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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(5): 923-926

www.thepharmajournal.com
Received: 02-03-2023
Accepted: 08-04-2023

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Impact on moisture content, bulk density and solubility index of skim milk powder of the operating variables

BS Chauhan and Sandeep GM Prasad

Abstract
The paper explain he work was conducted at he mother dairy food and vegetable private limited, Etawah (U.P.). We take inlet air temperature (175 °C) constant, feed flow (Kg/hr), feed concentration (Kg/m^3), feed temperature (°C), outlet air temperature (°C) varies. On the basis of that moisture content (%db), bulk density (gm/ml) and solubility index (mg) were calculated.

Keywords: Inlet air temperature, feed flow, feed concentration, feed temperature, outlet air temperature, moisture content, bulk density, solubility index

Introduction
The spray drying is a means of converting slurry or solution directly into powder or granular form by spraying the field into a stream of heated gas (air) which evaporates water from spray and results in fine dry suspended particles in air.
In this work we discuss the utilization of energy in evaporator section and drier section of spray drying. In evaporator section, we consider different variables which is applicable for energy consumption in evaporator. In dryer section we consider different variables which impact in guality of powder and also energy utilisation. Simultaneously we optimise the total energy consumption in evaporator and drawing section of milk powder plant in Mother Dairy Food and Vegetable Private Limited, Etawah Uttar Pradesh.

Materials and Methods
Evaporation Section
The evaporation plant was four-effect falling film type with thermal vapour recompress or was effected in the first effect and all four effects are working when making dairy whitner, WMP and SMP. The plant consist of three combination of holding tubes. The time of holding of milk in holding tubes are 60 seconds, 60 Seconds, 30 seconds and holding tube inlet temperature is 91 °C. Diameter of the holding tube was 36 mm. Milk was cames out from storage tank at 4^0 C then heated to temperature of 44 °C in preheat exchanger, from 44 °C to 66 °C direct contect heat, from 66 °C to 91 °C in direct steam injector.
Milk go to first calendria at 70-72 °C under vaccum, second calendria 67-68 °C, fourth calendria 62-63 °C then third calendria 56-57 °C.Condenser water come out at 52 °C to 53 °C. At the time of C.I.P.10000 to 15000 litre water is used.

Spray dryer section
The spray drier was a three stage drier equipped with a shaking bed. Powder after coming out from the drying chamber dry and cool in the vibro fluidizer. The presence of vibro fluidizer helped to permit the operation of the dryer with a higher inlet air temperature and a lower outlet air temperature thus increasing the thermal efficiency. There was also an agglomeration effect in the vibro fluidizer.
The dryer consisted of the following section:-

Hot air supply section
This section consisted of an air filters, centrifugal air supply fans, steam radiator for hot air generation and air disperser mounted at the top of the drying chamber to uniformly distribute the hot air over the atomized liquid droplets.

Feed Section
The feed section consisted of two feed concentrate balance tank to be used alternatively for

receiving the concentrated feed from the evaporation side. The feed was pumped by a 50 hp centrifugal pump feed to high pressure pump/ homogenizer through the concentrate tubular heater to the to spray nozzles. The pre heater was a shell and coil type pre heater.

Product recovery section

The dried powder from the chamber passed to the static bed and shaking bed respectively where drying and cooling took place. The powder from the shaking bed was shifted in a vibratary sieve and collected in 25 kg jute bags inside HDPE bags.

Fine particle from the dryer is sucked by the duct to the cyclone. Where fine particles was collected and from the cyclone fines particles went to the drying chamber for re-wetting and re-drying for making agglomeric powder, Powder quality parameters chosen as dependent variables were

1. Moisture content
2. Bulk density
3. Solubility index
4. Fat content
5. Protein
6. Carbohydrate
7. Ash
8. SPC
9. Yeast & mold

Determination of Qualiy parameters

Moisture content

Moisture was measured by infrared moisture balance. Moisture was directly measured in percentage dry basis. First the needle of the balance was set on the 100% sign for zero reading, the pointer at 0% reading was set. The 5.2 gm powder was taken and put on the balance plate. Now infrared light was on for heating the powder at the temperature of 105 +5 °C for 2-3 minutes. When the colour of the powder started to change from light yellow to dark yellow and burning smell just started, the was stopped. Again the pointer was set at the same line by given direct reading of the moisture content.

Bulk Density

For determination of powder bulk density 40 gm powder sample was taken and transferred in a 100 ml graduated measuring cylinder. The cylinder was placed on a rubber pad 10 mm thick between the jaws of burette clamp so arranged on the stand that it allowed the cylinder to be raised by 10 cm only. The cylinder was lifted up to the point where the bottom of the cylinder reached the burette clamp and allowed to drop ten times on the bubber pad. The surface of powder if needed was leveled off with the help of a spatula and the volume occupied by 40 gm powder was noted. So by weight of sample/volume occupied gave the bulk density of sample in gm/ml.

Solubility Index

Standard ADMI was used to determine the solubility index of the dried powder.10 gm powder for SMP was taken in a 250 ml mixing jar and reconstituted in 100 ml distilled water at a temperature of 37 °C.The jar was placed in a mixer and stirred for exactly for 90 seconds at 3600 rpm.The sample was then allowed to stand for a time sufficient for the separation of foam to assist its complete removal by a spoon.After removal of foam the sample was mixed for 15 seconds with a spoon.

The reconstituted milk was filled in the graduated conical centrifuge tubes upto the 50 mark. It was then centrifuged for seven minutes at the speed of 1200 rpm.The tubes were taken out and the sediment free liquid was more then 5 ml above the sediment layer was siphoned off. The centrifuge tubes was dispersed into the liquid phase with a wire.Tretubes were again centrifuged for 5 minutes at same speed.The tubes were then taken out of the centrifuge and held in a vertical position against a strong source of light and then upper level of sediment was read in ml which gave the solubility index of the sample.

Results and Discussion

Table 1: Experimental data for moisture content of SMP at 175 °C inlet air temperature**.**

Feed Flow (Kg/hr)	Feed Concentration (Kg/m^3)	Feed Temperature (°C)	Moisture content (%db)		
			Out air temperature (°C)		
			81	82	83
2200	1175	63	2.97	2.99	3.01
2200	1175	65	2.94	2.98	3.02
2200	1175	67	2.91	2.96	2.99
2200	1180	63	3.01	3.25	3.35
2200	1180	65	2.96	3.10	3.24
2200	1180	67	2.99	2.89	2.79
2200	1185	63	3.08	3.14	3.21
2200	1185	65	2.99	3.07	3.12
2200	1185	67	2.87	2.98	3.04
2400	1175	63	3.15	3.19	3.22
2400	1175	65	3.08	3.11	3.17
2400	1175	67	3.02	3.05	3.09
2400	1180	63	3.21	3.24	3.27
2400	1180	65	3.18	3.21	3.24
2400	1180	67	3.15	3.18	3.22
2400	1185	63	3.24	3.27	3.29
2400	1185	65	3.17	3.19	3.23
2400	1185	67	3.12	3.17	3.22
2600	1175	63	3.25	3.26	3.27
2600	1175	65	3.19	3.20	3.22
2600	1175	67	3.15	3.16	3.18

2600	1180	63	3.28	3.29	3.31
2600	1180	65	3.22	3.24	3.26
2600	1180	67	3.16	3.17	3.19
2600	1185	63	3.34	3.35	3.37
2600	1185	65	3.29	3.30	3.32
2600	1185	67	3.24	3.25	3.26

Table 2: Experimental data of Bulk Density of SMP at 175 °C inlet air temperature

Feed Flow (Kg/hr)	Feed Concentration Kg/m^3)	Feed Temperature (°C)	Bulk Density (20 Gm/100 ml) Out let Air Temperature (°C)		
			81	82	83
2200	1175	63	0.38	0.39	0.41
2200	1175	65	0.39	0.41	0.42
2200	1175	67	0.40	0.40	0.41
2200	1180	63	0.37	0.38	0.38
2200	1180	65	0.38	0.39	0.40
2200	1180	67	0.39	0.40	0.40
2200	1185	63	0.36	0.37	0.39
2200	1185	65	0.37	0.38	0.38
2200	1185	67	0.38	0.38	0.39
2400	1175	63	0.42	0.43	0.44
2400	1175	65	0.43	0.44	0.44
2400	1175	67	0.44	0.45	0.46
2400	1180	63	0.41	0.42	0.43
2400	1180	65	0.42	0.43	0.44
2400	1180	67	0.43	0.44	0.45
2400	1185	63	0.40	0.41	0.42
2400	1185	65	0.40	0.42	0.42
2400	1185	67	0.41	0.42	0.43
2600	1175	63	0.43	0.44	0.44
2600	1175	65	0.43	0.44	0.45
2600	1175	67	0.44	0.45	0.46
2600	1180	63	0.42	0.43	0.44
2600	1180	65	0.43	0.43	0.44
2600	1180	67	0.43	0.44	0.44
2600	1185	63	0.41	0.42	0.43
2600	1185	65	0.42	0.43	0.45
2600	1185	67	0.42	0.42	0.43

Table 3: Experimental data for Solubility Index of SMP at 175 °C Inlet Air Temperature

Feed Flow (Kg/hr)	Feed Concentration (Kg/m^3)	Feed Temperature (°C)	Solubility Index (mg) Outlet Air Temperature (°C)		
			81	82	83
2200	1175	63	0.2	0.2	0.3
2200	1175	65	0.3	0.3	0.3
2200	1175	67	0.3	0.3	0.3
2200	1180	63	0.3	0.3	0.3
2200	1180	65	0.4	0.4	0.4
2200	1180	67	0.4	0.4	0.4
2200	1185	63	0.4	0.4	0.4
2200	1185	65	0.4	0.4	0.4
2200	1185	67	0.4	0.4	0.4
2400	1175	63	0.5	0.5	0.5
2400	1175	65	0.5	0.5	0.5
2400	1175	67	0.5	0.5	0.5
2400	1180	63	0.5	0.5	0.5
2400	1180	65	0.5	0.5	0.5
2400	1180	67	0.5	0.5	0.5
2400	1185	63	0.5	0.5	0.5
2400	1185	65	0.5	0.5	0.5
2400	1185	67	0.5	0.5	0.5
2600	1175	63	0.5	0.5	0.5
2600	1175	65	0.5	0.5	0.5
2600	1175	67	0.6	0.6	0.6
2600	1180	63	0.6	0.6	0.6
2600	1180	65	0.6	0.6	0.6

2600	1180	67	0.6	0.6	0.6
2600	1185	63	0.6	0.6	0.6
2600	1185	65	0.6	0.6	0.6
2600	1185	67	0.6	0.6	0.6

Results shows that at 175 °C inlet air temperature when feed flow, feed concentration, feed temperature and outlet air temperature increases. The moisture of the powder increase 2.79 to 3.37(% db), bulk densiy 0.36 to 0.45 (gm/ml) and solubility index 0.2 to 0.6 (mg). All the three parameters are with in the range of industry limit.

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