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Practical investigation of spray dryer performance

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ABSTRACT

Undoubtedly, in order to have a better performance of spray drying the related knowledge of spray drying should rise up. Even though today spray dryersaresomewhatmanual operator, this practical investigation intends to advance the performance of spray dryer as the ultimate step in the chemical process. In order to have better product quality, enhanced safety practices and more environmentally friendly operations as well as higher efficiency, excelling energy yield and using of less material, this type of dryer is considered for investigating experimentally.

So,effective parameterincluding energy consumption, drying capacity, the optimum time to dry, the air velocity, the ratio of sodium chloride to the air flow velocity, chloride sodium solution color and water content are studied, experimentally. The results show that the optimal momentum of hot air is 1/7 meter per second.

KEYWORDS

Spray drying performance;
Production of salt crystals;
Consumption of energy;
Optimal conditions.

INTRODUCTION

In all industrial applications including the food, agricultural, mining and even manufacturing sectorsthe drying is considered as an initial stage. Today, most of the countries are investing significantly in order to generate better product quality, enhanced safety practices and more environmentally benign operations as well as higher productivity, better energy yield and reduced material wastage. Thus, development of experimental investigations in this sector might be very constructive and helpful to improve dryer operation and efficiency, correspondingly. Usually drying operation defines the stages through whicha liquid is removed from a solid by evaporation. In other words, at first it turnsinto a steam and then easily removed. But, the moisture separationbymechanicalmethod such as compression, andcentrifuge cannot be considered as adrying process. Usually, before a drying step,there is a mechanical dehumidifier operation and thismoisture separation method is much easier and cheaper in contrast with thermal methods. In some cases, instead of using thermal energy, other forms of energy such as chemical reactions and radio waves are used to evaporate the liquid. Liquid that evaporates during drying is notalways water. It is possible that they are volatile solvents and flammable substances and even toxic. According to the literature, obtained experimental studies on dryers markedly, spray dryers,which involve all the aspects of this apparatus are not sufficient and they are very rare. The aim of this investigation is to improve the performance of spray dryer as the final stage in chemical process. Drying time, ratio of salt flow rate per hot air flow rate, occupied capacity of spray dryer air, velocity of hot airand vaporization rate can have major impacts on the color, size distribution and the

amount of outlet dried salt crystals. So, this work has been perused major principles in the performance of one spray dryer supposed to production of dry saltcrystals and also vaporization rate. Also, the amount of energy consumption is evaluatedin each run.

MATERIALS AND METHODS

Spray drying is widely used in industrial processes, this technology seems ideal when final product has standardsstrict quality such as size,moisture content and density and also suitable particle structure. During the drying, heat andvolume transfer occurs in a same time ratio. This work begins with an atom of fodder in the form of spray droplet. Small drops are made with high pressureand these drops enter to hot air and they are cooled due to water consideration. The colder and damp air exit through a chamber, after the separation of dry particles, air is conducted into the atmosphere. Dry particles can be cooled and they are packed after separation. Spray drying process depends on the structure of salt. Some of the salt can be easily wiped, while others barely dry. This drying method has following benefits:(A top quality product, b)low energyconsumption, (C long operating time between cleaning process.

Figure 1 : Photo of the device using a spray dryer

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RESULTS AND DISCUSSION

Experiments are held to find the drying time, energy consumption, air velocity, variance in color and size of the salt crystals. The below curves illustrate the experimental results. In this study, the air velocity changes from 1.1 to 3/2 meter per second and the effects of changes in this parameter on energy consumption and overall costs are also checked.

Figure 2 showsthe variation of superficial air

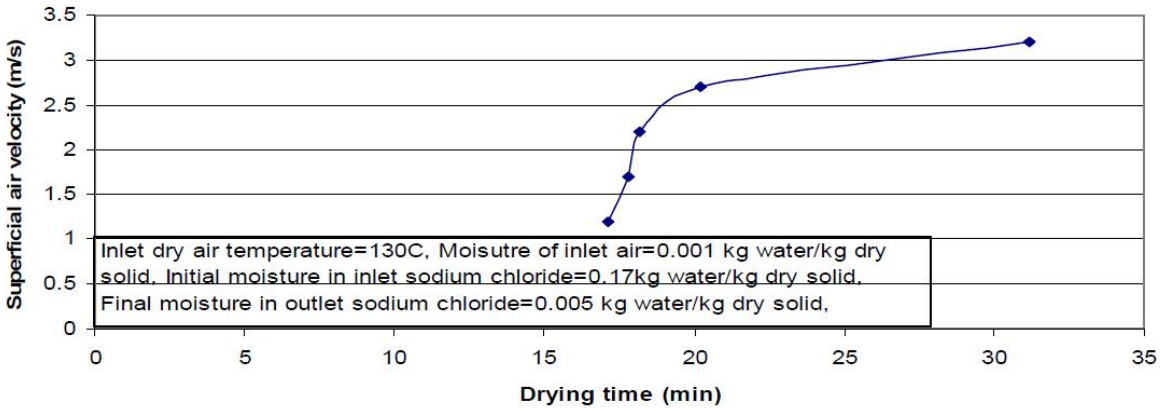

Figure 2 : The variation of superficial air velocity against the drying time

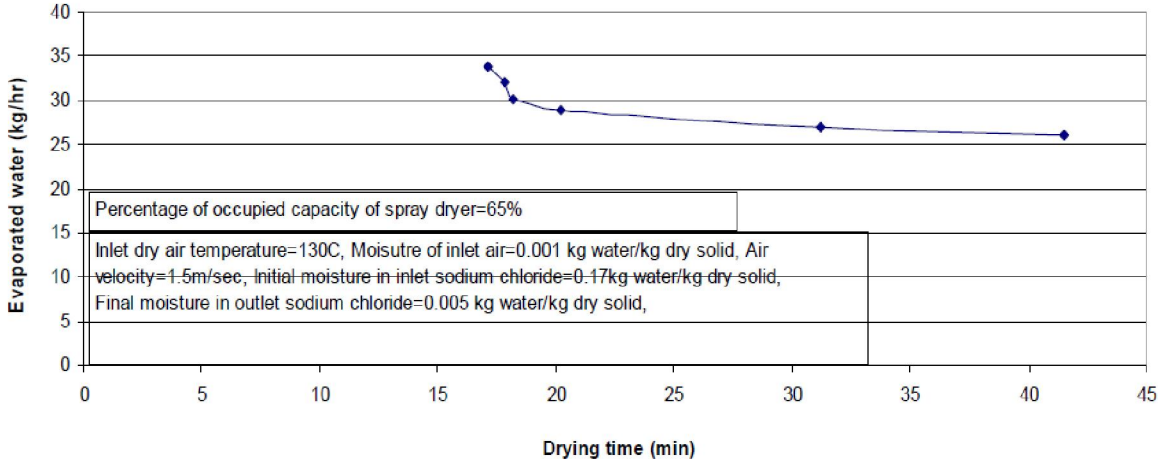

Figure 3 : The variation of drying time againstevaporated water

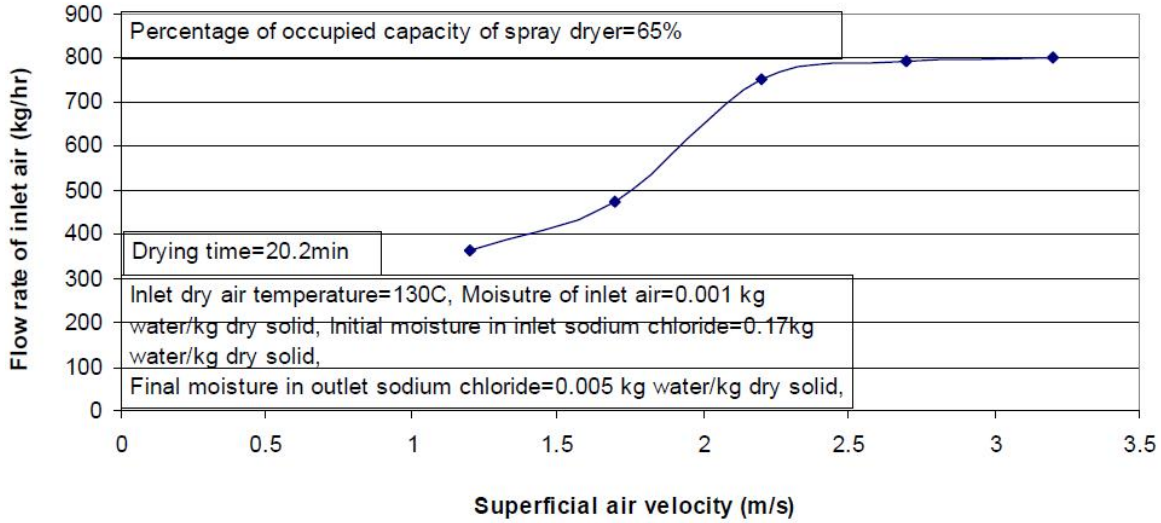

Figure 4 : The variation of superficial air velocity against flow rate of inlet air

velocity against the drying time. Since the importance of energy consumption and size range of outlet dried salt crystals from spray dryer, empirical data shows that the best drying time is 20.2 minutes. The drying time of 31.2 minutes is declined due to the color of outlet dried saline crystals from spray.

As it is shown in Figure 2, when the air velocity is 2/75meter per second the drying timeis 0/3 greater than the velocity of 1/7meter per second.

The variation of drying time againstevaporated water is depicted in Figure 3. As it is vividly shown, the evaporation rate reduces with the rise of drying time in the same conditions.

Figure 4 illustratesthe variation of superficial air velocity against flow rate of the inlet air. According to the Figure, flow rate of inlet air increases when the air velocity goes up. The drying time and percentage of occupied capacity of spray dryer are reported 20.2 minutes and 65, respectively.

Steep of air flowspeed in the condition of air velocity changing is critical.

Energy consumption is one of the most important and critical items in this survey. Figure 5 shows therelation between energy consumption and superficial air velocity. The energy consumption increases with the rise of air velocity, correspondingly. Experimental results show that there is a reverse relation between flow rates of outlet dried saline crystal from spray dryer and the amount of energy consumption. According to this Figure the moisture content of outlet dried salt crystals changes from 0.0056 kg to 0.008 kg of water per kg of dried salt crystals.

When the air velocity is 1/2meter per second, 0/56 kW hour energy is used.

Experimental results suggest that the optimal air velocity is 1/7meter per second. The amounts for 1/7 meter per second is 0/59 kWh that the below table shows the results of this assessment. The related results to evaluate the performance of dryer, energy anddrying cost for different velocities are given in TABLE 1.

Changes ofdrying time onthe quality of outletdriedsodium chloridefromdryerspray are shown in Figure 6.

According to the data,sizes of 0/7 and 0/8 ml are suitable for chloride crystals. These crystals of 0/7 and 0/8 ml aresatisfactory for cleaning, filtering, transport and storage.

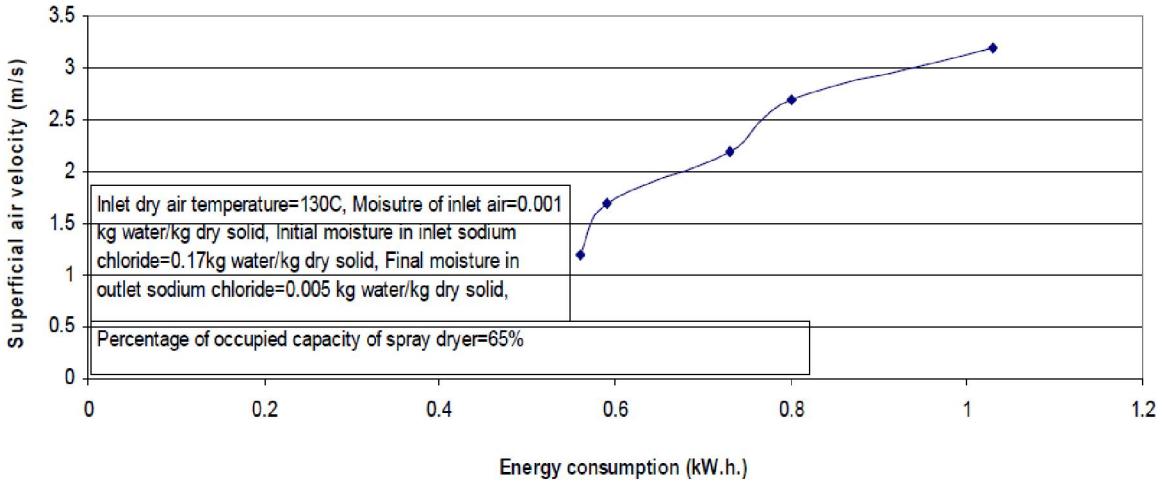

Figure 5 : Relation between energy consumption and superficial air velocity

TABLE 1 : The economical evaluation of used spray dryer with different hot air velocities

Hot air velocity (m/sec)	Drying time ratio	Energy consumption ratio	Total cost ratio	Total cost ratio for current spray dryers(without mentioned operating consideration)
1	1.33	1	$	
1.5	1	1.041	0.78$	
2	0.967	1.28	0.93$	
				3$<

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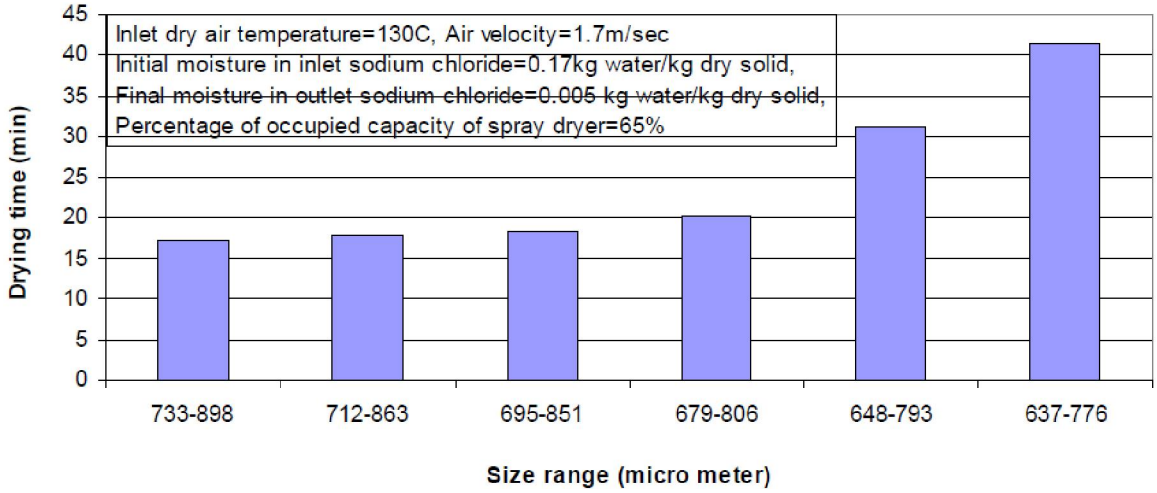

Figure 6 : The relation between size rang and drying time

Outlet crystals have the same shape and appearance. So, washing, filtering, transport and storage of them is desirable. Energy consumption is appropriate in contrast with other materials.

CONCLUSION

As drying is assuredly one of the most significant energy-intensive stages in factories, the growth of practical investigations brings an opportunity to advance the dryer operation and efficiency.

Drying is a critical process in which the liquid is removed. In this experimental project, a spray dryer is selected in order to dry solid crystals such as sodium chloride. The most affecting items are considered in the study. Research shows that the best drying time is 20/2 minutes because at this time the particle sizes are 679 to 806 and the consumption of energy is0/58 kilowatt-hour. It is obtained that the dimensions of the occupied space affects the size of crystals of sodium chloride and the drying rate. The optimum production of dried salt is obtained whenthe capacity of the dryer is 0/56. The other parameter is hot air velocity,whichoptimal value is reported 1/7 meter per second according to date.

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