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

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 Drug X 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 four batches. End-product testing of current batch was conducted to provide a documented evidence that drying process is controlled.

Results

For standard granulation, LOD NMT 2% was achieved within 7-8 minutes and 35 minutes using the Cyklon® and Standard air distribution plates respectively. This correlates to almost 80% reduction in drying time.

In heavy granulation, drying using Cyklon® air distribution plate required 20 minutes, which was half of that using standard air distribution plate. This correlates to an almost 50% 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.

Contents

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 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: Drug X, Povidone K-30, pregelatinized starch 1500

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

Experiments:

Dry Mixing: Drug X and pregelatinized starch were added in HSMG and mixed for 10 min at slow speed.

Binder preparation: Povidone K-30 was added into water under continuous stirring to form a binder solution.

Granulation: Binder solution 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.

a) **DRYING USING AIR CYKLON® PLATE**

Standard Granulation as per the BMR formula

Table 1: Formulation for standard granulation

Ingredients	Quantitative formula (g)
Drug X	2880
Pregelatinized starch	205
Povidone K-30	19.2
Purified water	427.072 + 300

Table 2: Results of standard granulation

Sr. No	Sampling details (min)	Blower RPM	Product temperature (ºC)	Loss on drying (%)
1	Right after granulation	-	-	20.95
2	5	1200	32	2.94
3	7	1200	34	2.01
4	10	1200	36	1.94
5	15	1200	39	0.99
6	35	1200	39	0.45

Heavy Granulation as per the BMR formula

Table 3: Formulation for heavy granulation

Ingredients	Quantitative formula (g)
Drug X	2880
Pregelatinized starch	205
Povidone k-30	19.2
Purified water	427.072 + 500

The blower RPM required for this trial was 1500. The increase in RPM was to initiate turbulence effect.

Table 4: Results of heavy granulation

Sr. No	Sampling details (min)	Blower rpm	Product temperature (ºC)	Loss on drying (%)
1	Right after granulation	-	-	21
2	5	1500	32	14.95
3	7	1500	34	12.01
4	10	1500	36	9.70
5	15	1500	39	6.66
6	20	1500	41	1.92
7	35	1500	42	1.56

b) DRYING USING STANDARD FBD PLATE

Standard Granulation as per the BMR formula

Table 5: Formulation for standard granulation

Ingredients	Quantitative formula (g)
Drug X	2880
Pregelatinized starch	205
Povidone k-30	19.2
Purified water	427.072 + 300

Table 6: Results of standard granulation

Sr. No	Sampling details (min)	Blower rpm	Product temperature (ºC)	Loss on drying (%)
1	Right after granulation	-	-	16.18
2	5	1200	32	8.91
3	7	1200	34	6.18
4	10	1200	36	3.2
5	15	1200	39	3.0
6	35	1200	43	1.56

Heavy granulation as per the BMR formula

Table 7: Formulation for heavy granulation

Ingredients	Quantitative formula (g)
Drug X	2880
Pregelatinized starch	205
Povidone k-30	19.2
Purified water	427.072 + 500

The blower RPM required for this trial was 1500. The increase in RPM was to initiate turbulence effect.

Table 8: Results of heavy granulation

Sr. No	Sampling details (min)	Blower rpm	Product temperature (ºC)	Loss on drying (%)
1	Right after granulation	-	-	18.095
2	5	1500	32	13.59
3	7	1500	34	12.01
4	10	1500	36	11.88
5	15	1500	39	10.56
6	20	1500	41	4.23
7	35	1500	42	2.05

Comparative study

Table 9: Comparison of Air Cyklon® and standard plate

Plate type	Air Cyklon® Plate		Standard Base Plate	
Granulation	Standard	Heavy	Standard	Heavy
Blower RPM	1200	1500	1200	1500
Exhaust Temperature (°C)	36	42	43	42
Time to Achieve LOD (NMT 2.0%) mins	7	18	35	35

Comparative data

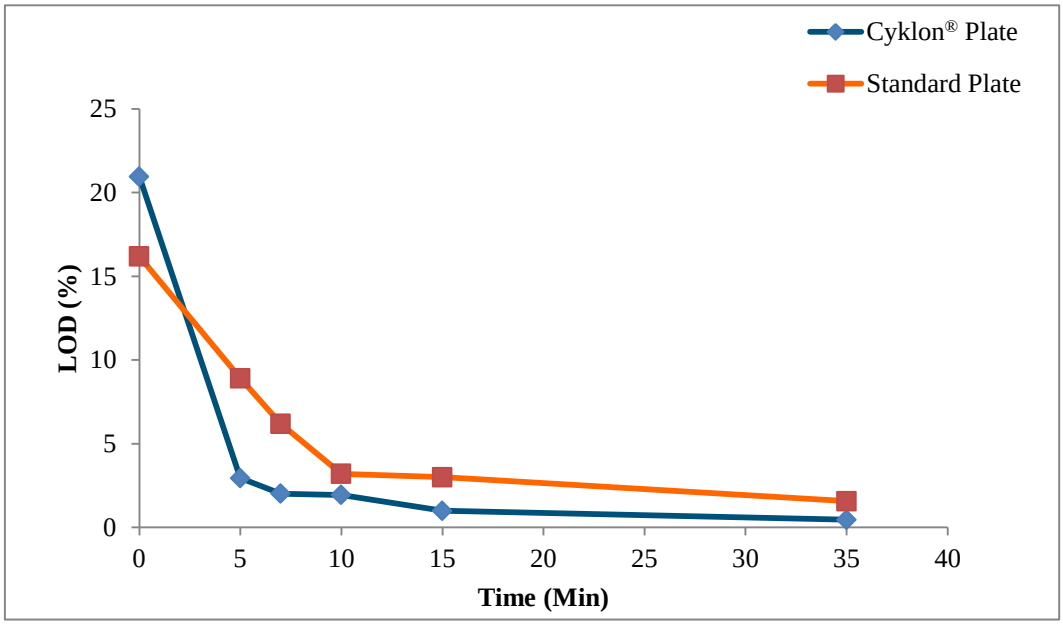

Figure 2: Standard granulation

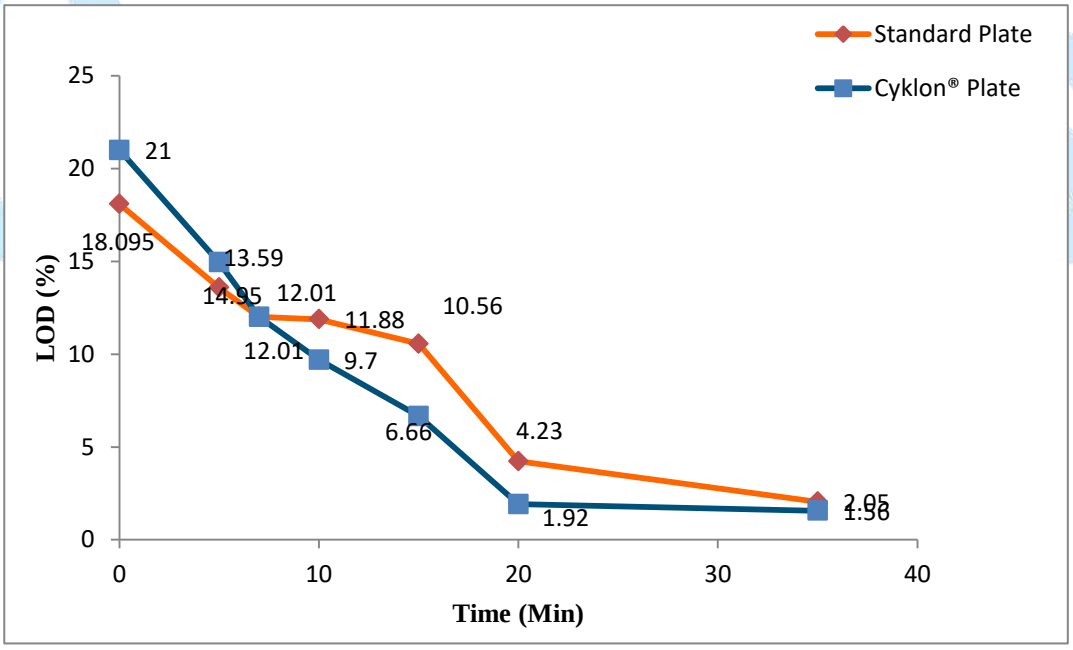

Figure 3 : Heavy granulation

Conclusion:

Post trials using the Standard base plate and the Air Cyklon® plate for heavy and standard granulation, it was concluded that the newly designed plate strongly improves the efficiency of the equipment by reducing the drying time effectively. Thus, the supremacy of the Cyklon® plate can be established.

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