Enhancing performance of Fluid Bed Processor/Dryer using Cyklon® Air Distribution Plate {Patent Pending}

Abstract

The drying of material in a fluidized bed dryer/processor (FBD/FBP) is largely dependent on the air distribution in the process chamber. This is guided by the air distribution plates present whose design plays a key role in reducing the drying time and increasing the equipment efficiency.

Aim & Objective

Our main aim was to compare Cyklon® and Standard air distribution plates used in FBD/FBPs in terms of drying efficiency.

Drying of placebo batch granules were carried out in a fluidized bed dryer using Standard air distribution plate and Cyklon® air distribution plate and drying efficiency was measured. In-process quality monitoring of all critical processing steps was done for two batches.

End-product testing of batches was conducted to provide a documented evidence that drying process is controlled.

Results

For heavy granulation, LOD 2-3 % was achieved within 25 minutes and 35 minutes using the Cyklon® and Standard air distribution plates respectively. This correlates to almost 30% reduction in drying time.

Conclusion

A decrease in the drying time was observed when the two distribution plates were compared for both wet and dry granulation. The cyclonic movement of the material guided by the special design of the Cyklon® plate maximized the residence time leading to reduction in overall drying time.

Project Objective

The objective of this study was to compare the performance of Cyklon® and Standard air distribution plates used in FBD/FBPs in terms of drying efficiency.

Introduction

Standard air distribution plates used in Air suspension/Fluidized bed dryers consist of a single flat, perforated plate installed in a horizontal plane situated at the base of the process chamber. The challenge associated with this kind of plate is inefficient drying due to limited contact between the particulate material being treated and the process air. This can be attributed to a considerable portion of the process air escaping the process chamber vertically through 'channels' in the material bed without interacting intimately with every particle of the material. Secondly, the perforated design of air distribution plates prolongs the cleaning time making cleaning validation tedious.

Principle of Cyklon® Air Distribution Plate

The residence time of process air moving vertically is lesser than when moving upwards gradually in a spiral motion. This is the basis for the new generation Cyklon® air distribution plate.

The Cyklon® Air Distribution Plate consists of concentric, overlapping, solid rings of progressively lesser diameters placed one above the other. The air enters the process chamber through the gaps between the imbricated rings. The underside of each solid ring of the Air-Distribution Plate has curved air guiding ridges or fins extending radially outwards. This provides a horizontal component to the movement of air. The Air Distribution Plate provides a cyclonic movement to the particulate matter being treated and can be incorporated into the process chamber of a fluidized bed dryer of any capacity.

Advantages of Cyklon® Air Distribution Plate

- It uniformly distributes process air into the process chamber of an air suspension dryer.
- Adds a horizontal component to the movement of air as it passes through the air distribution system. Thus, the fluidized material moves in a cyclonic manner inside the process chamber. This maximizes the residence time of the process air inside the process chamber for increased drying efficiency.
- It promotes intimacy of contact between the particulate material and the process air such that maximum surface area is exposed for drying. This is claimed to reduce drying time significantly.
- Air Distribution System is composed of solid surfaces rather than perforated surfaces (as mentioned in the prior art), it is easy to clean and validate.
- The solid rings disassemble with ease to provide flat, easy to clean surfaces.
- It helps in the production of better granules with high yield due to less friction.

Figure 1: Cyklon® Air Distribution plate

Methodology

Materials: Lactose monohydrate, Micro-crystalline cellulose (PH-101), Pregelatinized starch 1500.

Equipment: Gansons High Shear Mixing Granulator (2 L), Gansons Fluidized Bed Dryer (10 kg)

Experiment

Dry Mixing: Lactose monohydrate, Micro-crystalline cellulose(PH-101) and pregelatinized starch were added in HSMG and mixed for 1 min at slow speed.

Binder used: Water 1600 ml.

Granulation: Binding agent was poured onto the dry mixed material at slow speed till the granulation endpoint was reached.

The above steps were followed for all the four batches.

Batch A Formula:

Table 1: Formulation for granulation

Ingredient	Quantity (gm)
Lactose Monohydrate	1600
MCC (Avicel PH-101)	800
Pregelatinized Starch	800
Total	3200
Binder- Water	1600ml*

* Concentration of binding agent in above batch is 50 % which is comparatively high than that of commercial formulation.

STAGE -Granulation:

Table 2 : Granulation parameters

Batch	Dry mixing time (min)	Amperage (impeller)	Binder addition time (s)
Batch 1	1	2.14	68
Batch 2	1	2.12	66
Batch 3	1	2.09	86
Batch 4	1	2.60	85

Wet mass weight after granulation = 4.6 kg

Percentage moisture content right after wet granulation cycle was observed **18.48%**

STAGE: Drying with Cyklon® plate as Air Distribution Plate

PUSH-PULL SYSTEM

Table 3 : Drying parameters

Drying mixing time (min)	Blower RPM	Inlet temp (°C)		Product temp (°C)	LOD* (%)
		SET	ACT		
5	1200	60	60	34.2	16.20
10	1500	60	62	34.7	11.34
15	1500	60	65	38.4	7.90
20	1500	60	61	41.2	4.60
25	1500	60	62	44.2	2.67

*LOD taken at **105°C at 05 min** time interval.

Where,

ACT is Actual value.

Batch B Formula:

Table 4: Formulation for granulation

Ingredient	Quantity (gm)
Lactose Monohydrate	1600
MCC (Avicel PH-101)	800
Pregelatinized Starch	800
Total	3200
Binder- Water	1600ml*

* Concentration of binding agent in above batch is 50 % which is comparatively high than that of commercial formulation.

STAGE -Granulation:

Table 5: Granulation parameters

Batch	Dry mixing time (min)	Amperage (impeller)	Binder addition time (s)
Batch 1	1	2.09	72
Batch 2	1	2.10	90
Batch 3	1	2.10	79
Batch 4	1	2.11	75

Wet mass weight after granulation is 4.665 kg

Percentage moisture content right after wet granulation cycle was observed **17.80 %**

STAGE: Drying using standard perforated plate as Air Distribution plate:

PULL SYSTEM

Table 6: Drying parameters

Drying time (min)	Blower RPM	Inlet Temp. set		Product temp (°C)	LOD* (%)
		SET	ACT		
5	1500	60	60	37.2	15.40
10	1500	60	63	38.6	11.90
15	1500	60	61	43.0	8.67
20	1500	60	64	44.8	6.54
25	1500	60	62	45.4	4.12
30	1500	60	65	46.5	3.20
35	1500	60	65	47.0	2.42

*LOD taken at **105°C at 05 min** time interval.

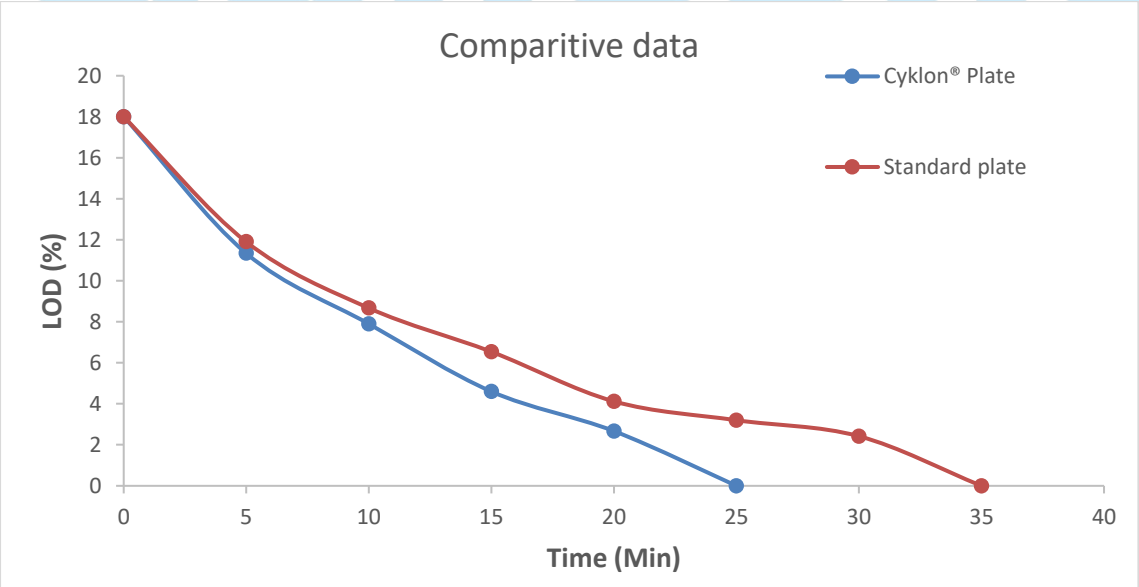

Figure 2: Comparison of Air Cyklon® plate and standard plate.

Conclusion:

1) From the above data, it is can be concluded that the drying efficiency has been improved using Cyklon® plate (keeping the quantity of binding agent same in both the batches).

2) Also, it can been clearly seen that total 30% reduction in drying time achieved using Cyklon® plate as compared to that of standard perforated plate.

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