

Performance Characteristics and Formulation of Kollicoat® Smartseal 30 D

Charles Cunningham, Chris Neely and Thomas Farrell

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Purpose

Kollicoat® Smartseal 30 D, a new methyl methacrylate and diethylaminoethyl methacrylate copolymer, is insoluble at basic and neutral pH and rapidly dissolves at pH < 5.5.¹ It is, therefore, well suited as a film coating for taste masking applications, where it is desirable for the coating to remain intact in the neutral pH of the mouth but rapidly dissolve in the acidic environment of the stomach. Kollicoat Smartseal 30 D is supplied as a liquid dispersion (30% solids concentration) and requires the addition of a plasticizer, detackifier, pigments and optionally an antioxidant in a multistep preparation process.² The objective of this study was to investigate the use of a preformulated additive system to enable efficient preparation and application of the Kollicoat Smartseal 30 D dispersion containing pigments for color matching if desired. The moisture permeability of sprayed films, the coating dispersion and application performance, and disintegration time of coated tablets in media of varying pH values was investigated.

Methods

A preformulated additive dispersion was developed comprising plasticizer (triethyl citrate), detackifier (talc) viscosity modifier (xanthan gum) and pigments. The pigmented dry additive formulation was dispersed in deionized water and allowed to mix (low shear) for 20 minutes. The Kollicoat Smartseal dispersion was added to the pigment dispersion and allowed to mix for 1 hour prior to sieving (200 μ) and coating. The dispersion composition is listed in **Table 1**. The final coating dispersion solids concentration was 20%.

Table 1. Coating Dispersion Composition

Ingredients	Supplier	Percentage (%)
Kollicoat Smartseal 30 D	BASF	34.7
Preformulated additive system	Colorcon, Inc.	9.6
Deionized water	n/a	55.7
Total		100.0

Acetaminophen (APAP) 500mg tablets (LNK International, Hauppauge, NY) were used as the substrate. The APAP tablets were coated with the Kollicoat Smartseal dispersion directly or after the application of a seal-coat (Opadry®, complete film coating system, Colorcon, Inc.). The coatings were applied in a 15" fully-perforated, side-vented coating pan (Labcoat I, O'Hara Technologies, Richmond Hill, Ontario, CA) equipped with 1 spray gun (VAU, Spraying Systems Inc. Wheaton, IL, USA). The coating parameters are listed in **Table 2**.

Table 2. Coating Process Parameters

Process Settings	Units	Trial 1		Trial 2
		Opadry Sealcoat Application	Kollicoat Smartseal Application	Kollicoat Smartseal Application
Coating dispersion solids concentration	%	10	20	20
Applied coating weight gain (WG)	%	3	4	4
Pan load	kg	3	3	3
Pan speed	rpm	18	18	18
Target product temperature*	°C	43-46	34-38	34-38
Spray rate	g/min	20	20	20
Process airflow	cfm /m ³ /hr	175 /290	175 /290	175 /290
Atomizing air pressure	psi / bar	20 /1.4	20 /1.4	20 /1.4
Pattern air pressure	psi / bar	20 /1.4	20 /1.4	20 /1.4

* Process inlet temperature was varied as needed to maintain the target product temperature setting for each trial.

Water vapor transmission rate (WVTR) was determined on sprayed films (thickness 100 \pm 10 microns) using a VTI WPA-100 unit fitted with a 6.39 cm² test cell. Coated tablets were assessed visually for appearance and using a Tricolor Systems Model 805A Surface Analysis System (Elgin, IL) for gloss values (GU). Disintegration time (DT) of the coated tablets was assessed according to USP 32-NF 27, <701> Disintegration. Tablets were tested in media of varying pH (0.1N HCl, pH 4.5 acetate buffer, pH 6.8 phosphate buffer).

Dissolution testing was performed according to the USP (32) Acetaminophen Tablets Monograph (Apparatus II, 900 mL, RPM = 50), with modified time points and media (0.1N HCl, pH 4.5 acetate buffer, pH 6.8 phosphate buffer).

Results

Dispersion Preparation

The standard method of preparing the Kollicoat Smartseal dispersion consists of multiple steps, materials and equipment (**Table 3**).²

Table 3. Preparation of the Coating Dispersion – Standard Method

Process Steps	Operation	Mixer	Number of Materials Dispensed in Each Step	Typical Preparation Time (min)
A	Dissolve antioxidant in liquid plasticizer	Low shear	2	30-60
B	Disperse pigment and detackifier in water	High shear	3+ Depending on # of pigments	15
C	Add Kollicoat Smartseal 30 D to pigment dispersion (note: pigment dispersion must be transferred to low shear mixer prior to Smartseal addition)	Low shear	1	120
D	Add antioxidant / plasticizer mixture to pigment dispersion	Low shear	-	
E	Pass final dispersion through a 200 μ sieve	-	-	5
		Total	6+	140 - 170

The simplified method of preparation using the preformulated additive is shown in **Table 4** and **Figures 1-2**.

Table 4. Preparation of the Coating Dispersion – Preformulated Additive Method

Process Steps	Operation	Mixer	Number of Materials Dispensed in Each Step	Typical Preparation Time (min)
A	Disperse preformulated additive in water	Low shear	2	20 - 30
B	Add Kollicoat Smartseal 30 D to pigment dispersion	Low shear	1	60
C	Pass final dispersion through a 200 μ sieve	-	-	5
		Total	3	85 - 95

Figure 1. Addition of Preformulated Additive to Water (Step A)

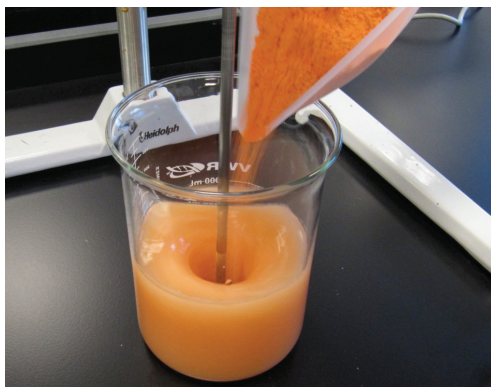


Figure 1. Addition of Kollicoat Smartseal 30 D to Preformulated Additive Dispersion (Step B)



The use of the pre-formulated additive system reduced the number of materials to be dispensed by 50% and eliminated the need for mixing the pigments with high shear. The total preparation time was reduced by almost 40%.

Water Vapor Permeability

The moisture permeability of the sprayed film (100 µm thickness) ranged from 5.5 – 6.5 g H₂O/ day/100in² (n=2). These values are very good and are consistent with commercially available film coatings specifically marketed for moisture barrier applications.³

Coated Tablet Appearance

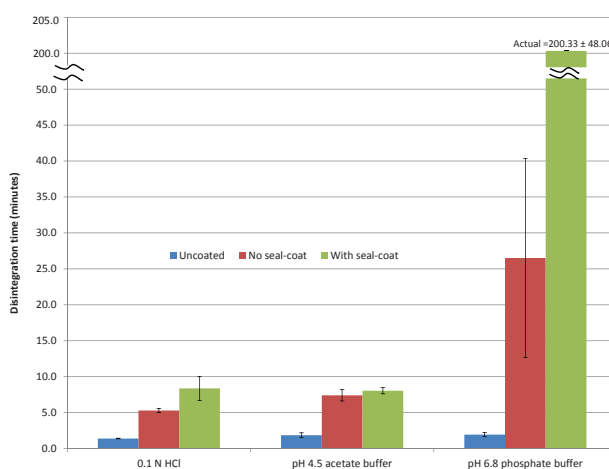
The coated APAP tablets were free of visual defects and uniform in appearance (**Figure 3**). The gloss of the coated tablets was 150 GU compared to 87 GU for the uncoated tablets.

Figure 3. Coated APAP Tablets (4% WG).



Coated tablets, with or without a seal-coat, fully disintegrated in less than 10 minutes in 0.1N HCl or pH 4.5 acetate buffer. As expected, in pH 6.8 phosphate buffer, the disintegration time (DT) was prolonged versus the DT in lower pH media. The DT in pH 6.8 ranged from 25 minutes without a seal-coat to > 200 minutes with a seal-coat (**Figures 4 and 5**).

Figure 4. Disintegration Test Results



The influence of the seal-coat on the disintegration time was significant. For the tablets with no seal-coat, it was observed that the film on the faces of the tablets remained intact while the edges began to fail around 15 minutes in pH 6.8. The edges of the tablets with a seal-coat remained intact for a substantially longer period of time. This indicates that the seal-coat adds strength to the sharp edges of the core prior to the application of the Smartseal coating. With or without a seal-coat, disintegration time was prolonged well past the time that a tablet would be expected to be retained in the mouth.

Dissolution Testing

The dissolution test results were consistent with the disintegration results. In 0.1N HCl or pH 4.5 acetate buffer, >90% APAP was released within 30 minutes (with or without a seal-coat). In pH 6.8 phosphate buffer, drug release was significantly slower for the tablets with no seal-coat, and no drug was released at all after 60 minutes for the tablets with a seal-coat (**Figures 5 and 6**). The standard deviation for % released in pH 6.8 was very high for the tablets without seal-coat. This was also observed in the disintegration test results. The thickness of applied films on capsule-shaped tablets can be very thin on the edges of the tablet vs. the faces of the tablet potentially leading to film failure on the edges.⁴ For oblong or capsule-shaped tablets, the seal-coat strengthens the core and rounds the sharp edges prior to application of the functional coating.

Figure 5. APAP Tablet (No Seal-coat) Dissolution with 4% WG Kollicoat Smartseal 30 D

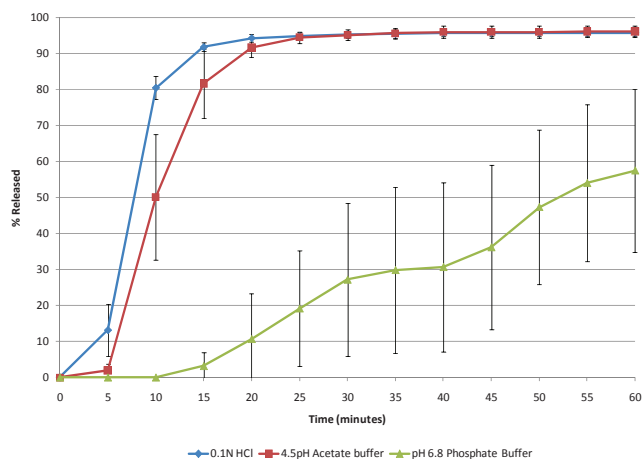
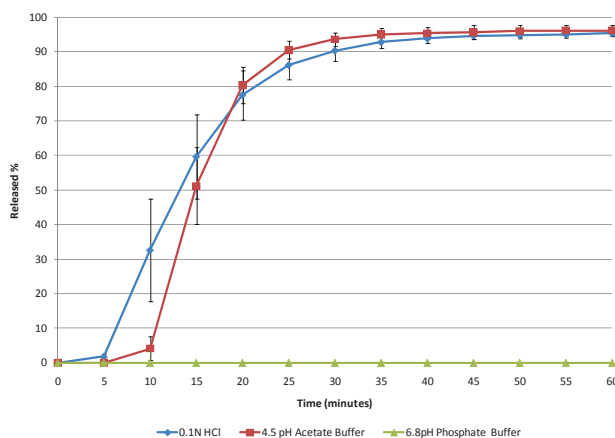


Figure 6. APAP Tablet (with Seal-coat) Dissolution with 4% WG Kollicoat Smartseal 30 D



Conclusions

The preformulated additive system greatly reduced the complexity of the Kollicoat Smartseal 30 D dispersion preparation process. Raw material dispensing steps were reduced by > 50% and total dispersion preparation time was reduced by > 40%. Color-matching is facilitated by the incorporation of pigments into the preformulated system. The APAP tablets coated with Kollicoat Smartseal 30 D exhibited desirable pH-dependent disintegration characteristics for taste masking applications. The low WVTR through sprayed films indicated that this polymer may also provide good moisture protection for coated tablets. The pre-formulated additive system provided further enhancement to the use of Kollicoat Smartseal 30 D in taste masking applications.

References

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For more information, contact your Colorcon representative or call:

North America
+1-215-699-7733

Europe/Middle East/Africa
+44-(0)-1322-293000

Asia Pacific
+65-6438-0318

Latin America
+54-1-5556-7700

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