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Evaluation of bio-based products in architectural paints

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Coatings Research Institute

Created by the Industry



CoRI is a Belgian non-profit organization funded in 1957 in order to stimulate innovation and research in the paint, varnish and coatings industry by scientific and technological developments.



For the Industry



Close collaboration with IVP (the professional federation of industries active in varnishes, paints, sealants, printing inks and artists' colors). IVP represents around 70 companies in these sectors, approximately 3,500 employees



Our mission

to provide assistance, support and services by offering



to paint manufacturers, raw materials suppliers, professional applicators and industrial users



ACTIVITIES



■ Research

- Collective research
- Contractual research
- Pre-normative

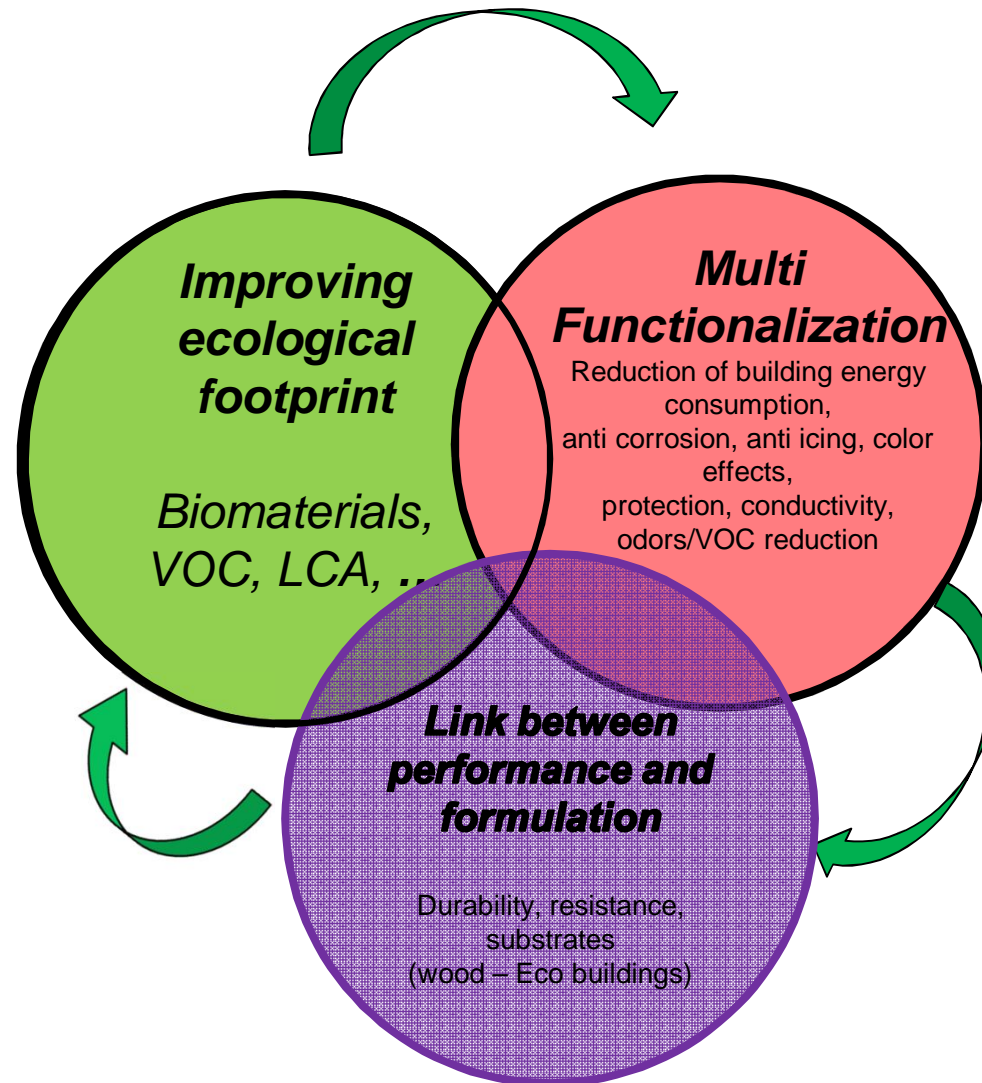
■ Testing and Analysis

■ Technical assistance and Expertise

■ Training - Congress



Research area



29 collective research programs between 2007 & 2015

Regulation Market

Objectives

- **Evaluation of bio-based products in architectural paint formulations**



<http://www.codeve.fr/peinture-batiment/232-peinture-mur-interieur.html>

- **Bio-based products:**

- Products wholly or partly derived from biomass, such as plants, trees or animals (the biomass can have undergone physical, chemical or biological treatment) (CEN 16575)



■ Considered bio-based products (II):

- The second part is dedicated to the use of **wheat gluten** as binder or co-binder in architectural paints.
- Wheat gluten is a by-products of the wheat starch industry. It's **widely available** and at **low price**.
- It can be distinguished from other industrial proteins by some of its **particular properties** like:
 - its insolubility in water,
 - its viscoelastic behaviour,
 - its potential film-forming ability,
 - its RH-dependent gas barrier properties and its rather high water vapour permeability.



Bio-based additives



Selected bio-based additives

Selected commercial biobased additives

Name	Chemical nature		Active matter (%)	Dry matter (%)
Disp 1	non-ionic, modified fatty acid derivative		100	
Disp 2	polymer		32	
	Sugar based	Chain-lenght	Active matter (%)	Dry matter (%)
Disp 3	APG*	C4		49-51
Disp 11	APG*	C8		65-70
Disp 4	APG*	C8	68-72	
Disp 5	APG*	C8-C10		60
Disp 6	APG*	C8-C10		60
Disp 7	APG*	C10	50	
Disp 8	APP**	C5	60	
Disp 9	APP**	C5 and C10-C12		60
Disp 10		Sugar-based polymer		51



Selected bio-based additives

■ Synthesized sugar esters

Disp 12: **Fructose palmitate** (C10),

Disp 13: **Fructose laurate** (C12)

Disp 14: **Fructose caprate** (C16)

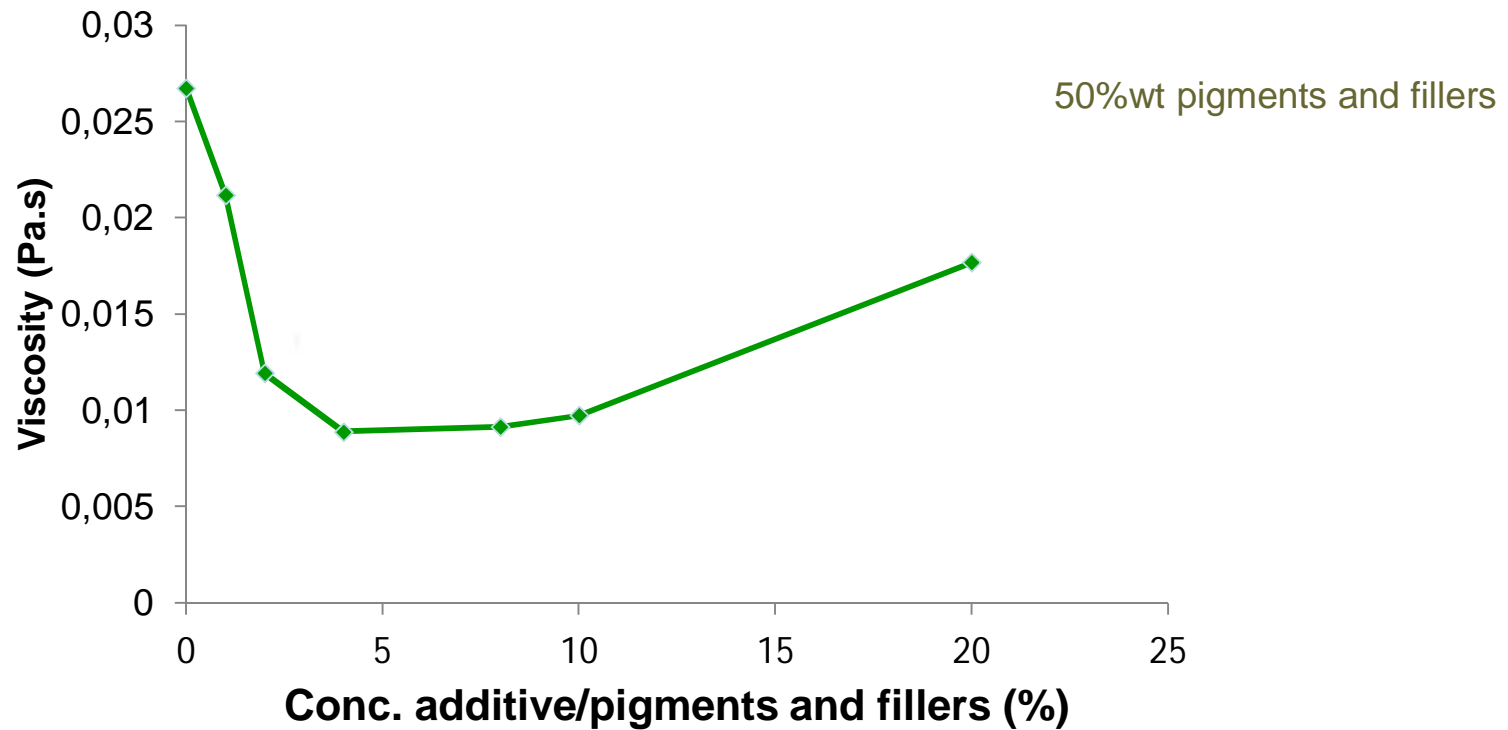
synthesised by the University of Liège according to an enzymatic PROCESS (Olive, G.; Pompeu Torezan, G.A.; Blecker, C.; C. R. Chimie 15 (2012) 1037)

■ Selected commercial petrochemical additive

Polyacrylic ammonium salt

Paints preparation

- **Dispersant demand curves** measurements to determine the amount of additives required to fully wet and disperse the pigments and fillers.





Paints preparation

- Replacement of **the petrochemical** dispersing and wetting agent of a reference architectural paint by **the bio-based** additives with the optimized concentration.

- The sugar ester were added with a fixed amount of 3.8% (ratio dry sugar ester/pigments and fillers).

- Architectural paint:
 - The binder : anionic aqueous dispersion of acrylic ester and styrene copolymer (Axilat UG DS2800 from Momentive).
 - Pigment volume concentration 38.5%
 - Dry matter 64.3%.



Liquid paints characterization

■ Storage stability

Viscosity measurements

- at the initial stage,
- after a storage of 1 month at room temperature and at 50°C.



The results show a strong increase of the viscosity after 1 month storage at 50°C for paints prepared with

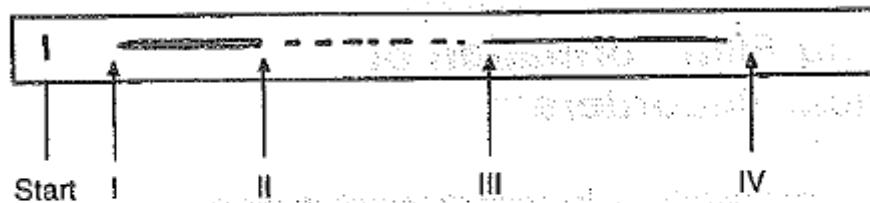
- Disp 7 (APG C10) at the highest concentration,
- Disp 5 (APG C8-10),
- Disp 6 (APG C8-C10),
- Disp 13 (fructose ester C12) and
- Disp 14 (fructose ester C10)

meaning that these paints have a limited storage stability.



Liquid paints characterization

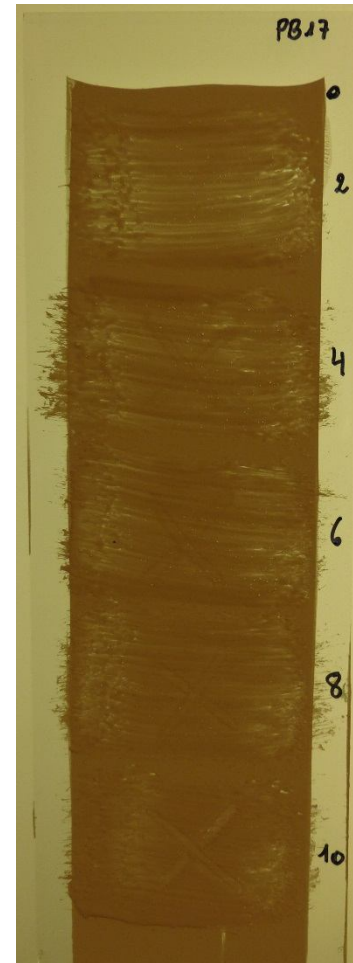
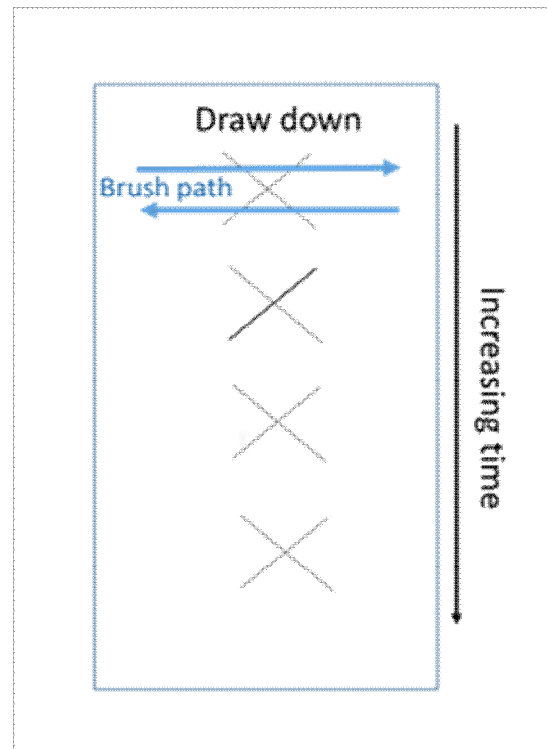
- **Drying time** ASTM D5895 - “Standard test methods for evaluating drying and curing during film formation of organic coatings using mechanical recorders”.



- Stage I — Set-to-Touch Time
- Stage II — Tack-Free Time
- Stage III — Dry-Hard Time
- Stage IV — Dry-Through Time

Liquid paints characterization

- **Open time** ASTM D7488 - "*Test method for open time of latex*"

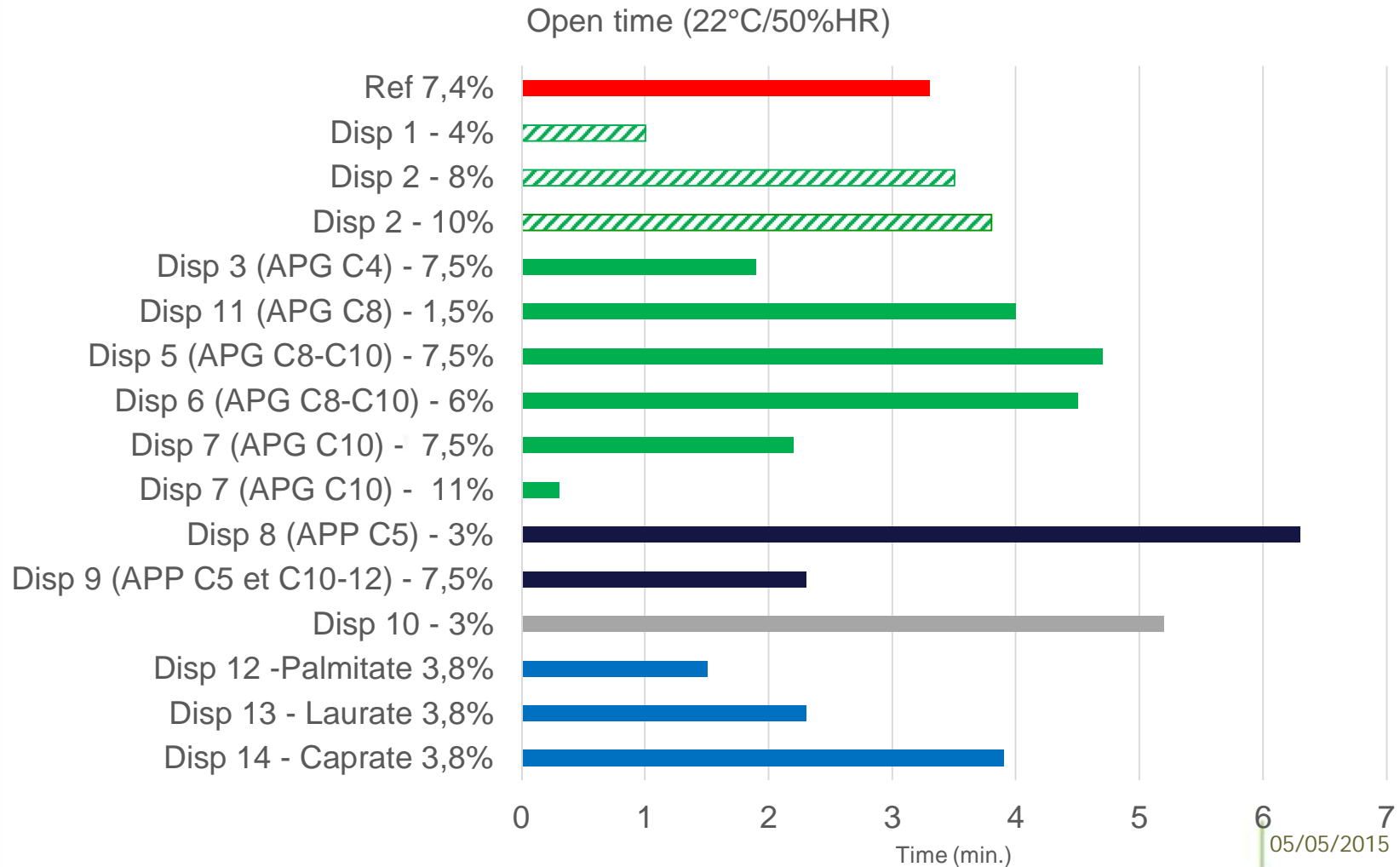




Liquid paints characterization

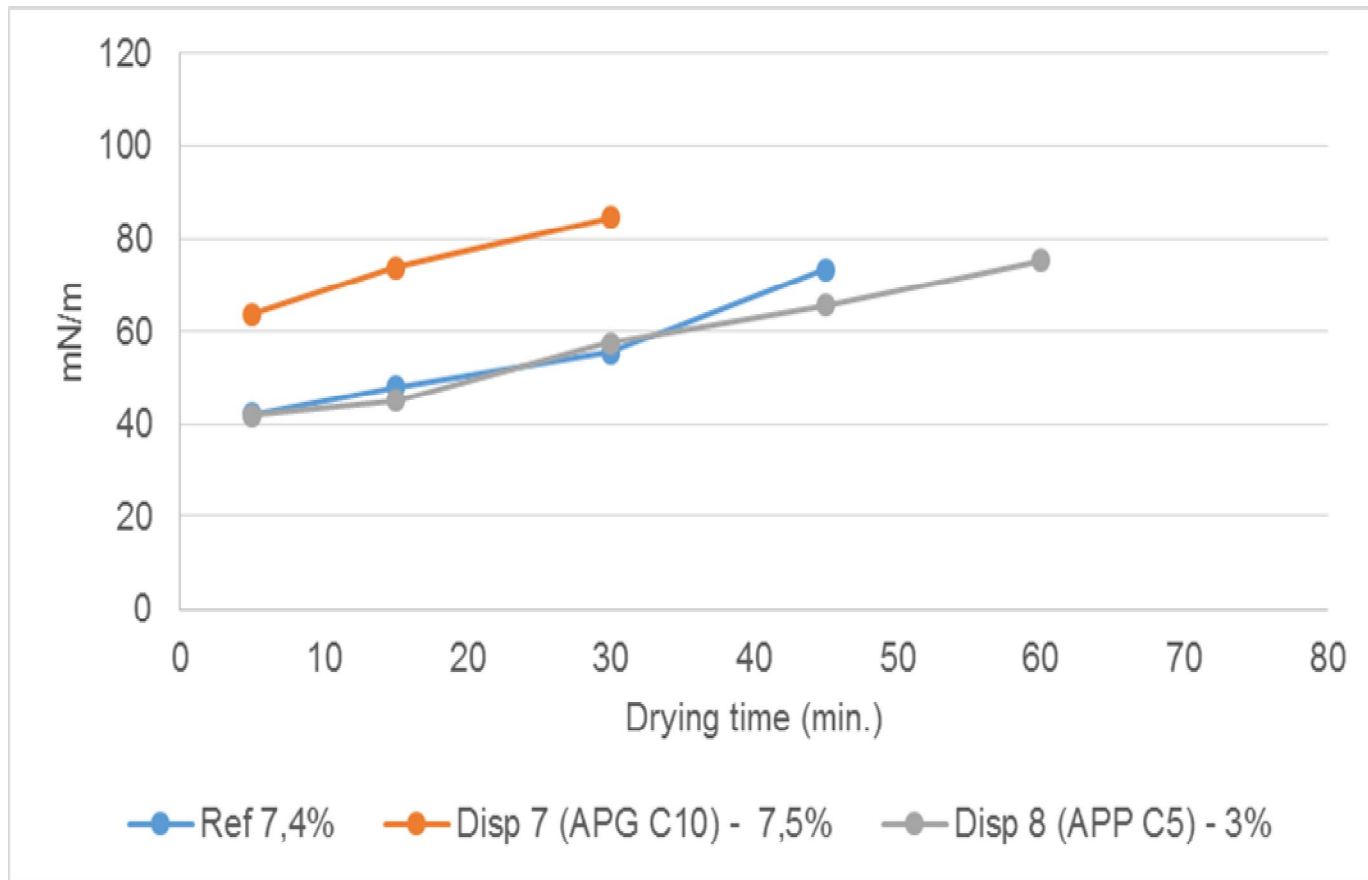
ASTM D5895

Open time



Liquid paints characterization

■ Dynamic surface tension

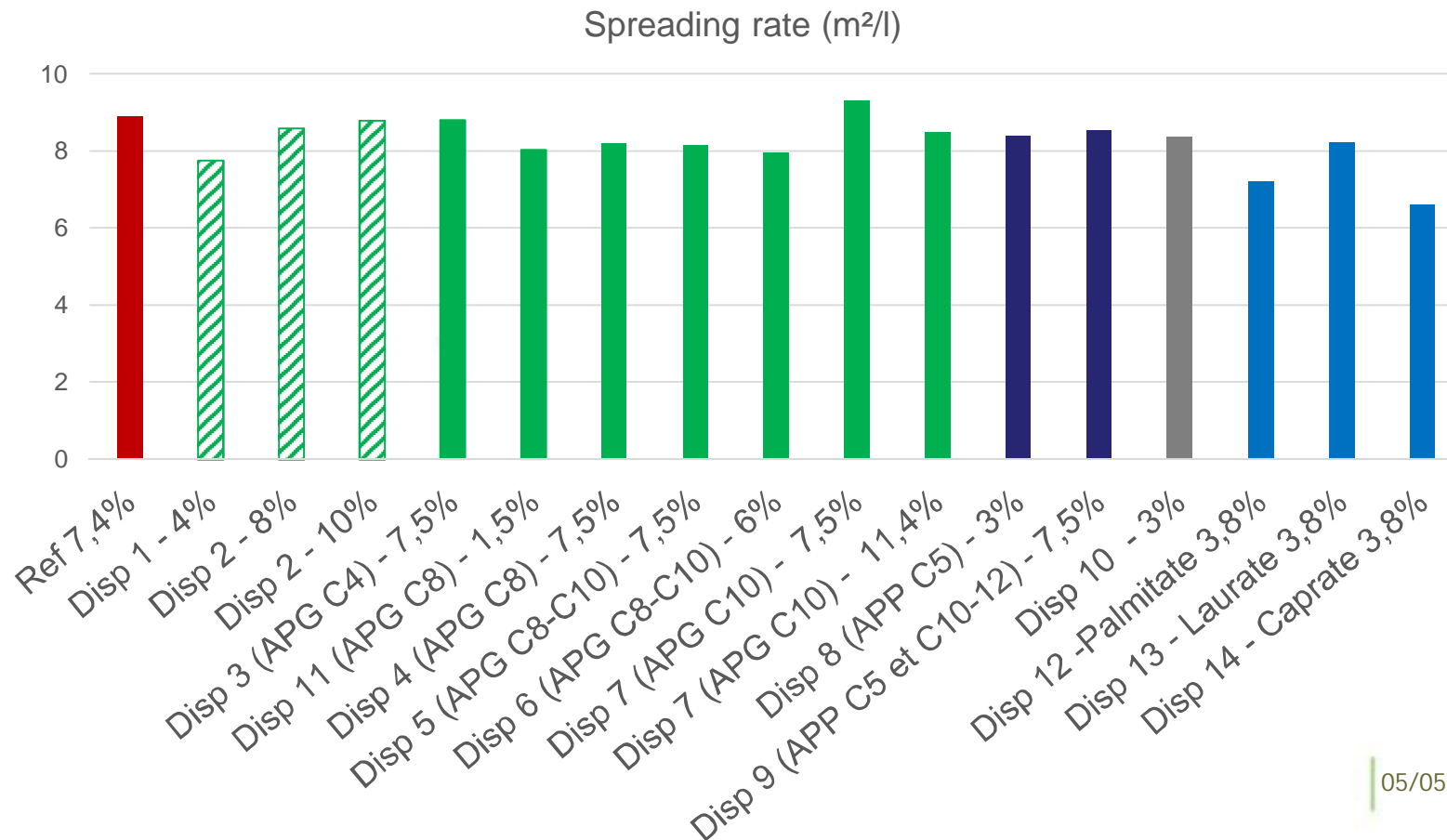


Krüss tensiometer at room temperature (platinum ring – vessel diameter: 44.5 mm - paint volume 20ml – immersion depth: 3 mm - rate :3 mm/min – Harkins Jordan method).



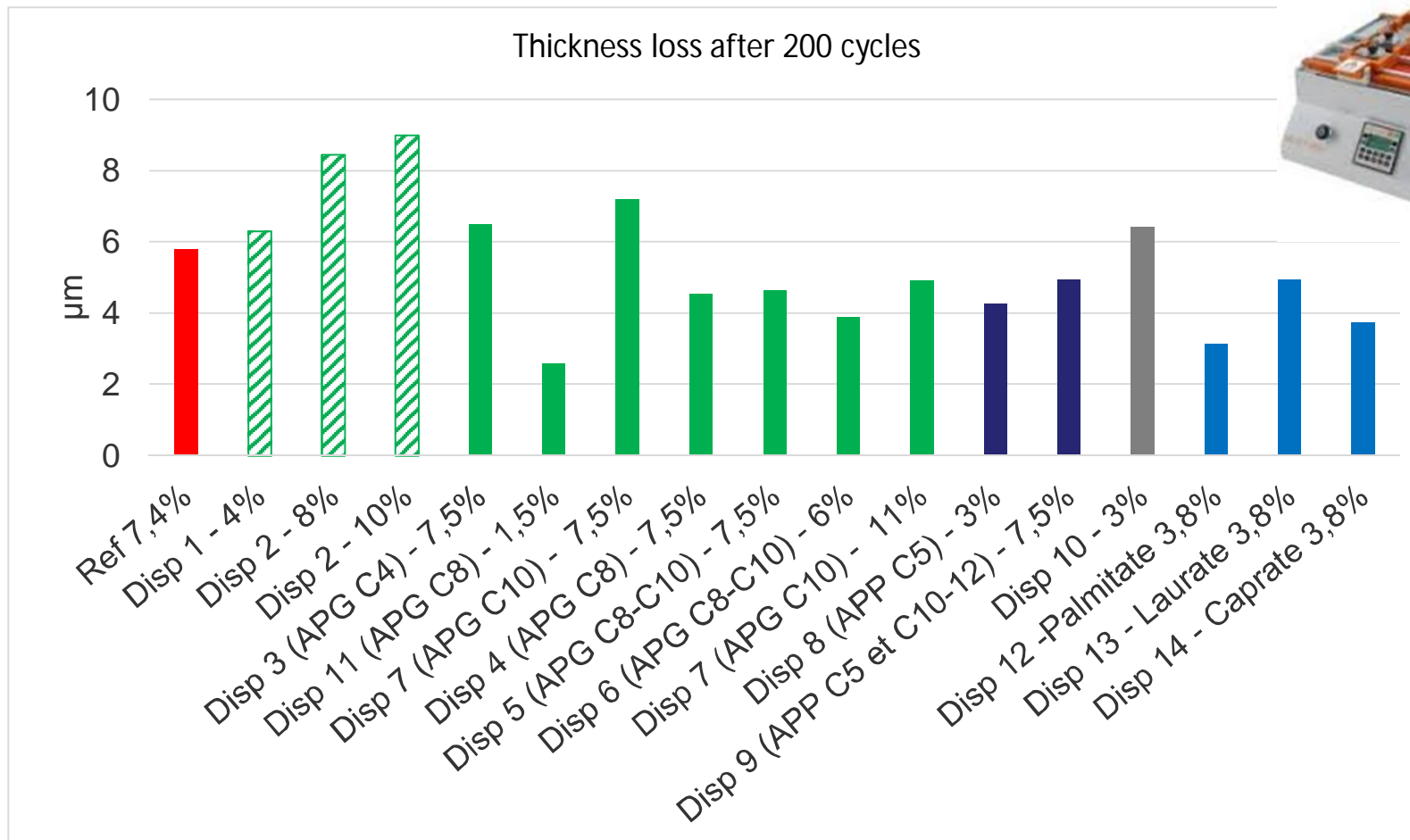
Dry paints characterization

- **Spreading rate at a hiding power of 98 %** ASTM D2805-11 – “Standard Test Method for Hiding Power of Paints by Reflectometry”.



Dry paints characterization

- **Wet scub resistance ISO 11998** – « *Paints and varnishes -- Determination of wet-scrub resistance and cleanability of coatings* ».





Biobased additives : conclusions

Name	Chemical nature		Additive/fillers and pigments (%)	Storage stability	Open time	Spreading rate	Wet srub resistance
Disp 1	non-ionic, modified fatty acid derivative		4				
Disp 2	aq. sol. of a polymer based on a renewable resource		8				
Disp 2	aq. sol. of a polymer based on a renewable resource		10				
	Sugar based	Chain-lenght					
Disp 3	APG*	C4	7,5				
Disp 11	APG*	C8	1,5				
Disp 4	APG*	C8	7,5		n.a.		
Disp 5	APG*	C8-C10	7,5				
Disp 6	APG*	C8-C10	6				
Disp 7	APG*	C10	7,5				
Disp 7	APG*	C10	11			++	
Disp 8	APP**	C5	3				
Disp 9	APP**	C5 and C10-C12	7,5				
Disp 10	Sugar based bio polymer		3				
Disp 12	Fructose	C16	3,8				
Disp 13	Fructose	C12	3,8				
Disp 14	Fructose	C10	3,8				



Gluten



Paints preparation

- Dispersion of wheat gluten (from Aldrich) in an aqueous solution
- Adjustment of the pH of the gluten dispersion to 8
- Mixing of the gluten dispersion with a styrene-acrylic dispersion (Axilat DS2100 or Axilat DS2800 from Momentive)

Paint	Binder	Dry ratio Gluten/Axilat	Dry content	PVC
A	Gluten/Axilat DS2100	1/6	33,8	41
B	Gluten/Axilat DS2800	1/6	33,8	41
C	Gluten/Axilat DS2100	1/1	36	12
D	Gluten/Axilat DS2800	1/1	36	12



Paints characterization

■ Storage stability

- Measurement of the viscosity at the initial stage, after a storage of one month at RT and at 50°C
- Paint B (Gluten/Axilat DS2800 1/6) is stable

Paints characterization

■ Dry paints characterization

	Persoz (s) ⁽¹⁾ ISO1522	Liquid water permeability (ml) ⁽²⁾ after 24H	Vapour water transmission coefficient (g/m ² /24h) (dry thickness) ⁽³⁾ ASTM D1653	Wet scrub resistance – thickness loss after 200 cycles (µm) ⁽⁴⁾ ISO11998
A :Glut 2100 1/6	90	5	406 ± 29 (88 ± 8 µm)	12,9
B : Glut 2800 1/6	28	1	165 ± 11 (75 ± 3 µm)	4,7
C : Glut 2100 1/1	85	6,5	545 ± 17 (60 ± 2 µm)	26,2
D : Glut 2800 1/1	64	7	542 ± 17 (67 ± 2 µm)	24,6

(1)Application on tinned iron panels (200 µm wet) (2)Application on porous substrate (two layers)
 (3)Free films composed of two layers (4)Free films composed of two layers



Conclusion

- In the tested architectural paint, some sugar-based additives gave results at least similar to the petrochemical one.
- The most promising ones are APG-C8 and APP-C5. Only small amount of dispersant is required
- Paints were successfully prepared from gluten and styrene-acrylic dispersion. One of them has good storage stability, high wet scrub resistance, high water vapour permeability and low liquid water permeability.



...thank you for your attention

