The cooperation of paper and adhesives

Dr. Hermann Onusseit

Industrieverband Klebstoffe e. V. (IVK)

INGEDE Symposium
Online 02. März 2021

Industrieverband Klebstoffe e.V.
Innovationen erkleben

ONUSSEIT Consulting

Paper and Adhesives

Good friends
Why bonding with adhesives?
Which adhesives are used?
How are adhesives applied?
What happens to the adhesive applications during paper recycling?
Conclusion!

Paper and Adhesives

Good friends

Good friends

min. 2 adhesive applications

min. 3 adhesive applications

min. 2 adhesive applications

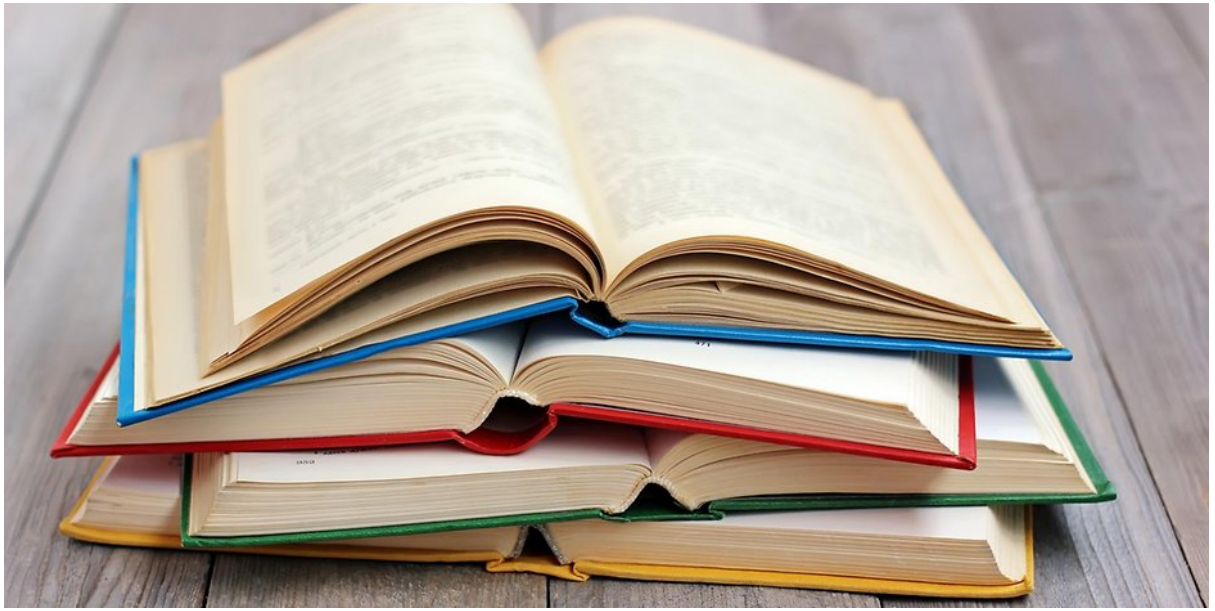
Good friends

min. 3 adhesive applications

min. 2 adhesive applications

min. 3 adhesive applications

Good friends



Up to 5 and more adhesive applications

Paper and Adhesives

Good friends
Why bonding with adhesives?

Why bonding with adhesives?

With the help of adhesives
solid and durable
material combinations
possible from almost all materials!

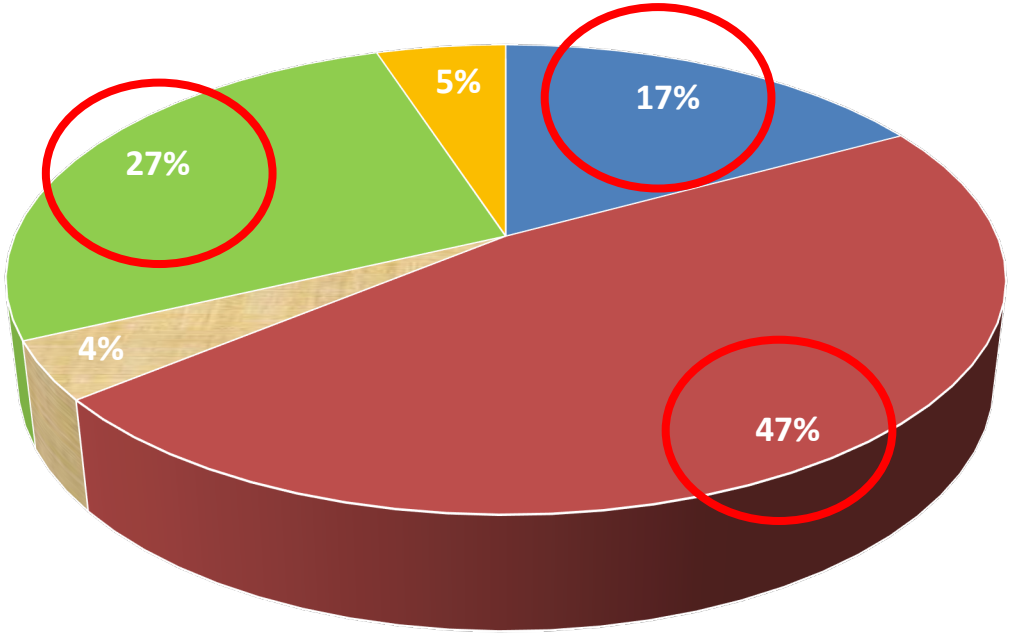
Paper - Paper
Paper - Plastics
Paper - Metal

Paper and Adhesives

Good friends
Why bonding with adhesives?
Which adhesives are used?

Which adhesives are used?

Adhesive consumption in Germany by product groups in the field of paper/packaging



Which adhesives are used?

Dispersion adhesives

<u>Water insoluble synthetic polymers</u>
Protective colloid
Water
Additives

Application: The liquid adhesive is usually applied at room temperature

Setting of the adhesive: Drying the applied adhesive

Which adhesives are used?

Hot melt adhesives

<u>Water insoluble synthetic polymers</u>
Resins
Waxes
Additives

Application: Melting the adhesives that are solid at room temperature

Setting of the adhesive: Cooling of the melt

Which adhesives are used?

Adhesives based on natural polymers

<u>In water colloidal soluble natural polymers</u>
Water
Additives

Application: The liquid adhesive is usually applied at room temperature

Setting of the adhesive: Drying the applied adhesive

Which adhesives are used?

“PSA”

When talking about “PSA adhesives”, one usually means surface-tacky coatings at room temperature, such as e.g. for adhesive labels or adhesive tapes.

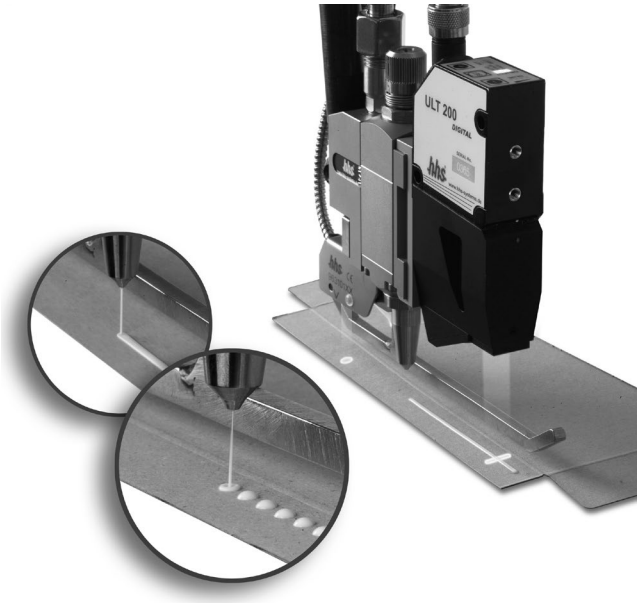
Application: During the manufacture of the pressure sensitive adhesive coated product, coating a carrier with a liquid adhesive
In use: "pressing" the coated product onto the product to be glued.

Setting of the adhesive: No additional setting!

Paper and Adhesives

Good friends
Why bonding with adhesives?
Which adhesives are used?
How are adhesives applied?

How are adhesives applied?



Paper and Adhesives

Good friends
Why bonding with adhesives?
Which adhesives are used?
How are adhesives applied?
What happens to the adhesive applications during paper recycling?

What happens to the adhesive applications during paper recycling?

During the pulping process,
the adhesive application can be disturbed!

In the paper-recycling process, adhesive applications can disintegrate during pulping to form “stickies”!

What happens to the adhesive applications during paper recycling?

During the pulping process,
the adhesive application can be disturbed!

The sufficient removal of adhesive applications is one of the challenges for paper manufacturers using paper for recycling.

What happens to the adhesive applications during paper recycling?

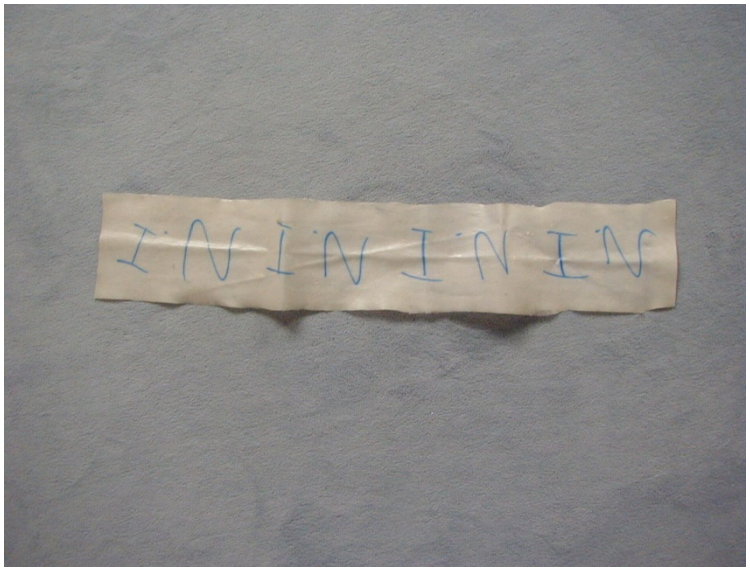
During the pulping process,
the adhesive application can be disturbed!

During the pulping process, the adhesive application will be influenced by:

Water
Chemicals
Heat

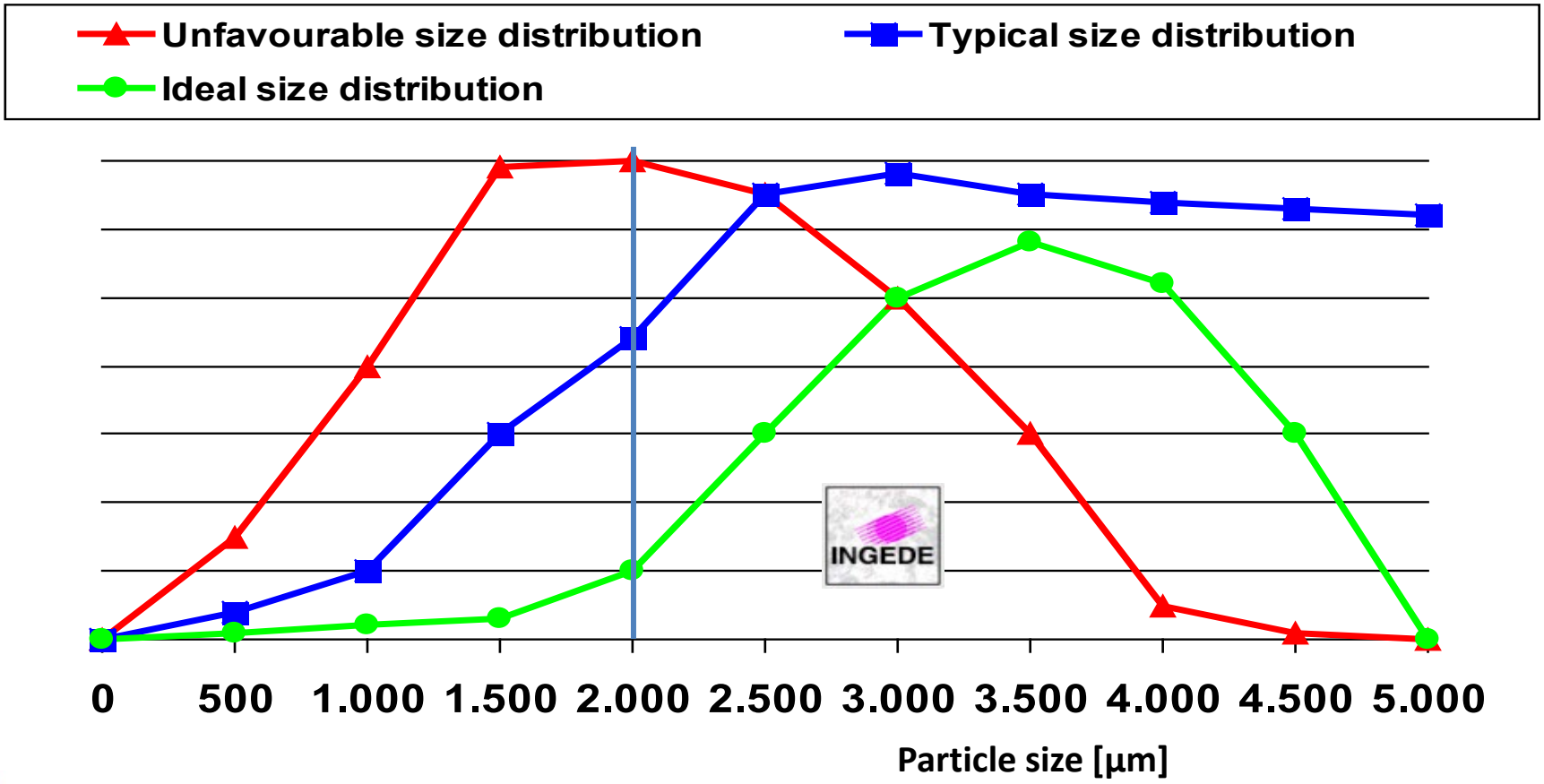
What happens to the adhesive applications during paper recycling?

During the pulping process, the adhesive application <u>can be</u> disturbed!



What happens to the adhesive applications during paper recycling?

INGEDE Methode 12 und 4



What happens to the adhesive applications during paper recycling?

Can good friends have problems too?

The biggest problem with adhesive applications is the lack of knowledge of many market participants about the properties of adhesive applications in the paper recycling process.

Unfortunately, there is a lot of "Fake News"

What happens to the adhesive applications during paper recycling?

“Fake News”

What happens to the adhesive applications during paper recycling?

“Fake News“ about adhesives applications

The behavior of dispersion adhesive applications in paper recycling depends on the chemical structure of the base polymer!

What happens to the adhesive applications during paper recycling?

“Fake News“ about dispersion-adhesives applications

In conclusion,

combining dispersion test results and adhesive composition still confirms the relevance of the test: products known to be quite water sensitive (PVA) usually show high dispersability, whereas products more resistant to water (PVAE, acrylic) usually lead to low dispersion rate and significant macro-stickies formation.

What happens to the adhesive applications during paper recycling?

“Fake News“ about dispersion-adhesives applications

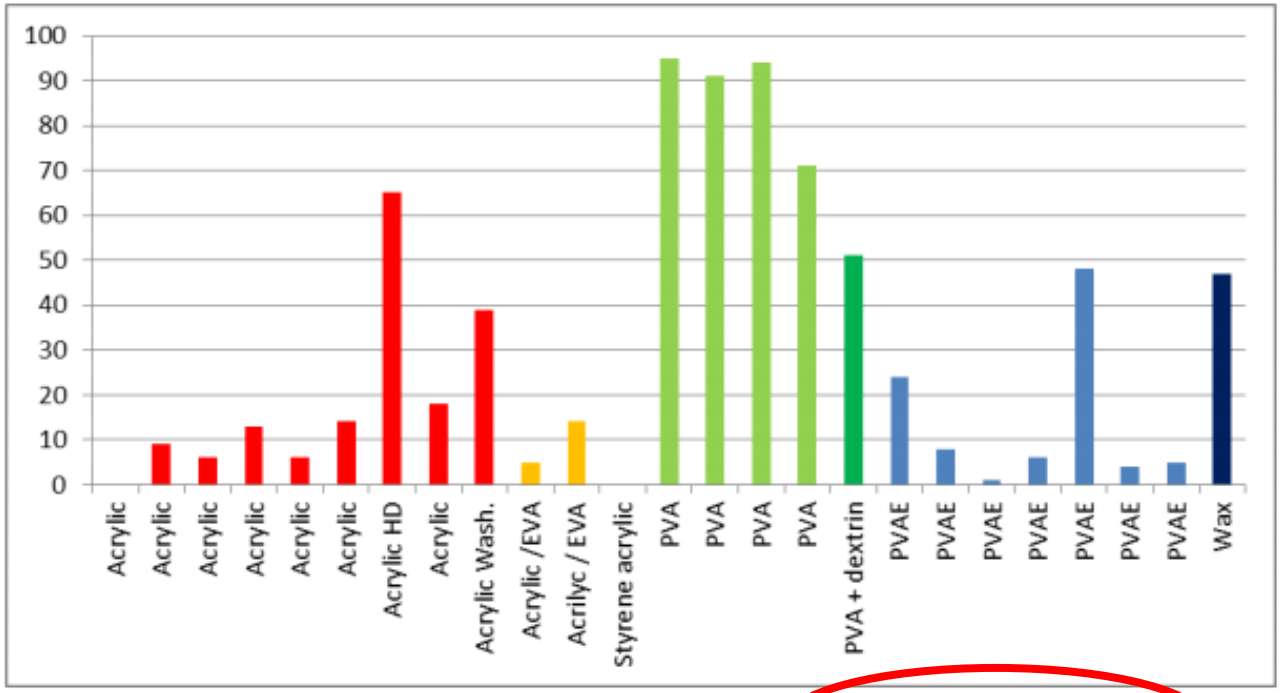
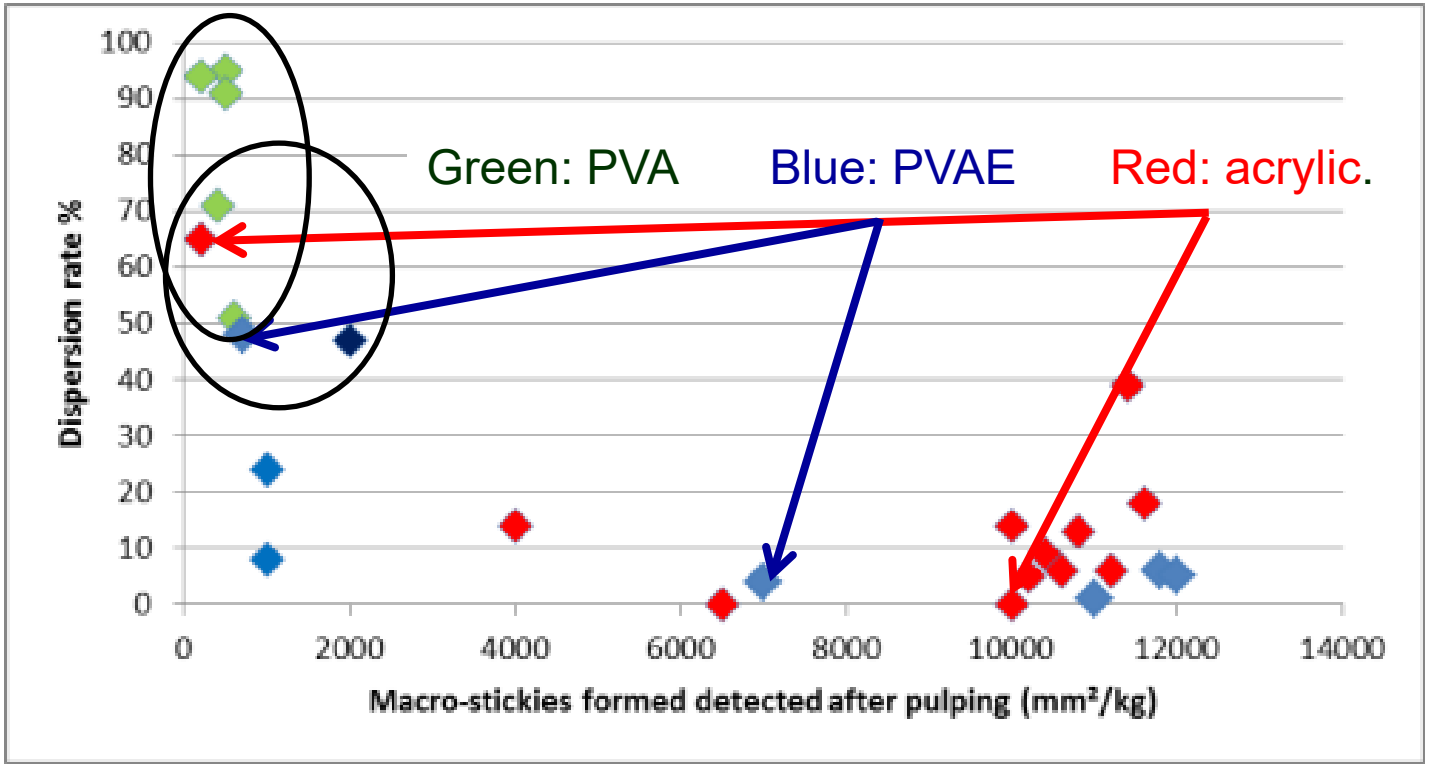


Figure 2-4 : Relationship between dispersion rate and chemical nature of the glue

What happens to the adhesive applications during paper recycling?

“Fake News“ about dispersion-adhesives applications



What happens to the adhesive applications during paper recycling?

“Fake News“ about dispersion-adhesives applications

Envelope manufacture					
Use for:	Ref	Nature	Macrostickies measurement		Dispersion test
			Total area (mm²/kg)	Share<2000µm %	Dispersion rate %
Remoistenable top flap	1	PVA	500	ND	95
	2	PVA	500	ND	91
	3	PVA	<200	ND	94
	4	PVA + dextrin	600	100%	51
	28	PVA	<500	ND	113
	33	PVA	<500	ND	100
PSA based Top flop	5	Acrylic copol.+COOH	>10 000	6	0
	6	Acrylic copol.+EVA	>10 000	65	5
	7	Acrylic copol.+EVA+PE wax	4000	58	14
	8	Styrene acrylic	6500	44	0
	9	Acrylic copol+ tackifiant	>10 000	13	9
	10	Acrylic copol. + modified resin	>10 000	34	6
	11	Acrylic copol.	>10 000	61	13
Window gluing	12	PVAE	1000	100	24
	13	PVAE	ND	ND	5
	34	PVAE	ND	ND	30
	35	PVAE	ND	ND	21
Side seam	14	PVAE	1000	100	8
	15	PVA	400	100	71
	16	PVAE	>10 000	20	1
	31	PVAE	<1000	ND	51
	32	PVAE	4500	90	26
Label / PSA					
Label / PSA	17	Acrylate	ND	ND	23
	18	Acrylate*	>10 000	30	6
	19	Acrylate*	>10 000	30	14
	20	Acrylate (washable)*	>10 000	30	39
	29	Acrylate	>10000	31	8
	30	Acrylate	700	ND	75
Self adhesive plastic film	21	Acrylate*	<200	ND	65
Repositionnable glues	22	Wax based	2000	44	47
	23	Acrylate	>10 000	34	18
Binding of booklets					
Fold gluing	24	Base EVA/Acrylique	>10 000	18	6
	25	Base EVA	700	100	48
	26	Base EVA	7000	34	4
	27	Base EVA	>10 000	80	5
Laminating					
Laminating	36	PVAE	2000		22
	37	Animal (gelatine)	200		100
Experimental					
Experimental	38	Acrylic (experimental)	200		100
	39	Acrylic (experimental)	200		100

PVA

PVAE

EVA

What happens to the adhesive applications during paper recycling?

“Fake News“ about adhesives applications

Stickies – a never ending story?

Typical adhesives in drying section deposits:

- PVAc dispersion glue
- Polyacrylates (very likely from PSA)
- Mixtures of PVAc and polyacrylate deposit

PVAE-dispersion adhesives?

Very rare or not in drying section deposits:

- Coating binders
- Starch
- EVA hotmelts

INGEDE Symposium 2019

Results from UPM R&D CERC

INGEDE

What happens to the adhesive applications during paper recycling?

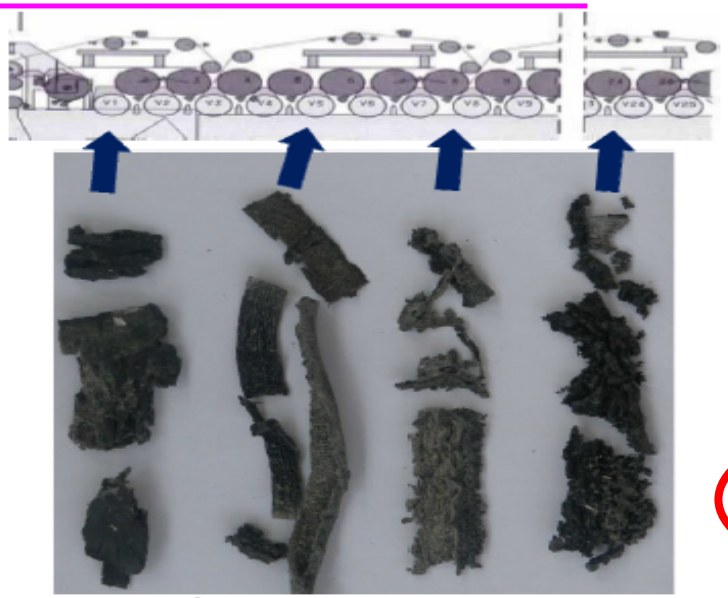
“Fake News“ about adhesives applications

<u>Adhesives applications are responsible for the formation of “secondary-stickies”!</u>

What happens to the adhesive applications during paper recycling?

“Fake News“ about adhesives applications

Stickies – a never ending story?



INGEDE Symposium 2019

Typical results:

- Stickies deposit mostly in the PM drying section
- Each type of adhesive has in a PM usually a typical deposit place in a PM
- The adhesive types can be determined by solvent extraction and FT-IR spectroscopy
- Deposits often consist of >50 % adhesives

Results from UPM R&D CERC

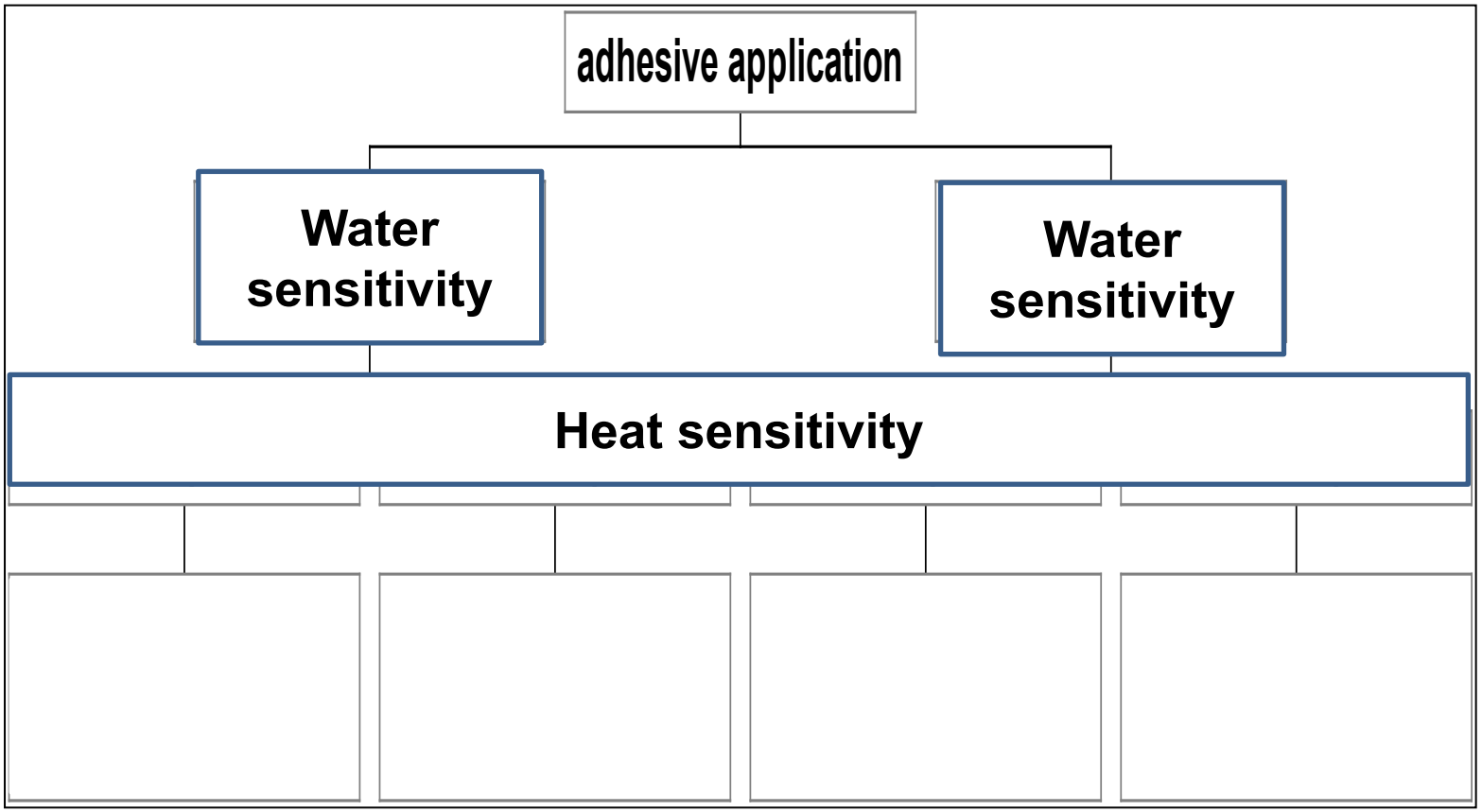
INGEDE

What happens to the adhesive applications during paper recycling?

Facts!

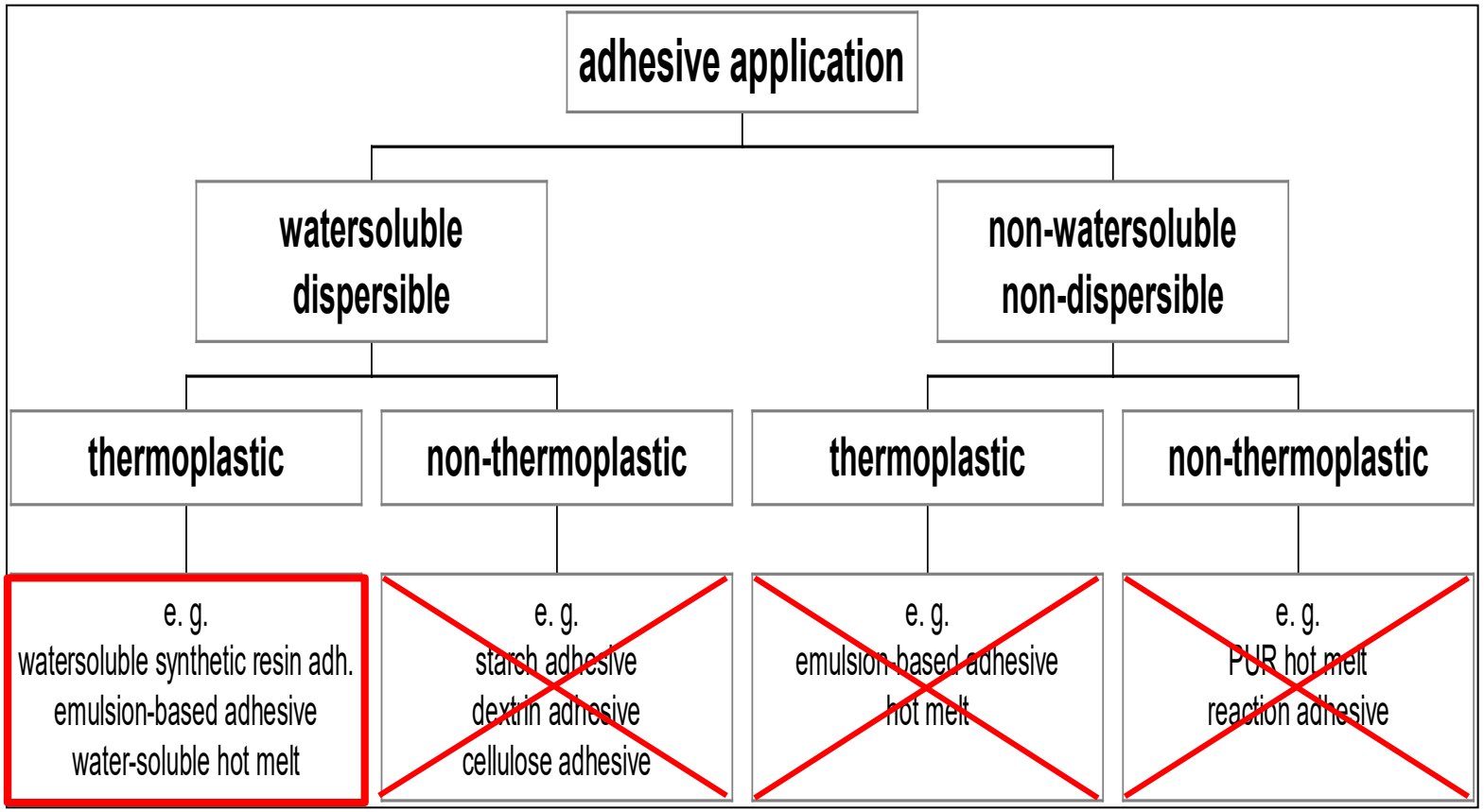
What happens to the adhesive applications during paper recycling?

Facts about adhesives applications



What happens to the adhesive applications during paper recycling?

Facts about adhesives applications



What happens to the adhesive applications during paper recycling?

Facts about adhesives applications

The behavior of adhesive applications in the recycling process depends on physical parameters!

e.g.
Water resistance
Temperature sensitivity
Geometry (layer thickness)

What happens to the adhesive applications during paper recycling?

Facts about adhesives applications

The physical parameters of the adhesives application depends on:

The formulation of the adhesive (not only from the base polymer)

The type of the application

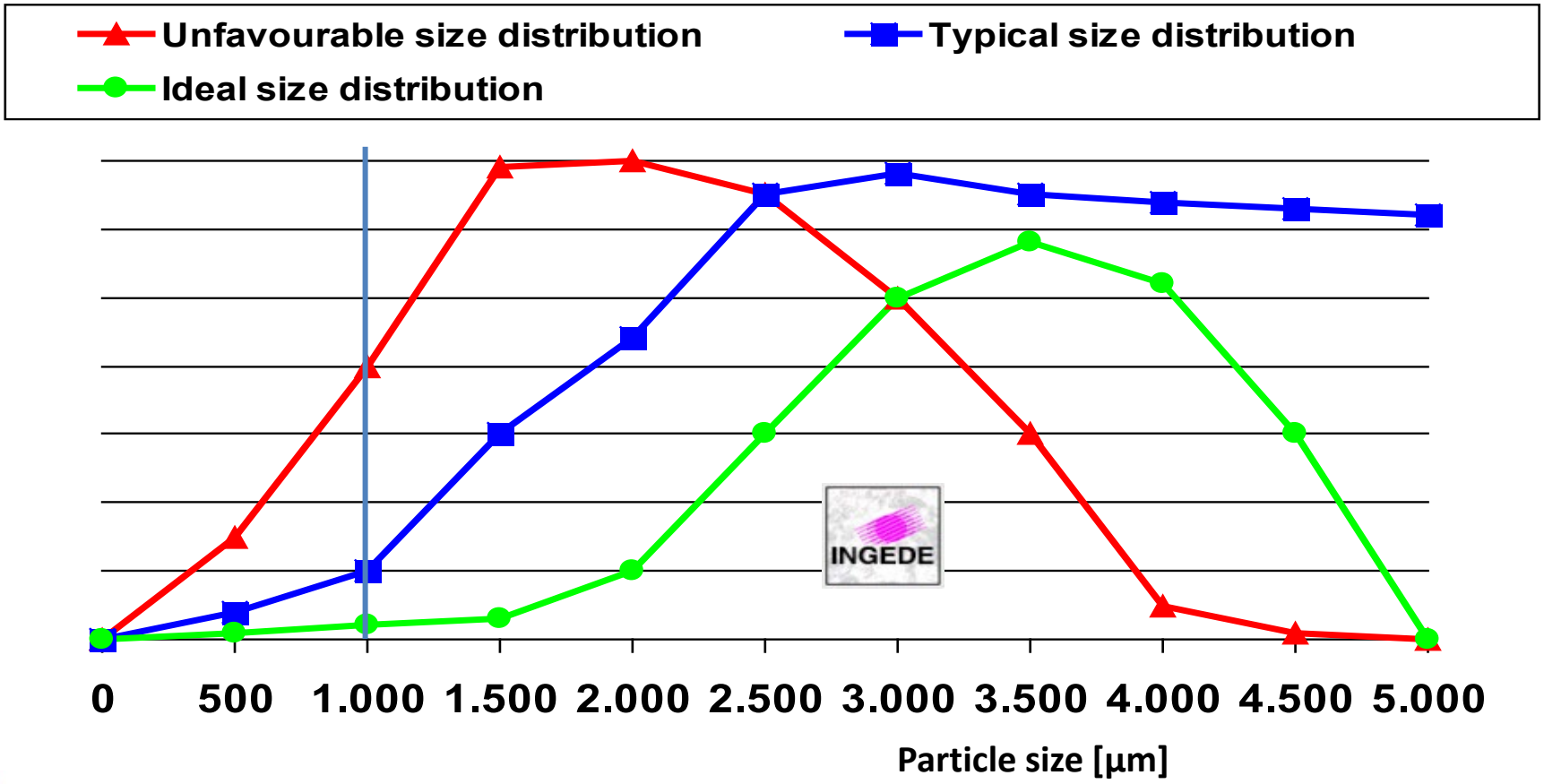
What happens to the adhesive applications during paper recycling?

Facts about adhesives applications

Most adhesive applications form "macro-stickies" in the recycling process, which are easy to sort out!

What happens to the adhesive applications during paper recycling?

Facts about adhesives applications

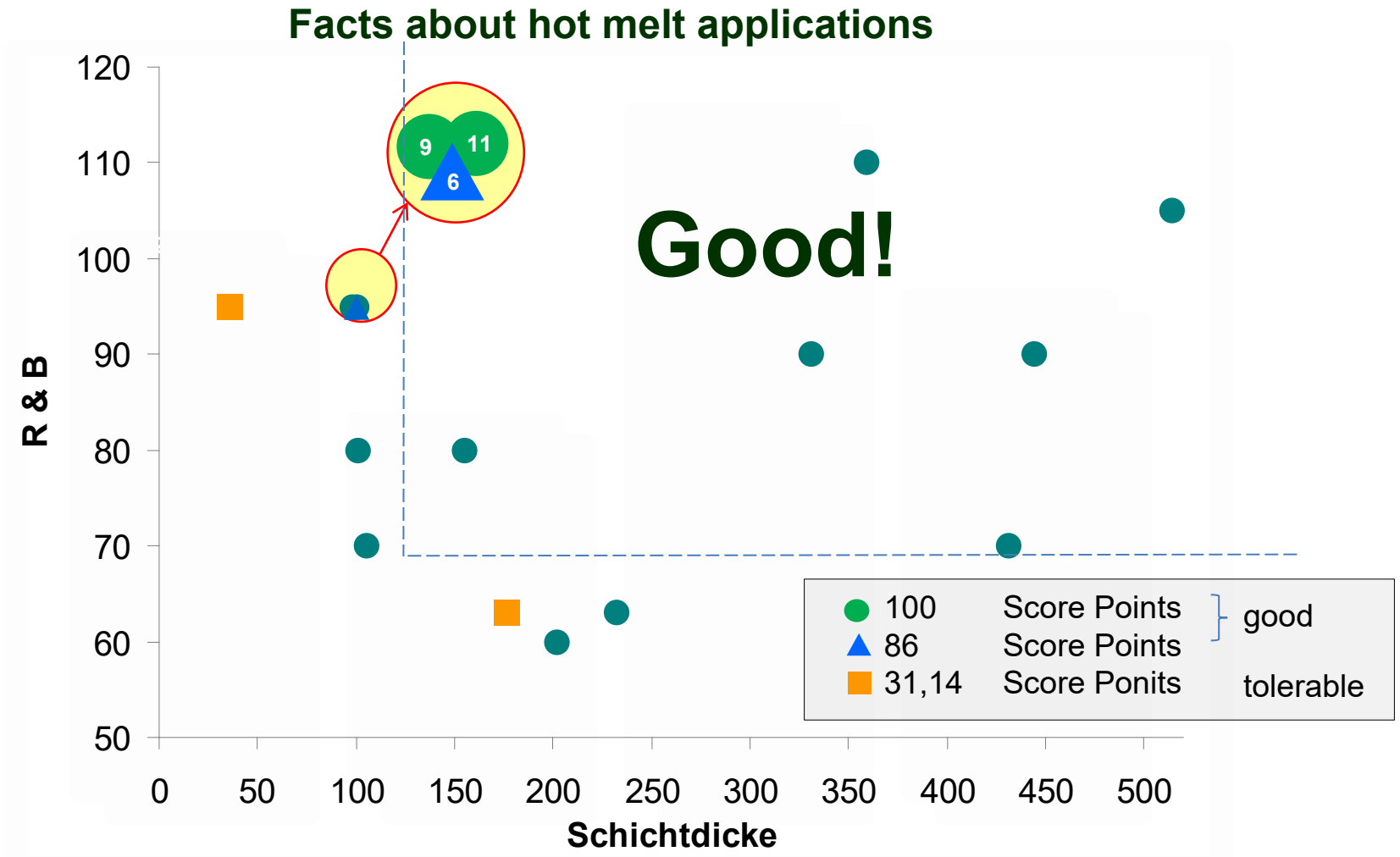


What happens to the adhesive applications during paper recycling?

Facts about hot melt applications

	R & B (in °C)	Viskosität (in mPas)	Schichtdicke gemessen PMV (in µm)			Removability Score gemessen PMV	
Verpackungshotmelt 1 Kunstharz FT-Wachs	110	~ 1500 bei 160°C	358,68	20	80	100	good
Verpackungshotmelt 2 Naturharz FT-Wachs	105	~ 1500 bei 160°C	514,48	20	80	100	good
(Verpackungs-) Schmelzklebstoff für Etikette (100)	95	~ 10000 bei 170°C	99,87	20	80	100	good
(Verpackungs-) Schmelzklebstoff für Etikette (20)	95	~ 10000 bei 170°C	36,27	12	19	31	tolerable
Verpackungshotmelt met cat	95	~ 1500 bei 160°C	98,10	20	80	100	good
Etikettenhotmelt (Rubber)	95	~ 10000 bei 170°C	100 (Henkel)	20	66	86	good
Buchbindereihotmelt Naturharz	90	~ 5000 bei 160°C	443,78	20	80	100	good
Karteneinklebungshotmelt (Rubber) – Fugiiv	90	~ 3000 bei 160°C	330,92	20	80	100	good
Verpackungshotmelt 2 Kunstharz Paraffin-Wachs (300)	80	~ 1000 bei 160°C	101,08	20	80	100	good
Verpackungshotmelt 2 Naturharz Paraffin-Wachs (500)	80	~ 1000 bei 160°C	154,56	20	80	100	good
Seitenleim EVA	70	~ 3000 bei 160°C	430,83	20	80	100	good
Buchbindereihotmelt Sitenleim	70	~ 3000 bei 160°C	104,50	20	80	100	good
PUR-Schmelzklebstoff	60	~ 4000 bei 130°C	202,00	20	80	100	good
PUR			498,64	20	80	100	good

What happens to the adhesive applications during paper recycling?



What happens to the adhesive applications during paper recycling?

Facts about dispersion-adhesives applications

Chemische Basis 2,50%	Acrylat	Acrylat	VAE	VAE	VAE
Zerfaserbarkeit					
Gesamtrückstand [%] auf 0,8 mm Lochplatte	2,1	0,8	2,0	0,5	0,3
Aussortierte Makro-Stickies [%]	84	32	80	20	12
Fasserstoffausbeute [%]	97,9	99,2	98,0	99,5	99,7

What happens to the adhesive applications during paper recycling?

Facts about adhesives applications

Most adhesive applications form "macro-stickies" in the recycling process, which are easy to sort out!

Nobody knows the mechanism of the formation of "secondary-stickies"!

What happens to the adhesive applications during paper recycling?

Facts about adhesives applications

What are the other components of the deposits?

Stickies – a never ending story?

INGEDE Symposium 2019

…esive has
…usually a typical deposit place in a PM
- The adhesive types can be determined by solvent extraction and FT-IR spectroscopy
- Deposits often consist of >50 % adhesives

Results from UPM R&D CERC

INGEDE

Paper and Adhesives

Good friends
Why bonding with adhesives?
Which adhesives are used?
How are adhesives applied?
What happens to the adhesive applications during paper recycling?
Conclusion!

Conclusion

Many paper products would not exist without adhesives!

The amount of adhesive applied is usually small compared to other auxiliary substances in paper products!

Most adhesive applications form "macro-stickies" in the recycling process, which are easy to sort out!

Conclusion

In principle, there are adhesives for all bonding operations in paper products that can be processed into applications, which can be 100% sorted out easily as "macro-stickies"!

Paper converters may have to invest in new production facilities to use such adhesives.

Conclusion

The behavior of adhesive applications depends on physical parameters, not on the "chemistry" of the recipe components!

Important physical parameters are:

The geometry!
The behavior in water (water sensitivity)!
The behavior at elevated temperatures (thermoplasticity)!

Conclusion

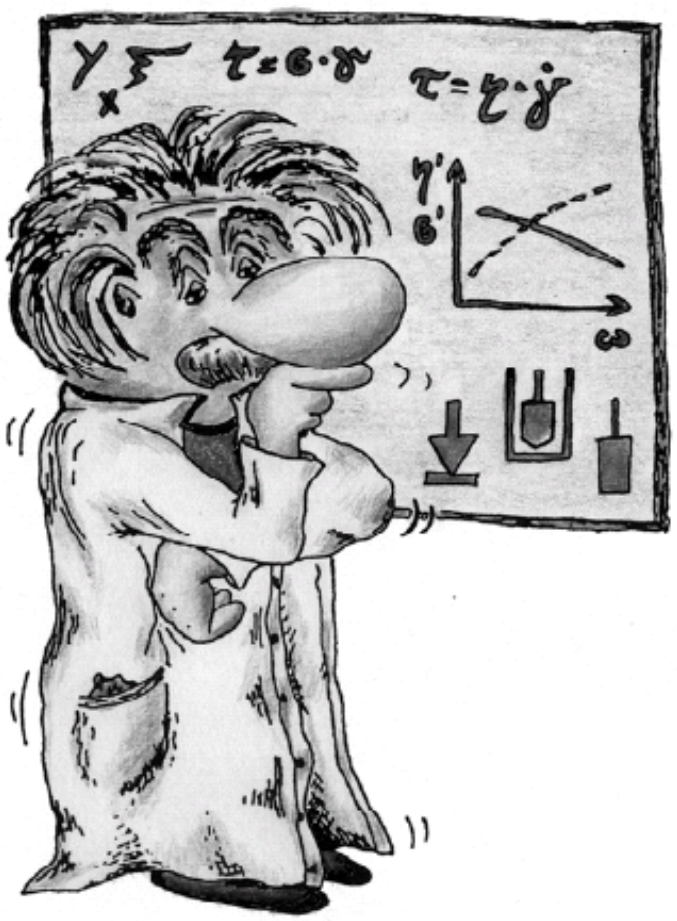
Adhesive applications that have been destroyed to form "micro-stickies" can be components of "secondary-stickies", just like many other paper additives.

Unfortunately, the process of "secondary-stickies" formation is not known, and therefore no reliable statements can be made about the influence of adhesive applications!

Conclusion

Paper and adhesives are really good friends!

The Intouchables



... any questions?