KARLVILLE

Date: July 16, 2019
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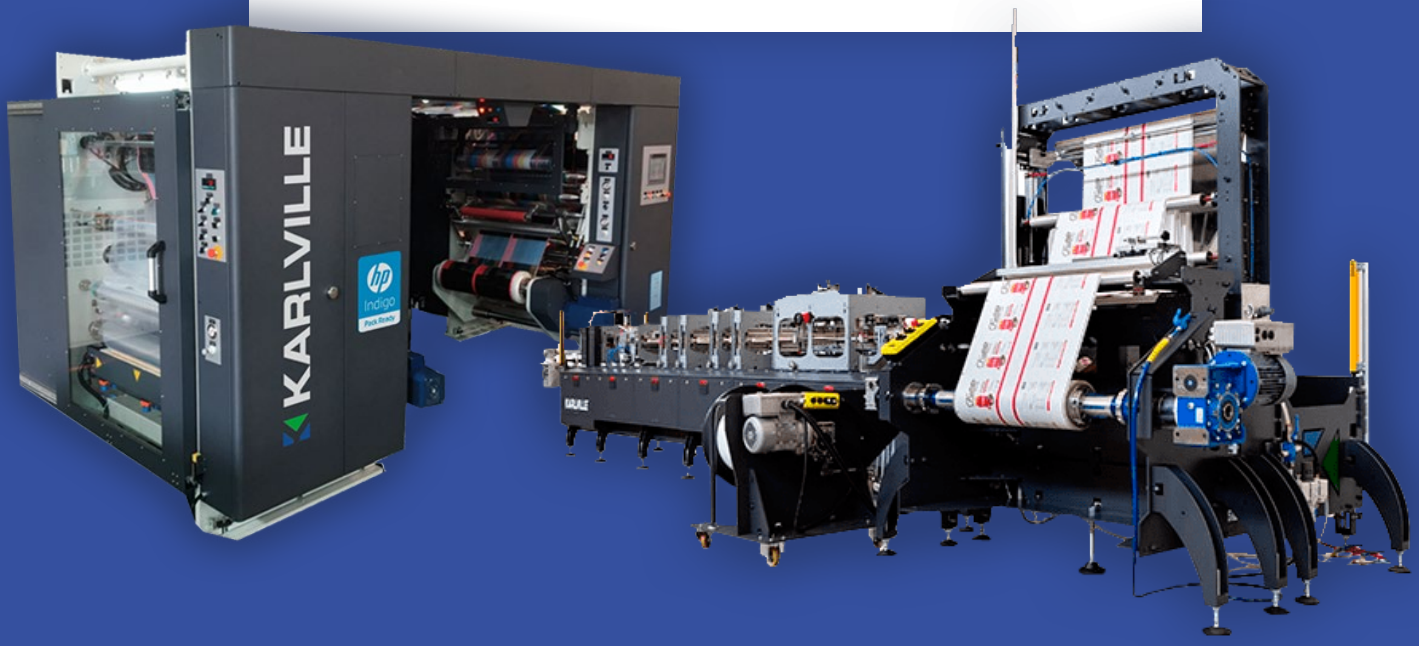
Indigo
Pack Ready

Validation Report: KDX BOPET EVA



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Subject: Pack Ready validation test report for KDX (film supplier) / KARLVILLE trial

Date July 16, 2019

(Supplier & Product) KDX BOPET EVA 20um - SUBMITTED FOR EVALUATION

Requirements:

1. **Roll Details:**
In Table 1 list number of rolls, size of rolls and details of all thermal lamination films including product codes, corona treatment, additives (if applicable) etc…
2. **SAMPLES to be sent to Israel:**
   a. 70m (230ft.) of laminated material (see test protocol supplied by HP-Indigo R&D)
   b. Pouching: Karlville to send pouches of the laminated film – **N/A**

Procedure:

Roll Details and condition: Each of the produced rolls underwent an incoming inspection and tested for:

- Visual inspection: Record general condition and/or any defects (coating quality, visual defects) & Curling
- Constructions: Each construction shall be listed along with all pertinent details captured in Table 2

Production /summary: Run lamination test based on test protocol supplied by HP R&D. fill Table 3 for process parameters.

- LBS testing: Each construction will be subject to Lamination Bond Strength (LBS) measurements as indicated in the test protocol. LBS measurements will be performed as follows:
  - Immediately after the lamination (to be performed by Karlville)
  - 24 hours after the lamination (to be performed by Karlville)
  - 2-4 weeks after the lamination (to be performed in parallel by Karlville & HP-Indigo R&D @ Israel)

Table 1 – Roll details:

Product code	Material	Resin EMA or EVA	Thickness [µm]	Roll width [mm]	Corona treatment [Y/N]	Additives
N/A	BOPET GLOSS	EVA	20	750	YES	N/A

Table 2 - Production summary & experimental details:

EXP. #	Printed substrate	Surface / reverse print	TAP substrate	TAP on top or 2'nd	Total Thickness [µm]
RS-003	12um PET / 62.5um PE	SURFACE	KDX BOPET GLOSS 20 mic. EVA	TOP	95

Table 3 - Process parameters:

EXP. #	Nip temperature [°C]	Lamination speed [m/min]	Corona on TAP [W]	Corona on print [W]	Wrapping angle [deg.]	Tension print [kg]	Tension tap [kg]	Tension RW [kg]	Tension infeed [kg]	Pressure [Bar] L/R	Pre-Heat [°C]
RS-003	140	75	2.0	2.0	100	2.0	4.0	6.0	10.0	.5 / .5	75

1. Pre-lamination – film inspection remarks:

- Curling score (in cm TD and MD): OK
- Thermal active layer coating quality: Good
- Visual defects: N/A
- Comments:

2. Post lamination results:

Exp. #	Composition		AVG. LBS [N/in] (Failure mode*)						Visual appearance (Y/N)		
			Left side of hot drum OS			Right side of hot drum GS					
			Patch 22	Patch 16	Patch 11	Patch 22	Patch 16	Patch 11	Curling	Wrinkles	Pinching
RS-003	PE/ADHESIVE/PET/INK/ EVA BOPET GLOSS	t=0	11.5	11.2	14.9	10.7	11.3	15.9	N/A	N/A	N/A
		t=24	10.9	10.5	10.8	10.4	10.5	11.2			

* The abbreviations of the failure modes stand for the following:

NT – No transfer of ink from the printed substrate to laminated substrate

TT – Total transfer of ink from the printed substrate to laminated substrate

PT – Partial Transfer of ink from the printed substrate (write the percentage of ink remaining on the printed substrate)

PTT – Partial TAP transfer from the Pack Ready film

TTT – Total TAP Transfer from the Pack Ready film to the printed substrate

3. Sealing bond strength results:

			Dwell time [sec]	SBS [N/in]				
				170C	180C	190C	200C	210C
RS-003	**PE/ADHESIVE/PET/INK/ EVA BOPET GLOSS**	**PE 62.5um**	**0.5**	**0**	**0**	**0**	**0.7**	**30**
			1	**0.7**	**9.4**	**57.5**	**58.1**	**58.9**

4. Sealed are appearance:

			Dwell time [sec]	SBS [N/in]				
				170C	180C	190C	200C	210C
RS-003	PE/ADHESIVE/PET/INK/ EVA BOPET GLOSS	PE 62.5um	0.5					
			1					

Color code reflects property rating: Red = Bad Yellow = Moderate Green = Good

Summary:

A BOPET Gloss with a thermal adhesive polymer (EVA) from KDX was used to laminate over a digitally surface printed 75um PET/PE (solventless laminated) prelam.

The appearance and LBS values of the finished product exceeded the acceptance criteria when using the process parameters listed above in Table #3.

Results show high LBS at speeds of 75M/min. Great appearance without any defects and no finished curl. *See pictures below.*

The SBS test results show none or partial SBS at temperatures of 170C, 180C and 190C with a dwell time of 0.5 and very low SBS at 170C and 180C with the dwell time set at 1.0 second, although the material exceeds the SBS test criteria with very good bond strenght and great appearance at temperatures of 190C - 200C and a 1 second dwell time. At 210C and dwell time of 1.0 sec the material wrinkled.

The KDX Gloss BOPET thermally laminated to the digitally surface printed 75um PET/PE has passed the lamination validation process.

A 70 M roll was sent to R&D Israel for further testing.