Investigation into the Flow Properties of Coated and Uncoated Tablets and Its Relevance to Blister Packing Efficiency

OBJECTIVES

To investigate and compare the flow properties of uncoated tablets and tablets coated with different film coating systems. To investigate the assumption that it is more efficient to blister pack coated tablets than uncoated tablets.

INTRODUCTION

Within the pharmaceutical industry, there is a general understanding that coated tablets are easier, cleaner and more efficient to pack than uncoated tablets. However, there is very little data available to prove or disprove this theory. This study is designed to address this issue.

MATERIALS AND METHODS

A new testing methodology was devised to assess the flow and slip of different tablet coatings by modifying methods already in use in the pharmaceutical industry. The data generated was used to select coatings to demonstrate packing efficiency on an IMA C90 blister packing line.

Coating Materials

Opadry®, Opadry® II (various formulations), Opadry® fx™, Opadry® ns-g and Opaglos® 2. All coatings were applied to a 3.0% weight gain.

Placebo Tablet Formulation: 69.4% w/w lactose monohydrate (Lactopress®, Borculo), 15% w/w partially pregelatinized maize starch (Starch 1500®, Colorcon), 15% w/w powdered cellulose (JRS), 0.5% w/w magnesium stearate (Peter Greven) and 0.1% w/w fumed silica (Aerosil® 200, Degussa). Tablets prepared by direct compression on a Fette 1200 24-station rotary press using 10mm round concave tooling to a breaking force of 8-10Kp.

Flow and Slip Testing

Coating Equipment: O'Hara Labcoat 11 x 15" perforated pan.

Flow Equipment: Copley Flowability Tester Model BEP[1] with a specially designed tablet platform constructed of stainless steel with a 7mm lip around the top edge to allow a peak to form.

Flowability

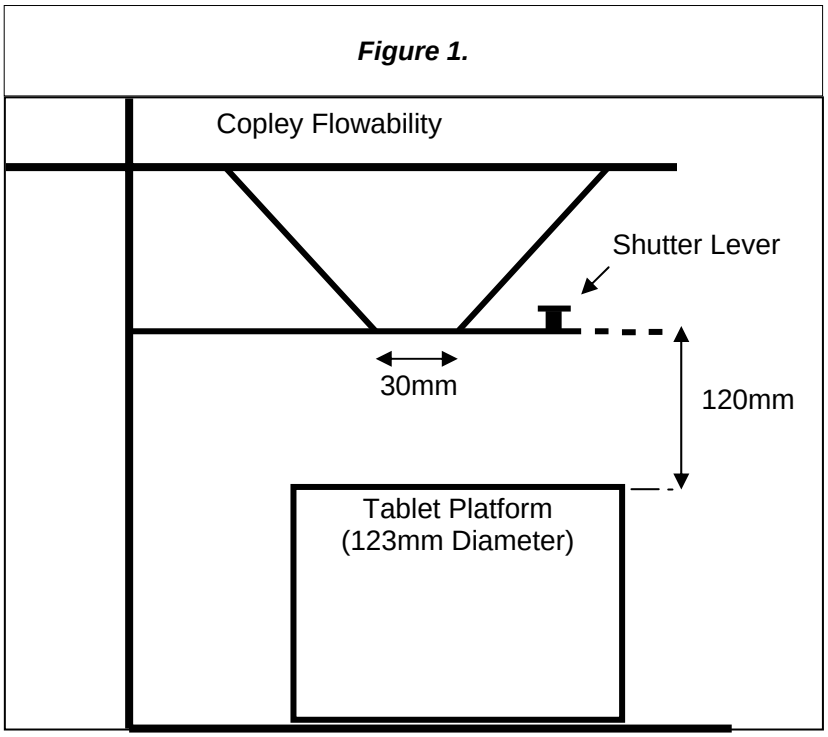
Although there are no compendial methods to evaluate tablet flow, there are pharmaceutical methods that are applicable. In particular the EP Method for Flowability.[2] This method uses 10, 15 and 25 mm apertures to measure the flow of pharmaceutical granules and powders. We adapted this method to tablets by utilizing the 25 mm aperture (nozzle 3) and 30 mm aperture (no nozzle). To fill the hopper, 400 g of tablets were required.

The shutter was then opened and the time for the hopper to empty was recorded. The test was repeated 9 times for each sample on both aperture sizes.
Results were expressed as seconds and tenths of seconds per 100 g of tablets. Failure of the sample to flow was recorded as a nominal 30 second result.

Angle of Repose

This method utilized the same equipment as the flowability method, with the addition of a tablet platform to allow the formation of a peak. To fill the hopper, 400 g of tablets were required. The shutter was opened to allow the tablets to flow through the hopper and form a peak on the platform 120 mm directly below the center of the aperture. The height of the peak was measured using a set square.

Figure 1.



The test was repeated 15 times. (three measurements were averaged to give a mean height used to calculate the Angle of Repose. This was repeated five times, then a mean Angle of Repose was calculated). The following calculation was used to determine the Angle of Repose:

$$\tan\theta = \frac{\text{height of peak}}{\text{radius of the base}}$$

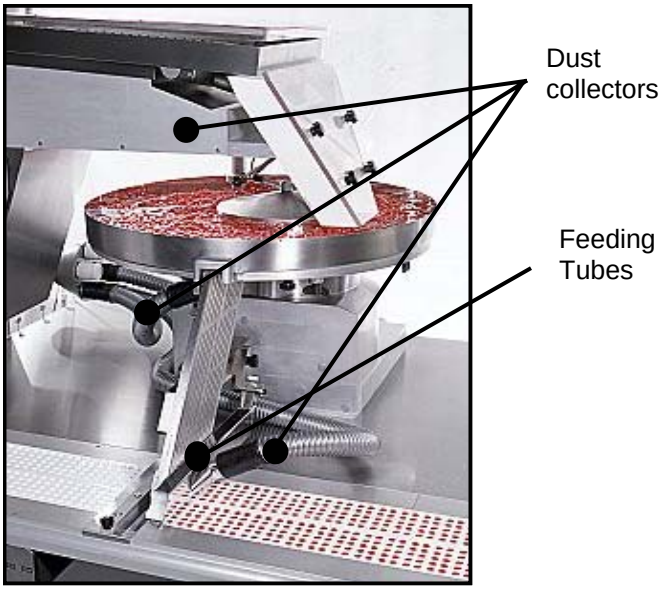
Packaging Efficiency Testing

Coating Equipment: IMA GS HTM 025, solid wall pan, equipped with aspirating paddles, mixing baffles, spray gun and peristaltic pump, total capacity 25 liters.

Blister Packing Equipment: IMA C90/A91 tube feeding system (maximum speed of 400 blisters/minute), blister format 10 tablets per blister. Direct feed system used to fill the blister pockets (Figures 2 and 3).

IMA team recommended line speeds: Caplets run at 200 blisters/min, round tablets at 300 blisters/min.

Figure 2. IMA Tube Feeding System



Sample Preparation

Placebo tablets prepared by direct compression on a Fette 1200 24-station rotary press using 11 mm round concave tooling and 18.4 mm x 7.2 mm caplet shape tooling. Round tablets had a breaking force of 8-12 Kp and the caplet tablets 12-16 Kp. Tablets coated to a 1% and 3% weight gain with Opadry II 85F19250 (clear) and 85F25215 (red), respectively.

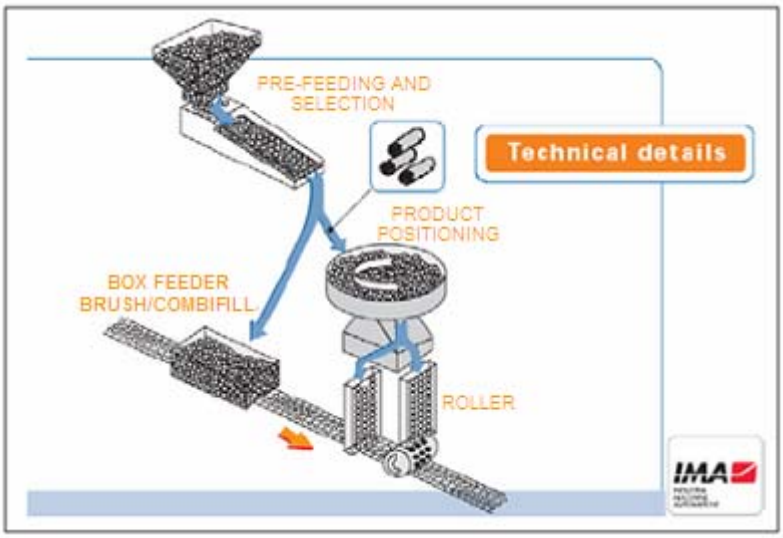
Methods

Speed Optimization: The speed of the motor running the web (formed blisters) was increased until rejects occurred. In the case of round tablets this was empty blister pockets, and line stoppages in the case of the caplet tablets.

Efficiency: Three 60-minute packing runs for each tablet shape: uncoated, 1% weight gain Opadry II 85F29105, and 3% weight gain Opadry II 85F25215. The number of line stoppages and reject blisters were monitored during each run.

Dust: Monitored dust and contamination caused by the different samples.

Figure 3. IMA Tube Feeding System



RESULTS

Table 1. Flow and Slip

Sample	Mean Angle of Repose	Mean Flows /100g 30 mm	# Fails	Mean Flows /100g 25 mm	# Fails
Opadry II 85F18422	23.70	0.54	0	0.92	0
Opadry ns-g 70W29079	23.07	0.57	0	0.92	0
Opadry fx 62W25333	25.15	0.59	0	0.99	0
Opadry II 45U28594	28.34	0.62	0	1.05	0
Opaglos 2 98Z19173	23.59	0.65	0	1.07	0
1% 98Z19173 on 3% 33G24690	23.59	0.65	0	1.07	0
Uncoated Placebo	36.63	0.89	0	3.60	3
Opadry II 33G24690	38.53	2.07	1	7.50	9

Flow Testing

Samples that did not flow at all should be recorded as infinity, but to be able to illustrate these results, failed samples were given a nominal time of 30 seconds for the 400 g to flow through. So when represented as seconds per 100 g of sample the maximum time (failure to flow) is recorded as 7.5 seconds (Figures 4 and 5).

Figure 4. Mean Flow Seconds/100g Tablets 30mm Aperture

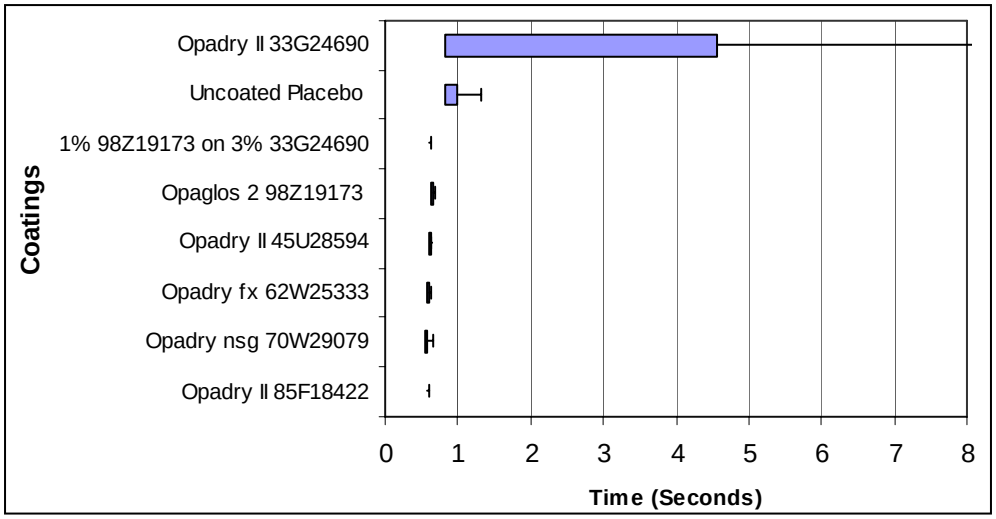
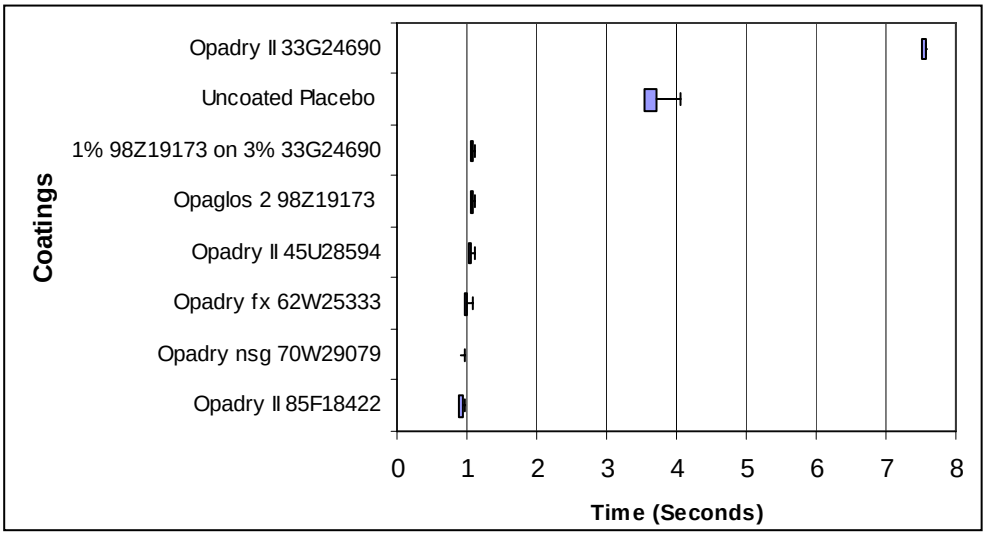


Figure 5. Mean Flow Seconds/100g Tablets 25 mm Aperture



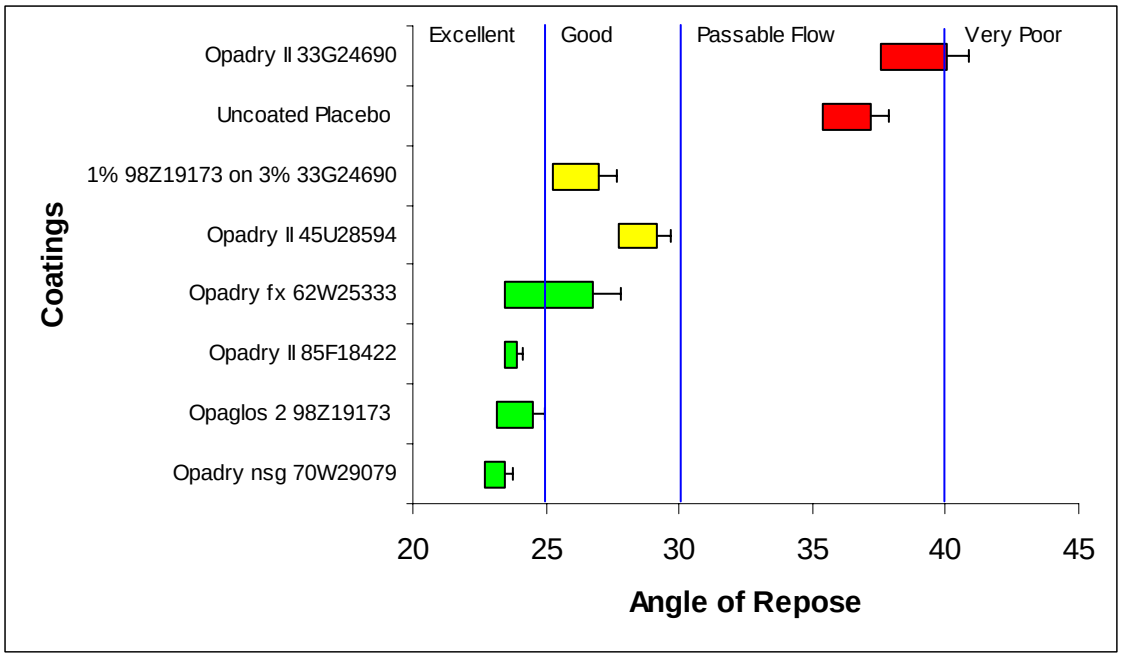
Angle of Repose

Results are interpreted by using the guide in Table 2 below, data is represented in Figure 6.

Table 2.

Angle of Repose (degrees)	Flow
< 25	Excellent
25-30	Good
30-40	Passable
> 40	Very Poor

Figure 6. Angle of Repose for 10 mm Round Tablets (3% Weight Gain)



Packaging Efficiency

Table 3.

Tablet	Coating	Maximum Line Speed with No Rejects (Blisters/min)
Round	Uncoated	400 (max)
Round	85F19250	400 (max)
Round	85F25215	400 (max)
Caplet	Uncoated	200
Caplet	85F19250	230
Caplet	85F25215	230

Maximum speed of the IMA C90 is 400 blisters per minute. We achieved this speed with all the round tablet samples.

Table 4.

Tablet Shape and Coating	Weight Gain	Number of Stoppages	Number of Minutes with Reduced Output	Failed Blisters %
Round Uncoated	0	8	9	1.9
Round Clear	1	0	0	0
Round Red	3	4	8	5.5
Caplet Uncoated	0	24	24	N/A
Caplet Clear	1	13	13	N/A
Caplet Red	3	9	9	N/A

In all cases, line stoppages were caused by tablets that broke during shipment and handling, before packing. Uncoated tablets had a significantly higher frequency of breaking.

Dust Generation: After 60 minutes of packing, (180,000 tablets), there was much greater contamination with uncoated tablets, and the dust left by the coated tablets was negligible (Figure 7).

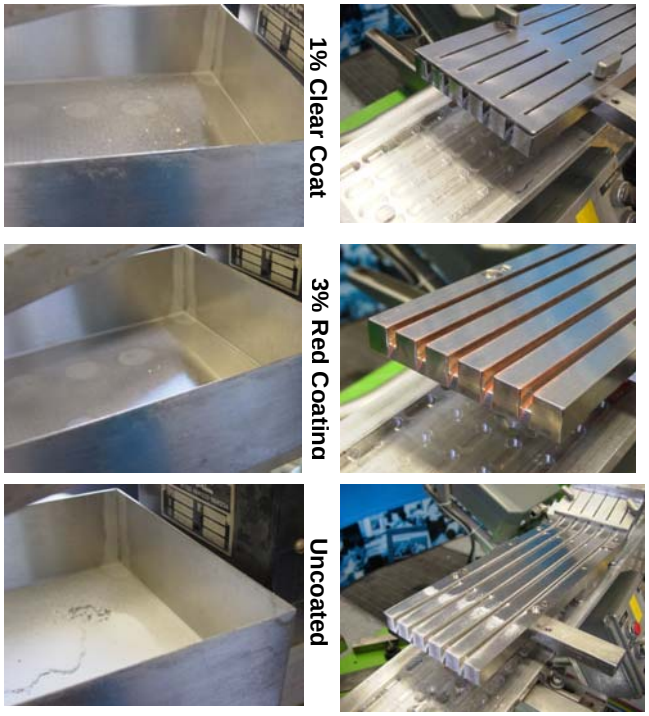
Discussion

Tablets coated with Opaglos 2, Opadry fx, Opadry II 85F18422, Opadry II 45U28594 and Opadry ns-g all flowed very well with no flow failures and had lower Angles of Repose. However, tablets coated with Opadry II 33G24690 and the uncoated tablets experienced flow failures, longer flow times through both apertures and had higher Angles of Repose. The coatings that had better flow contained a detackifier or hydrophobic plasticizer, both of which promote slip.

The improvement in the flow of a coated tablet was achieved with a nominal 1% weight gain of a high slip coating. The tablet coated with Opadry II 33G24690 had only passable flow; however, applying a 1% topcoat of Opaglos 2 onto this coated tablet improved the flow from passable to the high end of the good flow band. The Opaglos 2 topcoat also provided an elegant, high gloss finish.

The second phase of this study demonstrated that higher packing speeds were achieved with caplets coated with “high-slip” coatings (85F19250 and 85F25215) versus an uncoated caplet. This difference in packing speed translates to a time savings of 15%. The potential to speed up packing line speeds with coated tablets was determined to be shape dependent, since both uncoated and coated round tablets were packed at the same maximum speed. In this study, a highly efficient packaging machine was used; however, if less efficient packaging equipment were utilized, differences in maximum attainable packing speeds may have been observed even with round tablets.

Figure 7.



CONCLUSIONS

Tablets coated with Opaglos 2, Opadry II 85 series, Opadry fx or Opadry ns-g have excellent flow properties. The use of these coatings may provide time savings in the blister packing of tablets. Opadry II 85 series film coatings offer the dual benefit of maximum film coating productivity and maximum blister packaging efficiency. The use of any coating is expected to reduce the risk of contamination to the operator and machine from active dust. This could result in quicker clean down and reduced changeover times.

Reprint of poster presented at AAPS, Nov 2005. Authors: Kevin W. Hughes and Peter Wan.

REFERENCES

1 (2003) Copley Scientific Product Brochure, (180).
2 (2002) European Pharmacopoeia. *Method for Flowability2* (2.9.16). (208) 4th Edition.
3 (2005) Influence of Cab-O-Sil M-5P on the Angle of Repose and Flow Rates of Pharmaceutical Powders. Company Website.

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