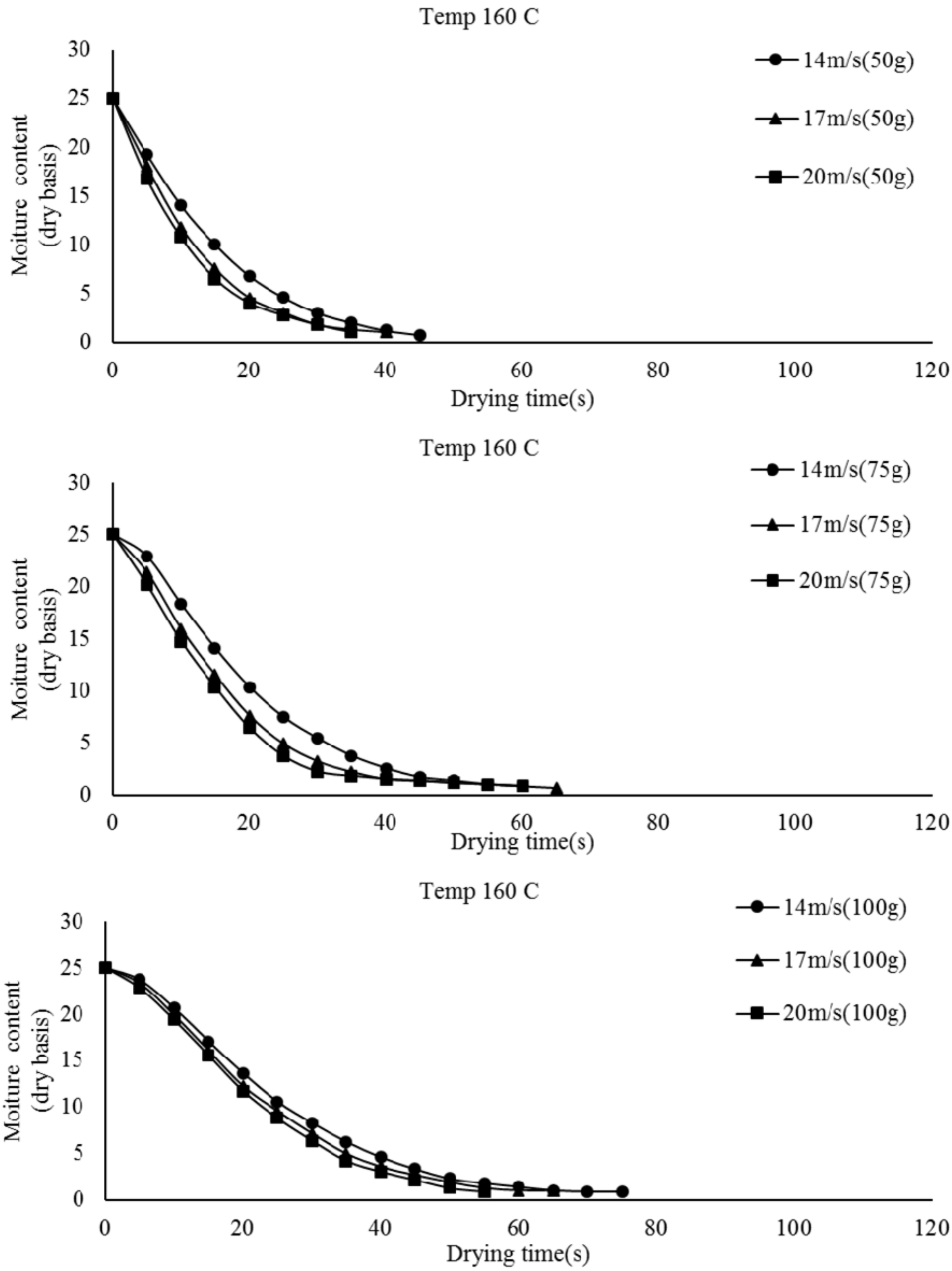

Figure 14. Variation of the average moisture content with drying time at a specific air temperature of 160 C for different drying hot air velocities for granule calcium with the dimeter of 3 mm for the different weight of 50 g, 75 g and 100 g.

The effect of mass of granule calcium on the moisture content is shown in Figure 13 and 14. At a specific condition of hot air velocity and the air temperature, increase granule calcium mass leads the decrease of drying time. This mean that at the same required final moisture content of 1%(dry basis.), the higher mass of granule calcium yields the slower drying process.

4. Conclusion

The granule calcium using air flow through dryer technique appears to improve considerable effect on drying rate. For the effect of drying air temperature, the drying rate increases when increasing air temperature. For the effect of drying air velocity, the drying rate increases when increasing air velocity. but the effect from drying air velocity is less than the effect from drying air temperature. When considering at the final moisture content of 1% dry basis, the bigger granule calcium size causes to increase the drying time of this process. To compare the effect of granule calcium mass at the same size, the results show that the drying time increases when granule calcium mass increases in same drying area with higher thickness. Drying process is productive when the thickness of the layer of the granule is appropriate. It is evident that the proposed drying process has higher drying and less dust diffusion than that of the conventional process. Therefore, the air flow through dryer is an appropriate drying process for granule calcium.

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