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| **(6th) DRAFT**<br>**22 December 2014** | **Assessment of Recyclability of Packaging Products – Recyclability Score –** | ***Grant No: CE555P3*** |

## 1 Introduction

Typically paper based packaging products are recyclable. However, in order to further improve material recycling within the paper industry this scorecard was developed. In the EcoPaperLoop project financed by the European Union, through the Central Europe 2013 program, the a laboratory standard procedure was developed to investigate the repulping behaviour of packaging paper and board products, to assess the fragmentation behaviour of adhesive applications as well as the determination of the amount of non-paper product materials.

Packaging products have to fulfil primarily the function to save the material packed. Sometimes non-paper product materials are necessary to execute the requirements of the packaging product. Nevertheless, the amount of non-paper product materials in packaging papers and boards should be minimized for the benefit of a proper fibre material recycling.

The underlying laboratory procedure simulates typical process conditions applied in the paper industry producing packaging paper and board. Some products, particularly composites, are often treated in specific processes. These can range from small process adaptations to significantly different process set-ups. The focus can be not only the recovery of pulp for papermaking but also of additional materials, e. g. aluminium and plastics from liquid packaging. For the time being, there is no generally acknowledged laboratory method available to assess the recyclability under modified process conditions and with view to multi material uses. Therefore there is no assessment of the recyclability of composite products in the present version of this Scorecard.

The need for removability of adhesive applications in paper mills using packaging papers and board grades for recycling is similar to paper mills using deinking processes. Adhesive applications have to be removed sufficiently during the stock preparation of paper for recycling to avoid tacky particles, so called stickies, in paper production. Stickies is a broad term for all tacky components in recovered paper pulp. Depending on their size and their behaviour they are called macrostickies, microstickies or potential secondary stickies. Mechanical screening with slotted screens is the most efficient tool for macrosticky removal. High removal efficiency can only be achieved if adhesive applications disintegrate into particles of large size. The smaller the particles are, the lower is their removal efficiency. In addition they can re-agglomerate in the papermaking process and form so-called secondary stickies.

Packaging products supplied by converters and therefore missing the final industrial seal of products usually coming into the collection system for paper for recycling by end-users are also considered as packaging products in the frame of this document although threshold and target values apply to final ("post-consumer") products.

The recyclability of a paper based packaging product as a whole can be assessed by its Recyclability Score, which can range from 0 points up to + 100 points. The Recyclability Score can get negative (up to - 90 points) if individual parameters exceed their threshold, indicating that the recyclability behaviour of the packaging product should be improved.

The focus of the underlying method and assessment is the behaviour of a packaging product in a standard recycling process with respect to mechanical and optical properties. For a complete assessment of recyclability also the chemical properties and a possible contamination by harmful substances is important, however, the latter it is neither covered by the method nor by the Scorecard. It is important to point out that the described method assess the recyclability behaviour of a single product and does not describe the behaviour of paper for recycling which always consist of a mixture of paper products.

# Assessment of Recyclability of Packaging Products – Recyclability Score –

## 2 Scope

This document provides an assessment of the recyclability of paper based packaging products for the production of new packaging paper and board by means of a laboratory test procedure.

## 3 Principle

Results of the recyclability test achieved by means of the EcoPaperLoop Method 1 (Recyclability Test for Packaging Products)[1] are converted into a Recyclability Score. For the four parameters – coarse reject, flake content, macrostickies and optical homogeneity – threshold and target values are defined; for the two parameters coarse reject and macrostickies an additional warning range is implemented prior to the threshold. Threshold values and warning ranges are equal for all product categories, whereas target values depend on the category of the packaging product. The recyclability assessment of a product is depending on the results of the individual parameters.

## 4 Determination of the Recyclability Score

In this chapter, particularly in the tables, abbreviations for the assessment parameters are used:

CR: Coarse reject
FC: Flake content
MSA: Macrostickies area
OH: Optical homogeneity.

Rounding of the parameters: MSA and OH to whole numbers; CR and FC to one decimal. The individual scores of each parameter are rounded to whole numbers as well. Method: financial rounding.

### 4.1 Classification of packaging products

Packaging materials to be assessed have to be classified in one of the existing product groups. Actually the following categories according to **Table 1** exist.

[1] ZELLCHEMING Technical Leaflet RECO 1 2/2014 (German version, issued 15.12.2014) is identical with EcoPaperLoop Method 1

# Assessment of Recyclability of Packaging Products – Recyclability Score –

**Table 1:** Packaging product categories

| Category of Packaging Product | Abbreviation |
|---|---|
| Corrugated Boxes (for all applications) | COB |
| Folding Cartons (for all applications) | FOC |
| Carrier Bags (open, with handles) | CAB |
| Moulded Products | MOP |
| Sacks (pure paper) | SPP |
| Sacks (composite materials) | SCP |
| Liquid Packages | LIP |
| Others | OTH |

For the above mentioned categories various threshold, warning and target values exist which are described in the chapters 5.4 to 5.6.

Description of the products in the individual categories:

Corrugated Boxes: Any paper based container which is made of corrugated board such as boxes and shipping containers, including also displays and furniture.

Folding Cartons: Any paper based container which is made of solid board such as boxes, disregarding whether the base material is uncoated, coated or laminated.

Carrier bags: Strong paper bags, usually reinforced at the opening, fitted with or incorporating a carrying handle, usually of paper or twine, designed for holding weights of a few kilograms or less.

Moulded Products: Any container or product protection which is made predominantly from moulded fibre, such as trays for eggs, meat, fruit and vegetables as well as protection for bottles and technical equipment.

Sacks (pure paper ): Heavy duty or shipping bags and sacks of all sizes for the transportation of solid materials, made of pure paper. This group also includes bags and sacks for bread, cookies and meat as well as product packaging of sugar, flour and the like.

| | |
|---|---|
| Sacks (composite materials): | Heavy duty or shipping bags and sacks of all sizes for the transportation of solid materials, made of paper and a composite material. The composite material can be a separate non-paper layer or a composite coating or a plastic window for the presentation of the material inside the bag. |
| Liquid Packages: | Paper based packaging of liquid or semi-liquid food and beverage, such as milk, fruit, vegetables, soups, sauces and the like. |
| Others: | All packaging materials not belonging to the above mentioned categories. |

## 4.2 Source of the recyclability results

The results of recyclability tests have to be obtained according to EcoPaperLoop Method 1.

## 4.3 Weighting of the parameters

The assessment of recyclability consists of four parameters. Two of those – macrostickies area and optical homogeneity – refer to the quality of the achieved recycled pulp, the other two – coarse reject and flake content – are process parameters affecting the process efficiency. Quality and process parameters are weighted equally (**Table 2**).

**Table 2:** Maximum score for each parameter

| Parameter | Coarse Reject (CR) | Flake Content (FC) | Macro-stickies Area (MSA) | Optical Homogeneity (OH) | Total |
|---|---|---|---|---|---|
| **Maximum Score** | 35 | 15 | 40 | 10 | 100 |

## 4.4 Threshold values (TH)

For a good recyclability the values for MSA, CR and FC have to be low. These parameters have an upper threshold. Exceeding the upper threshold results in a negative score for this parameter. Different packaging products have the same threshold values (**Table 3**).

**Table 3:** Threshold values

| Category of Packaging Product | Coarse Reject (CR) % | Flake Content (FC) % | Macrostickies Area (MSA) < 2.000 µm mm²/kg | Optical Homogeneity (OH) --- |
|---|---|---|---|---|
| **All categories acc. to Tab. 1** | 30 | 40 | 30.000 | n/a |

For the parameter optical homogeneity actually no quantitative measurement is available. Therefore results are categorized by visual impression of the prepared handsheets from the accept of sticky screening. Only inhomogeneities from non-fibre materials should be taken into account (not from coloured fibres). The following categories exist:

- Very good (no visible inhomogeneity): Score +10 points
- Good (some visible inhomogeneity): Score +5 points
- Tolerable (plenty of visible inhomogeneity): Score +0 points

The following photographs (**Figure 1**) give some examples of the three categories of optical inhomogeneity.

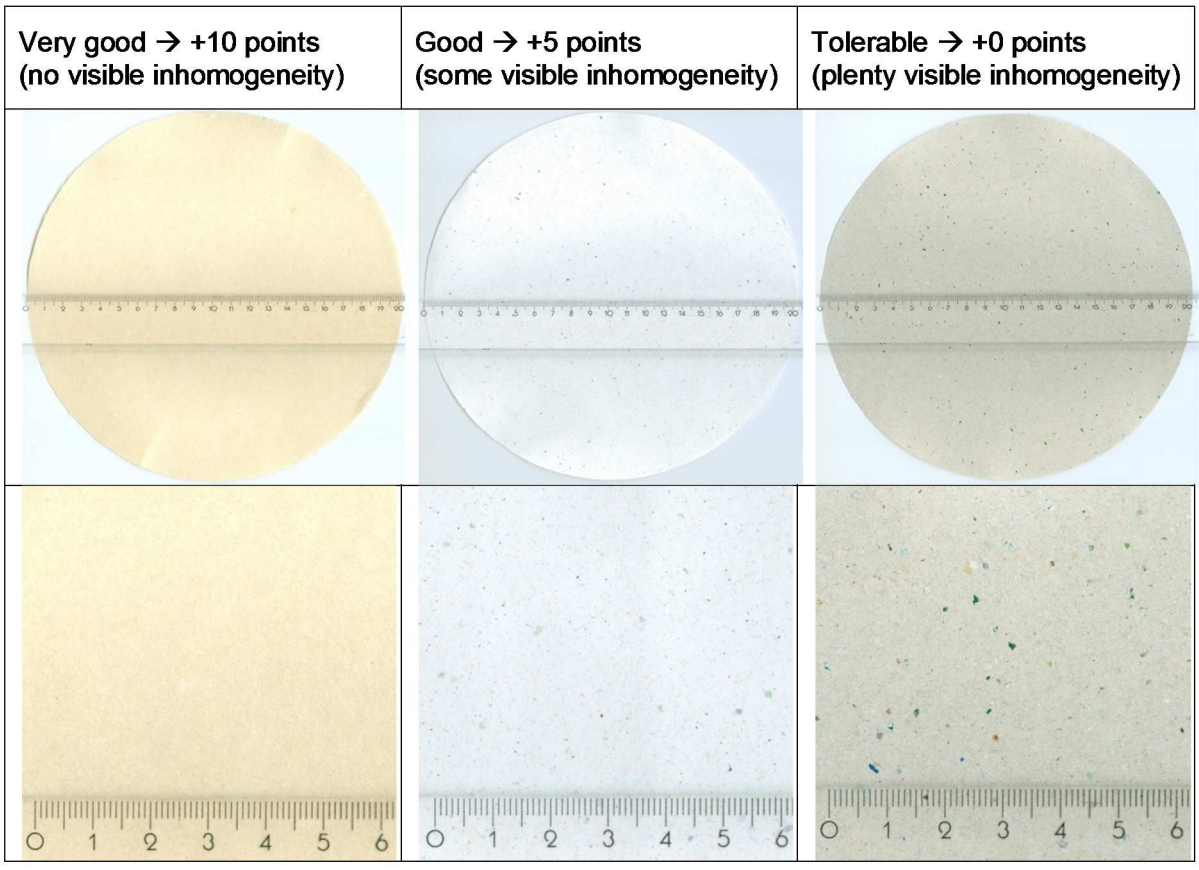

**Figure 1:** Examples for optical homogeneity

### 4.5 Warning range (WR)

For the CR and MSA warning ranges are established which are equal for all packaging product categories (**Table 4**). The upper end of the warning range ($WR_{high}$) is identical with the threshold level. If at least one of the parameters are in the warning range and the others are fulfilled, the assessment gives no total scoring points, but indicates either the need of design improvements and/or minor process adaptations.

**Table 4:** Warning ranges

| Category of Packaging Product | Coarse Reject (CR) | | Macrostickies Area (MSA) < 2.000 µm | |
|---|---|---|---|---|
| | $WR_{low}$ % | $WR_{high}$ = TH % | $WR_{low}$ mm²/kg | $WR_{high}$ = TH mm²/kg |
| **All categories according to Tab. 1** | 20 | 30 | 20.000 | 30.000 |

### 4.6 Target values

Each parameter has a target value depending on the packaging product category (**Table 5**). Different target values for CR are established for the packaging products with composite materials (SCP and LIP) to consider the functionalities of those packages.

**Table 5:** Target values

| Category of Packaging Product | Coarse Reject (CR) % | Flake Content (FC) % | Macrostickies Area (MSA) < 2.000 µm mm²/kg | Optical Homogeneity (OH) -- |
|---|---|---|---|---|
| **Corrugated Boxes** | ≤ 2 | ≤ 5 | ≤ 1.000 | Very good |
| **Folding Cartons** | ≤ 2 | ≤ 5 | ≤ 1.000 | Very good |
| **Carrier Bags** | ≤ 2 | ≤ 5 | ≤ 1.000 | Very good |
| **Moulded Products** | ≤ 2 | ≤ 5 | ≤ 1.000 | Very good |
| **Sacks (pure paper)** | ≤ 2 | ≤ 5 | ≤ 1.000 | Very good |
| **Sacks (composites)** | ≤ 10 | ≤ 5 | ≤ 1.000 | Very good |

| | | | | |
|---|---|---|---|---|
| **Liquid Packages** | ≤ 10 | ≤ 5 | ≤ 1.000 | Very good |
| **Others** | ≤ 2 | ≤ 5 | ≤ 1.000 | Very good |

## 4.7 Determination of the Recyclability Score

It is recommended to use spreadsheet software to calculate the score. The ERPC office can provide the formulae in Microsoft Excel® format.

### 4.7.1 Calculation of the score per parameter

Results of the individual parameters which meet or exceed the target values receive the maximum scores for these parameters (according to **Table 2**). "Exceeding the target values" means in the case of MSA, CR and FC a numeric result below the target values.

If at least one result for CR or MSA is in the warning range and all other results are below the thresholds, no total score has to be calculated. The result is zero scoring points.

If at least one parameter is worse than the threshold, only the negative scores are displayed. All positive scores are regarded as zero.

For all other cases the score has to be calculated. For results below the lower warning range ($WR_{low}$) Formula A is valid, for results above the upper warning range ($WR_{up}$) Formula B has to be used. For FC, where no warning range exists, the threshold values have to be used instead of the warning values. For each individual parameter, the ratio of units between warning range and result value, divided by the range between warning range and target values, multiplied by the maximum score for this parameter, gives the Recyclability Score for this parameter. All individual scores are rounded to whole numbers by financial rounding.

Calculation for one individual parameter:

$$RS_P = \frac{(WR_{low} - R_P)}{(WR_{low} - T_P)} * MS_P$$ (Formula A valid for : $0 < R_P < WR_{low}$)

$$RS_P = \frac{(WR_{high} - R_P)}{(WR_{high} - T_P)} * MS_P$$ (Formula B valid for : $WR_{high} < R_P \leq 100$)

For $WR_{low} < R_P < WR_{high}$ the Recyclability Score is zero.

Where

The index letter P stands for one of the three parameters MSA, CR and FC

$RS_P$ is the Recyclability Score of the parameter P

$TH_P$ is the threshold value of the parameter P (according to **Table 3**)

$WR_{low}$ is the lower warning value of the parameter P (according to **Table 4**)

$WR_{high}$ is the upper warning value of the parameter P (according to **Table 4**)

$R_P$ is the result of the parameter P

$T_P$ is the target value of the parameter P (according to **Table 5**)

$MS_P$ is the maximum score of the parameter P (according to **Table 2**)

Example: Recyclability Score $RS_{MSA}$ for the macro stickies of corrugated boxes

| | |
|---|---|
| Macro stickies area (MSA) < 2.000 µm: | 3.450 mm²/kg |
| Lower Warning Range $WR_{MSA}$: | 20.000 mm²/kg |
| Target $T_{MSA}$: | 1.000 mm²/kg |
| Maximum score $MS_{MSA}$: | 40 Points |

$$RS_{MSA} = \frac{(20.000 - 3.450)}{(20.000 - 1.000)} \cdot 40 = 35 \text{ Points}$$

The RS is limited to the maximum score of each individual parameter, even if the calculation gives a higher result. In that case it is not possible to compensate a weak result in one parameter with a very good result of another parameter.

If the result is worse than the threshold, the score is negative for this parameter. In that case the absolute number is limited to the same value as the maximum score for this parameter.

The scores for CR or MSA are zero if the values of the parameters are within the warning range.

### 4.7.2 Calculation of the Recyclability Score

For a complete evaluation of the recyclability, the four individual scores are added. If one or both individual scores of CR and MSA are set to zero the assessment is "tolerable" with recommendations how to improve the packaging product. If MSA is above threshold the assessment is "not suitable for use in any recycling processes". If only CR and/or FC are negative, the assessment of the packaging product is “not suitable for use in a standard paper recycling process, but can possibly be used in specialized processes". This indicates that even for those products a material recycling could be possible in particular adopted paper mills with special process technology. **Table 6** shows some examples for corrugated boxes.

# Assessment of Recyclability of Packaging Products – Recyclability Score –

**Table 6:** Examples (Corrugated Boxes)

| Parameter | Coarse Reject (CR) % | Flake Content (FC) % | Macrostickies Area (MSA) < 2.000 µm mm²/kg | Optical Homogeneity (OH) -- | Recyclability Score / Assessment |
|---|---|---|---|---|---|
| **$WR_{low}$ / TH** | 20 / 30 | -- / 40 | 20.000 / 30.000 | Not accept. | |
| **Target** | ≤ 2 | ≤ 5 | ≤ 1.000 | Very good | |
| **Max. Score** | 35 | 15 | 40 | 10 | |
| **Sample A** | | | | | |
| **Result** | 5,4 | 8,0 | 3.200 | Good | |
| **Score** | 28 | 14 | 35 | 5 | **82 Points** Good recyclability |
| **Sample B** | | | | | |
| **Result** | 10,2 | 3,3 | 25.500 | Good | |
| **Score** | 19 | 15 | 0 | 5 | **0 Points** Tolerable, but needs improved adhesive applications |
| **Sample C** | | | | | |
| **Result** | 55,5 | 4,5 | 350 | Very good | |
| **Score** | -32 | 15 | 40 | 10 | **-32 Points** Not suitable for use in standard paper recycling processes, but can possibly be used in specialized processes |
| **Sample D** | | | | | |
| **Result** | 24,6 | 1,5 | 55.400 | Good | |
| **Score** | 0 | 15 | -35 | 5 | **-35 Points** Not suitable for use in any recycling processes |

## 5 Rating of the Results

In order to give the user an idea of the relevance of the Packaging Recyclability Scores, they should be assessed according to **Table 7**. The judgement "not suitable for use in any recycling processes as individual product" means that these packaging products as singular raw material are not suitable for recycling in a paper mill and that the design of the packaging product has to be improved. As part of paper for recycling a certain small amount of those paper products might be acceptable. The judgement

"not suitable for use in a standard recycling process, but can possibly be used in specialized processes" does mean that the packaging products should be supplied as special secondary raw material furnish to paper mills equipped to treat this material. The assessment "tolerable recyclability" gives an indication in which ways the packaging product should be improved, but it still can be treated in standard recycling mills. Packaging products assessed as "good" or "fair" recyclable are suitable for use in a standard recycling paper mill.

**Table 7:** Rating of the Packaging Recyclability Scores

| Packaging Recyclability Score | Evaluation of Recyclability |
|---|---|
| 71 to 100 Points | Good recyclability |
| 1 to 70 Points | Fair recyclability |
| CR is in the warning range | Tolerable recyclability, but needs design improvements and/or process adaptations |
| MSA is in the warning range | Tolerable recyclability, but needs improved adhesive applications |
| CR and/or FC above threshold | Not suitable for use in standard recycling processes, but can possibly be used in specialized processes |
| MSA above threshold | Not suitable for use in any recycling processes as individual product |

## 6 Report

The report should contain detailed data of the packaging product, the manufacturing process, the materials (incl. adhesives) used and the recyclability test:

- Identification of packaging product as to name, manufacturing company, date of production, product category, status of the product (complete packaging product with final seal or semi-finished product from converters), paper/board quality, adhesive application, additional converting processes.
- Parameters and settings adhesive applications or other relevant converting processes (e. g. PE varnish, plastic lamination, metallization, waxing, ...).
- Name and exact identification of adhesives or coatings.
- Documentation by photographs of the packaging product, the coarse rejects, the flakes and the optical homogeneities.
- Results of the recyclability test according to EcoPaperLoop Method 1 or ZELLCHEMING Technical Leaflet RECO 1 2/2014 (issued 15.12.2014) including fibre yield.

- The laboratory equipment used for the recyclability test and deviations from EcoPaperLoop Method 1 or ZELLCHEMING Technical Leaflet RECO 1 2/2014 (issued 15.12.2014), if any.
- Recyclability Scores for every parameter and total (total only if all four scores are 0 or higher). The results can be provided either numerical or as graphics. For a graphic presentation column stacked charts are recommended. If at least one element of the stacked columns points to the negative side, no positive results should be shown.
- Assessment of the recyclability according to **Table 7**.
- Optional but desired: Any interpretation of the result which is possible with the help of the technical data.

## 7 References


- EcoPaperLoop Method 1 - Recyclability Test for Packaging Products (Issue: July 2014)
- ZELLCHEMING Technical Leaflet RECO 1 2/2014 (issued 15.12.2014): Prüfung des Rezyklierverhaltens von Verpackungen
- Zellcheming Technical Leaflet RECO 1, 1/2006 (issued 28 August 2006): Terminology of stickies