

## TEST REPORT

DV.BRJ.04.1167 dated 10/11/2004 (STEP IV)  
SUBJECT: Envelopes recyclability

### SAMPLES

**Designation(s):** Envelopes received at CTP on 23<sup>rd</sup> november 2005

**Observations:**

### ORDER

**V/ Re:** Mail from Peter ENGERT on 29 April 2005

**Customer:** Peter ENGERT

**Company:** UPM / Envelution Group

### TESTS

**Laboratory :** Recycled Fibres

**Responsible for the tests:** Josiane BRUN

**Signature**

**Main operator:** Pascal DE LUCA

This report concerns only the samples tested.  
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This report is made of...11 pages (including cover)

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# TEST REPORT

## ENVELUTION PROGRAMME

### Step IV – Study on window film & window adhesives

The window film and the window glues are studied:

- 1 window films grades (20 and 40µm thick) is used to built one window size (standard width x height - 120 x 70 mm). The windows are tested with:
- 2 window film glues grades applied with one dry adhesive coat weight on one type of paper (same as in all previous studies post insert 80g/m<sup>2</sup>)
- ink is not studied

**Lab Pulping conditions:** Helico pulper, alkaline conventional deinking conditions (10% consistency, 0.7% Soda, 0.7% peroxide, 0.75% soap, 2% silicate)

**Characterizations:**

1. Characterization of the window film behaviour during repulping: how it is broken, size of the film particles
2. Characterisation of macro and micro-stickies formation
3. Characterisation of reslushing water

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## 1. PRELIMINARY TESTS

The window is made of “procite” film. The film weight represents around 5 % of the envelope weight. Considering this rate, it was decided to introduce 5 % film in the base paper to test the recycling behaviour of the film. The envelopes of batch 2 were taken (paper and film).

Concerning the 2 window glues, it was compulsory to test them with film in the mixture. The dry adhesive coat weight was evaluated considering the film and paper grammages. Rather low coat weights were found, compared to the others glue weights on the envelopes. The figures are summarized in Table 1.

Reference	(mg) glue weight /envelope	% glue /envelope
A 7145-25 - Batch 2	0.0118	0.26
A 7261 – Batch 4	0.0136	0.3

Table 1 : deposition levels of the glue

Considering these low deposition levels, it was decided to test mixtures containing only 1 % glue. Nevertheless to make the mixtures for one pulper, 314 envelopes have to be used for batch 2, 271 envelopes for batch 4.

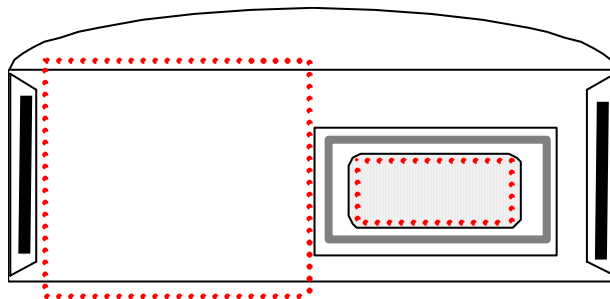
If the windows are used entirely in the mixture, it would lead to a too high amount of film in the mixture (around 20%). It was then decided to cut off window pieces so that at the end the mixture will contain only 10% of film, it was the minimum feasible.

## 2. EXPERIMENTAL CONDITIONS :

During step III, blank tests were done with the paper alone, without glue, these tests were used also as blank for step IV.

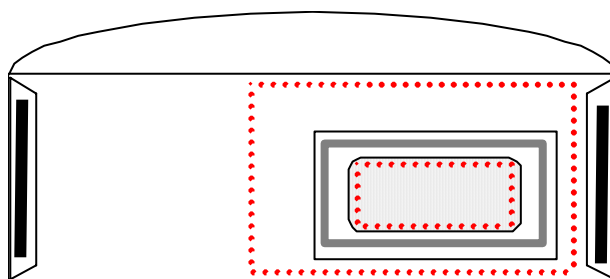
### 2.1 Preparation of mixtures : film + paper

The pieces represented by the red rectangles on the following drawing were used to make the mixture including 5 % film PE. Only the inner part of the windows were used to avoid window glue.



## 2.2 Preparation of mixtures : window glue + film + paper

For these tests, the amount of window glue in the mixture is 1 %.



The envelopes pieces taken to make the mixtures are represented by the larger red rectangles, the central part corresponding to PE film is taken off, to minimize as much as possible the film content ( if the total window were taken in the mixture, the film amount would be 20%).

The Table 2 summarizes the confection of the different mixtures for the two window glues.

Reference and glue	A 7145-25	A 7261
Nb envelopes	314	271
Envelopes total weight (g)	1440	1247
Window glue weight (g)	3.7	3.7
Total PE weight (g)	73.4	63.5
PE weight let in the mixture (g - %)	42 g - (11.35%)	42g - (11.35%)
Total raw materials in the pulper (g)	370	370

Table 2 : confection of the different mixtures for pulping

## 2.3 PULPING :

Helico lab pulping conditions have been applied :

- 10% consistency, 15 minutes, 45°C
- 0.7% Soda
- 0.7% peroxide
- 0.75% soap
- 2% silicate

These conditions are convenient to achieve a good disintegration.

## 2.4 PULP CHARACTERISATION

### • Macro contaminants, macro-stickies characterisation

After pulping the mixture is characterised by Somerville screening (equipped with 8/100 mm slots). This test will determine if macro contaminants (larger than 80µm) are present, eventually macro stickies. The weight of Somerville rejects will be assessed.

If the rejects are sticky, the INGEDE method 12 and 13 will be performed.

### • Micro-stickies characterisation

DCM extracts (representing hydrophobic substances liable to deposit along the paper process) are performed on entire dry pulp obtained after pulping and on hyperwashed pulp. The

contribution to DCM extracts of the different glues compared to the blank paper will be determined.

## 2.5 PULPING WATERS CHARACTERISATION

### • Waters characteristics

• After filtering the pulp on a 100µ wire, the following measurements are performed: pH, conductivity, Turbidity, total material content (drying residue at 105°C), cationic demand.

• Part of these waters are then centrifuged to perform the following measurements:

Dissolved materials content, Turbidity, COD, Cationic demand, Colloids size and potential, surface tension.

### • Wire plugging test

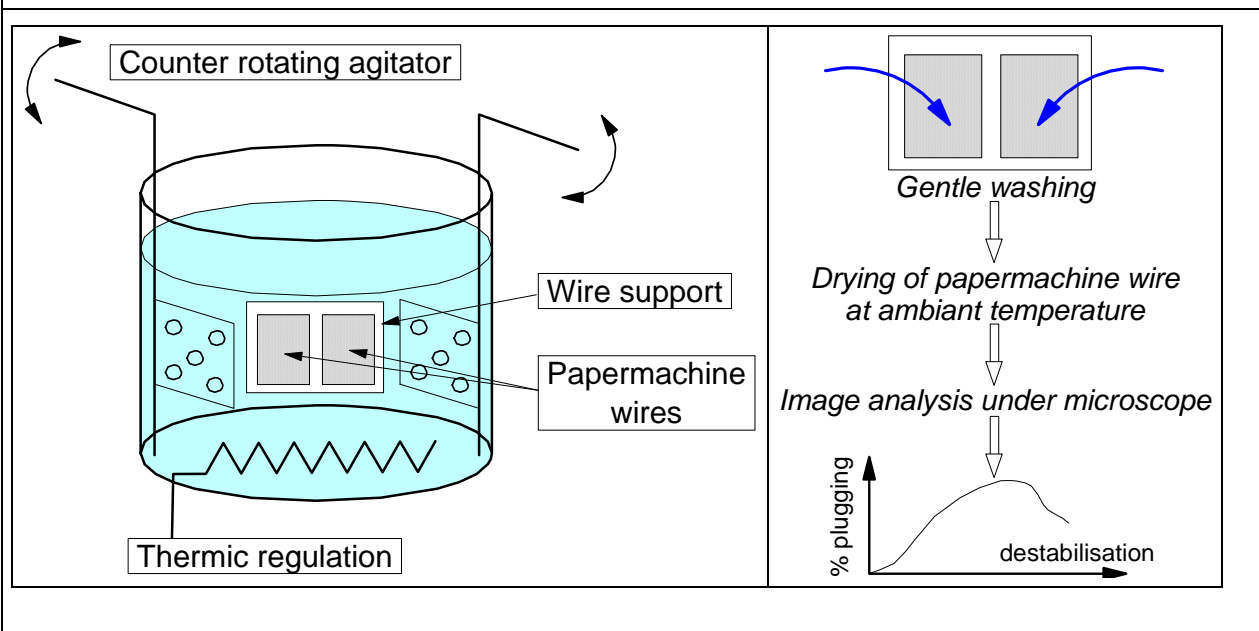
100g pulp are diluted to 10g/l with tap water at 45°C, then filtered on a 100µ wire to remove the fibres. The plugging test illustrated on Figure 1 is then performed.

It consists in plunging a papermachine wire into the agitated suspension, and then removing it to control the deposits. The cationic demand of the waters is determined with a cationic polymer Polyethylenimine. Then, several fractions (1/2, 3/3) of the theoretical volume ( $V_{th}$ ) necessary to neutralise the suspension are added in order to destabilise the suspension.

For each volume of PEI added, there is an equilibrium time of 10 minutes after which the papermachine wire (50 % polyester / 50 % polyamide) is added into the suspension for 5 minutes under shearing conditions. After that mixing time, the wire is removed, rinsed cautiously with tap water and dried at ambient temperature. The contamination is then measured by image analysis. It corresponds to the surface of the holes of the wire which are plugged by electrostatically destabilised “secondary stickies”. Image analysis is performed with a scanner and a black background (deposits look white).

The results are expressed as a percentage of the wire hole area which is plugged as a function of the destabilisation conditions.

Figure 1 : Plugging test



### 3. RESULTS

#### 3.1 PULP CHARACTERISATION

- **Macro-stickies characterisation**

The Table 3 summarises the different values obtained for pulp characterisation.

		Film	Window glues	
	BLANK	Procite film	A 7145-25	A 7261
Pulping consistency (%)	9.3	8.75	9.0	9.0
Pulping pH	11.0	11.10	11.0	11.0
Somerville rejects (%)	0.29	5.1 ***	16.8	16.6

Table 3 : Pulp characteristics after lab helico pulping

##### a) Mixture with 5% PE film

Due to the dispersion of film pieces in the mixture after pulping, the sampling for a usual Somerville test was not representative of the whole sample (9.6% rejects were obtained)

Therefore, the whole pulp recovered after one helico pulping was taken gradually through the Somerville screen. At the end, only the film pieces are recovered and weighed. The total film weight is recovered \*\*\* (5,1%) only some fibres are caught in the small film rolls so that the recovered weight is slightly higher.

The Figure 2 shows rejects from Somerville test.



Figure 2: Somerville rejects photography when window film tested

*Conclusion :*

*The « procite » film used for windows is shown to be entirely removable*

##### b) Mixture with window glue (and PE film)

The Somerville tests with the window glues have been performed according the usual way. The rejects rate are high (only 11.35% film introduced and 16.6% rejects). It was shown that the film could be entirely recovered by screening ; the rejects have been visually controlled: pieces of film were retained, fibres are attached to film, there is no particles corresponding to glue specks.

*Conclusion :*

*There is no macro-stickies formation after repulping mixtures containing window glues*

- **Micro-stickies characterisation**

PE film is soluble in Dichloromethane. Extractions are not possible.

### 3.2 PULPING WATERS CHARACTERISATION

- **Waters characteristics**

The average values are summarised in the Table 4.

	BLANK	Film	A 7145-25	A 7261
<b>FILTERED WATERS</b>				
pH	10.6	10.60	10.3	10.5
Conductivity (mS/cm)	2.6	2.5	2.5	2.6
Total materials (g/l)	9.8	9.0	9.1	8.7
Cationic demand (meq/l)	4.1	4.9	3.9	4.1
<b>CENTRIFUGED WATERS</b>				
Dissolved Materials (g/l)	6.6	5.6	5.6	5.5
Turbidity (NTU)	200	203	166	177
COD (mg/l)	6075	5610	5270	5495
Cationic Demand (meq/l)	4.0	4.2	3.2	3.6
Colloids size (nm)	281	189	174	176
Colloids Zeta Potential (mV)	-1	-7	-6	-7
Surface Tension (mN/m)	54.6	55.3	52.2	49.6
Table 4 : Repulping waters characteristics				

Considering filtered waters, the total materials content is lower when film or film+window glues are contained in the mixture. It may be induced by a lower content of fillers and fines coming from the paper. The amount is similar when 5% or 11.35% paper is replaced by film. The presence more than the amount of film seems to have influence: the film pieces are attracting particles, these particles are not following the water when filtering, they are kept by the film surface. Furthermore, the dissolved substances amount is decreased (6.6 to around 5.6 g/l).

Cationic demand remains in the same range whatever film or window glue presence.

Considering the centrifuged waters when introducing film or film+glue in the mixture, their characteristics are just somewhat different:

- lower dissolved materials amount (induced by lower paper content in the mixture),
- almost same turbidity with 5% film, lower turbidity when 10% film and 1% glue – the effect of 10% film is dominant (less soluble materials), 1% glue is negligible,
- COD is decreasing with introduction of film, less materials from paper (7% with 5% film, 10 to 13% with 11.35% film+1% glue)

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- Surface tension seems to be unchanged when 5% film is added, and slightly decreased when 11.3% film+1% glue is present in the mixture, the glue A 7261 gives the highest decrease.

- **Wire plugging test**

The plugging levels obtained with the blank, the mixture with film and the mixture with film+glue are summarised in the Table 5.

	<b>BLANK</b>	<b>Film</b>	<b>A 7145-25</b>	<b>A 7261</b>
Plugging at V1/2	18%	~5%	16%	15%
Plugging at Vth	13%	~6%	21%	15%

Table 5 : Plugging values

All the values are too low to give significant information (the test is informative when plugging values above 30% are compared. Such slight plugging are very often obtained.

There is no plugging effect due to film or to film+glue.

#### **4. CONCLUSION**

As the film used for envelopes window was shown to have minor influence on recycling behaviour of envelopes :

- during pulping, the window are not fragmented in small pieces
- therefore it can be easily recovered by screening just after pulping
- however it will induce some reject losses due to its affinity to fibres

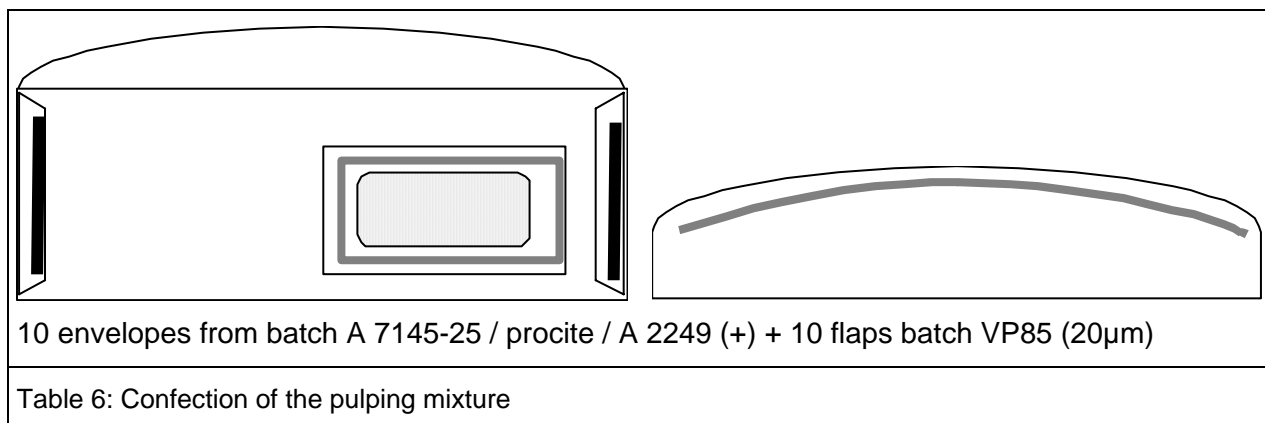
Two window glues used for envelope production were tested considering their influence on envelope recycling behaviour. The amount of glue used was rather low, mixtures containing only 1% glue were tested. Moreover, polyethylene film was present during the characterisation of the influence of the glues and may trouble the measurements.

The influence of window glue and window film were not important, repulping waters characteristics are rather similar.

To complete these tests, mixtures containing entire envelopes and paper have been tested, the results are reported in the annex I.

## ANNEX I : RECYCLING BEHAVIOUR OF A RAW MATERIALS CONTAINING 12% ENVELOPES

An “entire envelope” was made in taking a flap from the envelopes batch “VP 85 (20µm)” produced for the test on flap gum and an envelope from the batch “A 7145-25 (side seam glue) – Procite window – A 2249 (+) window glue. The mixture was made with 10 envelopes / pulper, representing around 12% of the total pulp (Table 6).



The characteristics of the mixture are summarized in Table 7.

Nb envelopes	10
Top flap gum (mg)	755
Side seam glue (mg)	483
Window glue (mg)	118
Total glue in the mixture (g - %)	1.355 g – 0.37%
PE weight in the mixture (g - %)	2.34 g – 0.63%
Total raw materials in the pulper (g)	370
Table 7 : Characteristics of the mixture	

The corresponding amount of envelopes (12%) appears somewhat high compared to a current raw material, however the total amount of glue is very low.

A blank was realised with the same mixing way, but only with paper from the two envelopes batches.

### a) **PULP CHARACTERISATION**

- **Macro-stickies characterisation**

The Table 3 summarises the different values obtained for pulp characterisation.

Concerning the blank samples, rejects are made of some paper pieces which are not well disintegrated. The rate is similar to all the blank tests which have been done along the study.

The reject rate is increased (0.4% to 1.36%) when entire envelopes are added in the mixture, due to film pieces which are removed (0.63% PE film). It has been shown that PE film is entirely removed, in addition the film pieces catch some materials from the paper, fibres fines or fillers. Even if the reject rate is increased, sticky particles are not present.

	<b>BLANK</b>	<b>Mixture</b>
Pulping consistency (%)	9.9	9.9
Pulping pH	11	11
Somerville rejects (%)	0.4	1.36
Table 8 : <b>Pulps characteristics after lab helico pulping</b>		

- **Micro-stickies characterisation**

This PE film is soluble in Dichloromethane. Extractions are not possible.

**b) PULPING WATERS CHARACTERISATION**

- **Waters characteristics**

The average values are summarised in the Table 4.

	<b>BLANK</b>	<b>Mixture</b>
<b>FILTERED WATERS</b>		
pH	10.6	10.5
Conductivity (mS/cm)	2.8	2.8
Total materials (g/l)	9.7	10.3
Cationic demand (meq/l)	5.5	5.2
<b>CENTRIFUGED WATERS</b>		
Dissolved Materials (g/l)	6.94	6.95
Turbidity (NTU)	192	213
COD (mg/l)	6640	6880
Cationic Demand (meq/l)	4.9	4.6
Colloids size (nm)	168	176
Colloids Zeta Potential (mV)	-7.4	-6.4
Surface Tension (mN/m)	52.5	52.7
Table 9 : Repulping waters characteristics		

The values summarized in Table 9 show that the repulping waters characteristics are almost the same when envelopes are present in the mixture. The influence of 0.37% of glue and 0.63% PE film has no influence on the recycling behaviour of the mixture.

The only test able to give real information will probably be a pilot test (pulping + screening) of a raw materials containing a given percentage of envelopes.