



Corona Treatment of Paper Experiences and Findings

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- Coating Trials with different Treatment methods.
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Current Status and preconditions

- Several Surface Treatment methods are used to improve functionality of surfaces.
- Mainly to increase wettability and adhesion.
- Experiences have mostly been made on plastic films and most applications exist in this area.
- Some research has been done on treatment of paper but there is no big picture yet.
- “Paper” is not just a substrate as there is a variety of papers and cardboards on the market. Many different coatings and additives are applied and it is expected, that results vary according to these differences.

Goal of this paper

- This presentation gives an overview. We are no experts in the process but in plasma, corona and machinery. The presentation just shows, what we observed during trials.
- We performed several trials and had a look at coating properties and wettability.
- Please keep in mind: Different substrates may lead to different results!

1. Treatment of Cardboard

Treatment of Cardboard: Settings

- A line was chosen to perform coating trials with several treatment methods at different speeds (up to 800 m/min).
- Flame / Ozone / Corona had to be available and controlled to perform several settings.
- Lab equipment necessary.
- To avoid influences from different inks, back side of a 270 gsm cardboard was used.



Treatment of Cardboard: Settings II

- Working width: 513 mm
- Speed: 400 / 600 / 800 m/min
- Ozone: 4-6 m³/h depending on speed
- Flame: 1690 – 3000 l/min (@ .25:1; burner distance 40 mm)
- Corona: 15 – 40 kW
- Melt Temperature: 315°C LDPE
- Grammage: 20 gsm

Treatment of Cardboard: Measurements

- If possible we performed 180 degree peel strength in dry conditions for 15 mm sample width, 100 mm/min cross-head speed with Instron tensile testing. Residual fibers were observed.
- Residual moisture after different treatments was measured.
- Optical microscopy gave some insights on paper surface after treatment.

Treatment of Cardboard: Measurements

- For distinction 3 grades of adhesion were used:
 - **Grade 1:** many fibre clusters on the PE after peel strength test, or adhesion impossible to measurement due to the breaking of the LDPE layer due to high adhesion.
 - **Grade 2:** less fibres than grade 1 but still fibres on the PE after peel strength test.
 - **Grade 3:** total and easy delamination between paper and LDPE.

Coating: Results I (400 m/min)

ID	Speed [m/min]	Corona*	Treating Flame**	Ozone***	Adhesion [N/m]	Adhesion grade
1	400	Off	std*	std**	NM	1
2	400	37,5	std	std	NM	1
3	400	37,5	std	off	NM	1
4	400	75	std	off	NM	1
5	400	100	std	off	NM	1
6	400	100	off	off	NM	1
7	400	75	off	off	NM	1
8	400	37,5	off	off	NM	1
9	400	37,5	off	std	NM	1

* In Wmin/m²; ** Std gas flow = 1690 l/min; ***std ozone flow = 4 m³/h

Coating: Results I (800 m/min)

ID	Speed [m/min]	Treating	Grammage [gsm]	Adhesion [N/m]	Adhesion grade
1	600	Flame + Corona + Ozone	21.69	NM	1
2	800	Flame + Corona + Ozone	20.71	NM	1
3	800	Flame + Corona	20.49	NM	1
4	800	Flame	20.69	13	3
5	800	Corona	21.24	9	3
6	800	Untreated	21.37	3	3

Corona Dose = 50 Wmin/m², * gas flow = 3000 l/min; ozone flow = 6 m³/h

Coating: Results II (Deviation)

Untreated

Sample ID	Average Load (N/m)
2	3
3	3
4	3
5	3
6	4
std	0,42

Flame

Sample ID	Average Load (N/m)
2	16
3	14
4	20
5	17
6	17
Std	3,76

Corona

Sample ID	Average Load (N/m)
2	10
3	10
4	10
5	11
6	10
Std	0,96

Δ Temp = 20°C

Δ Temp = 17°C

Coating: Results III

- Measurements showed according to experience, that flame treated paper had less residual humidity than corona treated paper.
- Flame treated paper is more brittle than Corona treated paper.
- Not a new finding, but approved by the trials: Standard deviation of tear strength is higher with flame treated paper. Corona treated paper shows better uniformity.

Coating: Results IV

- Optical microscopy showed that neither flame nor corona damaged the cardboard surface.
- We were not able to see fibres cutting through the melt and create pinholes in the coating.
- At 800 m/min neither flame nor corona is enough to create suitable adhesion conditions. Using flame together with corona showed adequate adhesion.

2. Wetability improvement on Paper



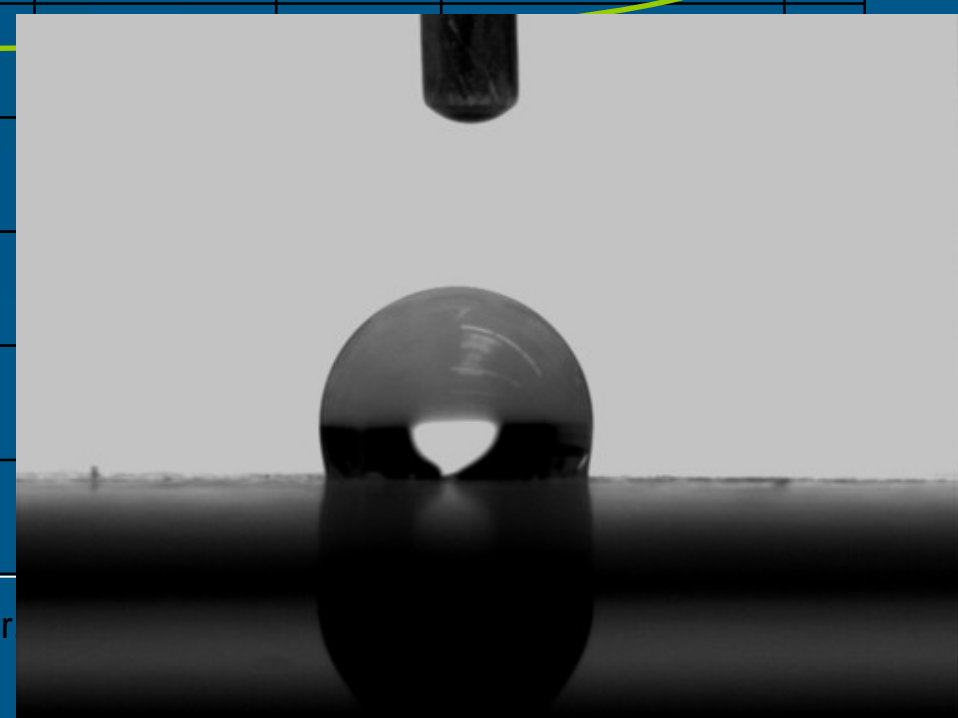
Wetability improvement on Paper

- Test design:
 - Regular Corona Treatment Station
 - Ceramic roller / ceramic electrodes
 - Several Corona Doses applied
 - Clay Coated Paper with 150 gsm



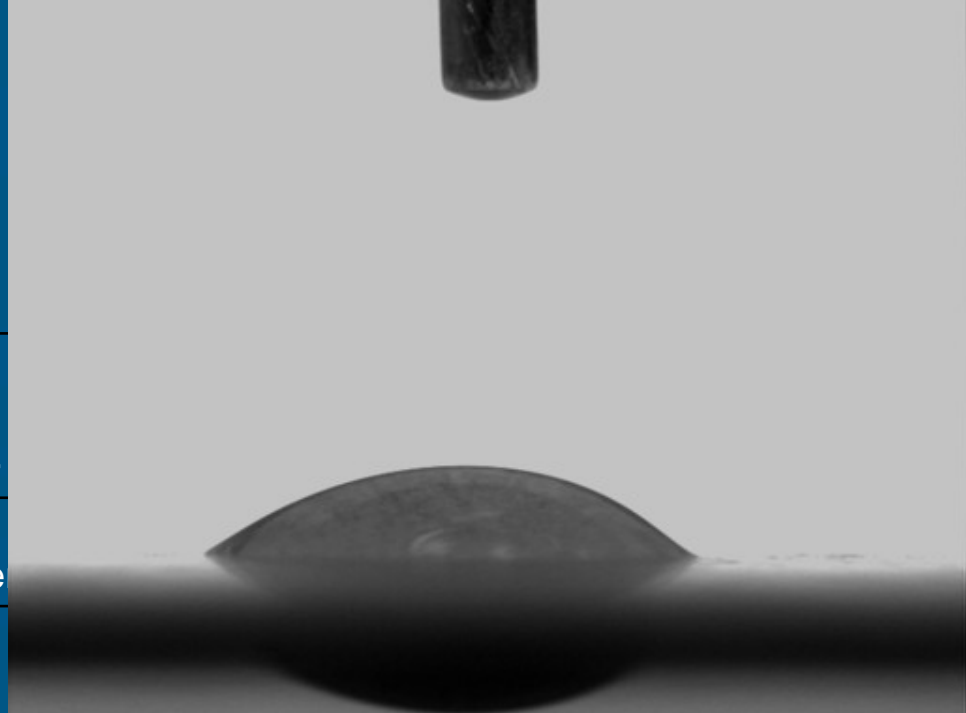
Results

Dose	Speed	Power		CER - CER		After Corona Treatment		
				Wmin/m ²	m/min	W	W/cm	number
0,00	0	0	0	0	0			112°
10,00	50	650	0,63	8				
20,00	50	1300	1,25	8				
40,00	50	2600	2,5	8				
60,00	50	3900	3,75	8				
80,00	50	5200	5	8				



Results

Dose Wmin/m ²	Speed m/min	Power W	W/cm	CER -					
				numbe					
0,00	0	0	0	0					
10,00	50	650	0,63	8	1300			62°	
20,00	50	1300	1,25	8	1300			45°	
40,00	50	2600	2,5	8	1300			19°	
60,00	50	3900	3,75	8	1300			18°	
80,00	50	5200	5	8	1300			13°	



Results

Dose Wmin/m ²	Speed m/min	Power W	W/cm	CER -					
				numbe					
0,00	0	0	0	0					
10,00	50	650	0,63	8	1300			62°	
20,00	50	1300	1,25	8	1300			45°	
40,00	50	2600	2,5	8	1300			19°	
60,00	50	3900	3,75	8	1300			18°	
80,00	50	5200	5	8	1300			13°	

Results

Dose	Speed	Power		CER -					
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10,00	50	650	0,63	8	1300			62°	
20,00	50	1300	1,25	8	1300			45°	
40,00	50	2600	2,5	8	1300			19°	
60,00	50	3900	3,75	8	1300			18°	
80,00	50	5200	5	8	1300			13°	

Findings on Wettability

- Regular Corona Treatment improves wettability.
- It increases proportionally to the energy input.
- Clay Coating is not a drawback but may induce need for higher corona doses.
- As wettability is one of the components of adhesion it is expected, that adhesion will also increase.
- By the way: Hot air does not show any effect. I.e. moisture is not the only parameter for adhesion.

Conclusions I

- Treatment results are comparable. Flame and Corona lead to better wettability and adhesion.
- Increase of wettability is not (only) induced by changes in humidity (hot air alone shows no result at all).
- At 800 m/min none of both is able to create sufficient adhesion on its own.

Conclusions II

- Material is less dry with corona treatment and therefore easier to handle.
- Flame treatment leads to higher adhesion values but at a higher standard deviation. The controlled corona against a backup roll leads to a more uniform surface.
- Even at high speeds, surface treatment with corona stays uniform over the whole surface.

Comparison Flame vs. Corona

- Treatment results comparable and more uniform with corona.
- Corona treated paper does not need any remoistening
- Less brittle substrate and easier to handle.
- No fire hazard with Corona treatment, no extinguishing equipment needed.
- Low running costs and easy to install.



Corona Treatment: Recommendations

- Station as close as possible to the laminator and as less idle rollers as possible in between.
- Industry treats paper between 17 and 60 Wmin/m².
- Clearance between electrodes to prevent congestion due to dust.
- Stations should be easy to clean to enable high availability of the process.



Thank you for your attention

- **Your questions ...**