Recyclability Test for Packaging Products	**Leaflet**
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1 Introduction

In order to minimise the problems occurring during recovered paper processing, it is essential that packaging products are manufactured considering a good recyclability. In favour of this, the packaging products have to be manufactured for the most part from fibres and must be easy to disintegrate. This increases fibre yield and reduces energy demand as well as the amount of rejects to be disposed. Alike, adhesive applications used for packaging products have to be shear resistant to withstand shear forces during stock preparation processes, and to fragment mostly into particles of adequate size which can be removed during the process.

The following laboratory method defines a procedure to assess the processing of packaging material. For this purpose the content of non-paper components, content of difficult to disintegrate material, the flake content, the macrosticky potential and also the ash content and fibre yield after a disintegration step are investigated. The determined data can be used to assess the packaging product's recyclability. Currently, such a general assessment scheme is not available.

2 Purpose and Application

The purpose of the method is to simulate the behaviour of packaging material during stock preparation in a paper mill. During the investigation, the packaging material is probed considering the content of non-paper components, content of difficult to disintegrate material, flake content, macrosticky potential, ash content and fibre yield.

The content of non-paper components as well as the content of difficult to disintegrate material and the flake content allow the evaluation of the disintegration behaviour of the packaging material. The non-paper components and the content of difficult to disintegrate material form coarse impurities which can stress the coarse screening process in a paper mill. The flake content detects impurities like small plastic parts and primarily fibre bundles which have to be removed during the fine screening steps of a paper mill. The flake content therefore gives information about the load of the industrial fine screening process.

The macrosticky potential is analysed by measuring the macrosticky area. The macrosticky area reflects the load of adhesive impurities within the industrial stock preparation.

The fibre yield is calculated with the yield and the ash content after coarse screening. It allows evaluation of the fibre content of the packaging material.

Handsheets are made from the accept of the macrosticky analysis. They give information about the optical properties of the stock.

3 Definitions

Non-paper components
Packaging materials are designed for different functions. For this reason, they are manufactured using a combination of paper and different other materials like plastics or metals. These non-paper components can disturb, hamper or avoid the material's recyclability.

Content of difficult to disintegrate material
As several packaging products show a certain water resistance and are more robust during disintegration in water, it is not possible to suspend certain fibre materials into single fibres, instead, fibre bundles remain. Such water resistant packaging materials disturb or hamper the preparation process and the material's recyclability.

Disintegration behaviour
The disintegration behaviour describes how the packaging material can be suspended into single fibres. The disintegration behaviour is analysed by considering the content of non-paper components, the content of difficult to disintegrate materials and the flake content.

Flake content
The flake content describes impurities like small plastic parts and primarily fibre bundles.

Yield
The yield describes the amount of usable solid stock material which passes the coarse screening step. By using the ash content a fibre yield could be calculated.

Ash Content
The ash content describes the inorganic content after incineration (525 °C) of the solid stock material which passes the coarse screening step.

Fibre Yield
The fibre yield describes the fibre content of the solid stock material which passes the coarse screening step. It is calculated by using the yield and the ash content.

Macrosticky potential
The macrosticky potential describes the macrosticky area after disintegration of the packaging material.

Handsheets
Handsheets from the accept of the macrosticky evaluation are prepared for visual inspection of the optical properties of the pulp.

4 Principle

This leaflet describes the preparation and investigation with its main steps of sample preparation, disintegration, coarse screening, ash content evaluation, flake content evaluation, macrosticky potential evaluation, yield and fibre yield calculation. For this purpose, a defined amount of the packaging material has to be prepared and then disintegrated at low consistency. The generated suspension has to be screened using a hole screen. The reject on the screen has to be evaluated gravimetrically and the yield has to be calculated. The screening accept has to be homogenised and analysed for flake content using Zellcheming Leaflet ZM V/18/62 [1] or alternatively by an adapted method suitable for the Haindl Classifier. For the macrosticky area the determination follows a macrosticky method based on INGEDE Method 4 [2]. From the accept of the macrosticky screening step handsheets have to be prepared according to ISO 5269-2 [3]. Furthermore from the accept of the coarse screening step the ash content has to be measured according to ISO 1762:2001 [4] and the fibre yield has to be calculated.

The flow chart of the procedure is given by **Figure 1**.

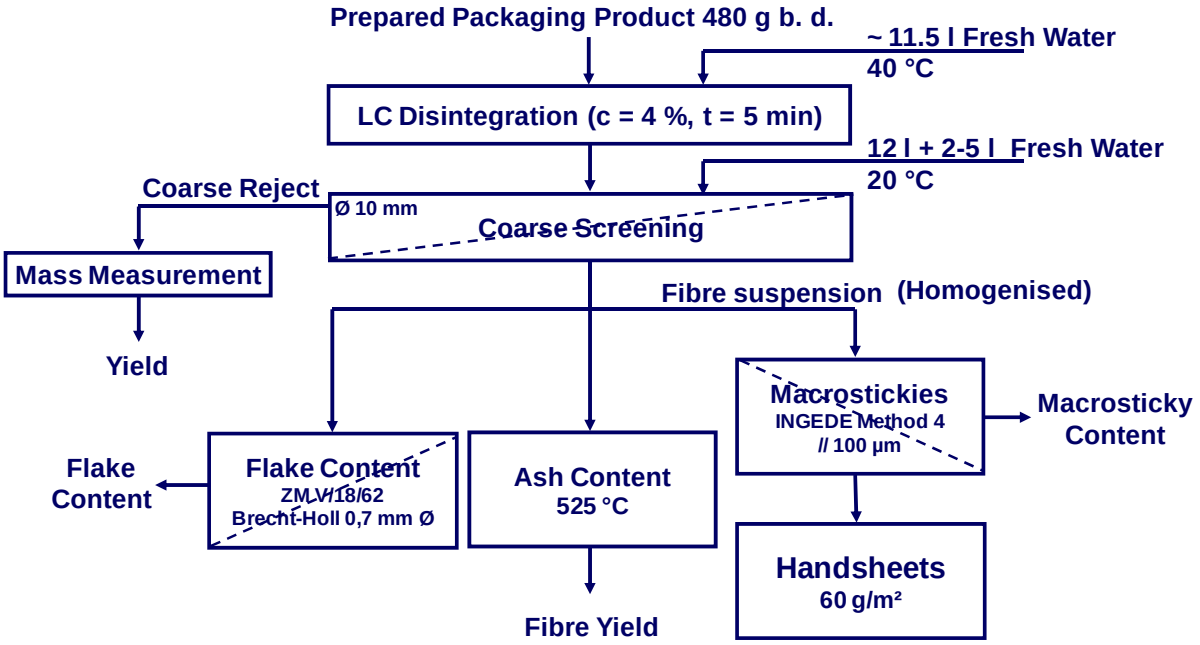

Figure 1: Flow chart of the procedure for the assessment of packaging material recyclability

5 Equipment and Tools

5.1 Disintegration equipment

The disintegration shall be carried out using a low consistency laboratory pulper that can handle a suspension volume of 12 l with a stock consistency of 4 %.

5.2 Coarse screening equipment

The coarse screening is performed utilising a screening device with a 10 mm hole screening plate at the bottom and a volume of 12 l in minimum has to be used. The accept stream of the screen has to be interruptible by an outlet valve. The screening holes have to be kept free during the screening process by using a stirrer. The stirrer blade has to be positioned 10–20 mm above the screen plate and has to run at 200 rpm. As the stirrer has to overcome high resistance forces if excessive coarse rejects are accumulated, the motor has to transmit high moment of torque to the stirrer. For this application the driving motor of a pillar drilling machine is suitable.

5.3 Screening equipment for flake content test

The flake content shall be measured with a Brecht-Holl screening device. The device is described in [5]. Alternatively, a Haindl Classifier can be used.

5.4 Equipment for ash determination

The ash content is determined according to ISO 1762:2001(E). - Paper, board and pulps – Determination of residue (ash) on ignition at 525 °C [4].

5.5 Screening equipment for macrosticky test

The macrosticky test must be performed using the screening equipment as described in INGEDE Method 4 [2]. A screening plate with 100 µm slot width is necessary. Using of a Haindl screening device according to ZELLCHEMING Leaflet V/1.4/86 [6] is recommended.

5.6. Equipment for handsheet preparation

Laboratory handsheets are prepared according to ISO 5269-2 [3] using a standard sheet former (model: Rapid-Köthen) with dryer (vacuum 95 kPa, 94 ºC).

5.7 Other Tools

- Distributor for suspension homogenisation
- Garden pump sprayer, e. g. “Gardena”
- Analytical balance
- Drying cabinet
- Laboratory sheet former “Rapid-Köthen”
- Büchner funnel 150 mm diameter
- Filter paper 150 mm diameter (e. g. Munktell Grade 12/N)
- Filter paper 240 mm diameter (medium to large pores, medium filtration speed, machine finished, good wet strength, white (e. g. Macherey-Nagel MN 617≡Nr.4)
- One sided, silicone-coated release paper (60 g/m²)
- Black water-based ink, e. g. Pelikan No. 4001
- Specially fused alumina powder: white, sharp-edged particles, grain size 220 according to FEPA Method.

6 Sampling and Sample Preparation

6.1 Determination of the adherend proportion

Before disintegration in the laboratory pulper, the dry content of the packaging sample has to be determined as well as the proportion of the adherend. To determine the mass ratio of the adherend, the mass of the air-dry packaging sample has to be measured. Afterwards the entire adherend is cut out tight with all adhesive material and weighed. The ratio between the mass of adherend (plus adhesive) and the mass of the total sample is defined as adherend ratio.

$$X_{Adherend}\ [\%] = \frac{m_{Adherend}\ [g]}{m_{Packaging\ Sample}\ [g]} * 100\ \%$$

$X_{Adherend}$: Adherend ratio in %
$m_{Adherend}$: Adherend mass (adhesive and glued packaging paper) in g
$m_{Packaging\ Sample}$: Total Packaging sample mass in g

6.2 Sample preparation

480 g oven-dry material is needed for one investigation. By using the dry content of the samples, the respective amount of packaging products is determined. If a packaging product has to be divided to reach sufficient amount of material, the correct ratio between adherend and non-adherend material has to be maintained. Therefore, parts of the adherend and non-adherend material should be added following the adherend ratio.

Afterwards the complete sample material has to be cut to palm size.

7 Procedure

7.1 Disintegration of the sample material

The palm size cut material has to be filled into the pulper completely adding water of 40 °C temperature. The amount of water has to be calculated in order to reach a disintegration stock consistency of 4 %. The disintegration time is 5 min. After disintegration, the complete sample is removed from the pulper. The sample with a volume of approx. 12 l will be processed further using the coarse screening device.

7.2 Coarse screening

The coarse screening is used to separate large and difficult to disintegrate paper parts as well as large non-paper components. The objective is to achieve a nearly fibre free reject. The device consists of a 10 mm hole screen and is defined in Chapter 5.2.

Before starting the process, a container with a capacity of 30 l in minimum is placed below the screening device to collect the screening accept. The outlet valve below the screen is closed. The stirrer is agitated with 200 rpm and has to be operated during the complete screening process. The suspension with the volume of 12 l is

filled in the screening device completely and agitated for 3 more seconds. Then the outlet is opened to start the screening process.

When the suspension is drained completely, the outlet valve is closed, then 12 l tap water are filled into the device. After agitating for 3 more seconds the outlet is opened and the device is drained again.

Then, free fibres still attached to the screening plate or the surface of the device, are drained through the screen using 2–5 l tap water, sprayed using the garden pump sprayer. The water-jet is arranged like spray. The objective is a nearly fibre free reject. Otherwise excessive spraying might dilute the suspension after the coarse screening too much; a very low stock consistency might be problematic for the following tests. Here a good compromise must be found. Therefore it is recommended to use 2–5 l tap water for this step. In exceptional cases up to 10 l tap water can be used for the benefit of a fibre free coarse screening reject.

Then the stirrer is stopped, and the reject on the screening plate is transferred to a weighted and heat resistant case in order to dry the reject until constant weight. The temperature during the drying should be 105 °C. Afterwards the reject mass is determined gravimetrically.

7.3 Yield calculation

The yield can be calculated using the coarse reject as following:

$$Yield\ [\%] = \frac{Packaging\ Product\ used\ [g\ oven-dry] - Coarse\ Reject\ [g\ oven-dry]}{Packaging\ Product\ used\ [g\ oven-dry]} * 100\ \%$$

7.4 Homogenisation of screening accept

The accept of the coarse screening must be mixed gently by hand to guarantee a well mixed suspension in order to ensure a homogenous sampling for flake content evaluation, macrosticky determination and ash content measurement. A minimum of 70 g oven-dry pulp sample should be filled directly into a distributor to have a sufficient amount of material for all trials. The pulp is then diluted to a stock consistency of approximately 1 %. After gentle mixing of two minutes minimum, samples for the respective trials can be taken. The distributor stirs until all samples are taken.

7.5 Determination of flake content

The homogenised accept of the coarse screening has to be tested for flake content acc. to ZELLCHEMING Leaflet V/18/62 [1]. In contrast to this method, non-paper components like small plastic parts are not removed from the reject on the screen plate but examined as part of the flake content. As screening plate a metal plate with a hole diameter of 0,7 mm has to be used, complying with the requirements of the method. 5 samples with 2 g oven-dry sample material each have to be classified for 5 min using 100 double strokes per minute.

Alternatively to the Brecht-Holl screening device a Haindl Classifier could be used. If a Haindl Classifier is used, a water volume flow of 3,33 l/min or 0,2 m³/h has to be applied.

In the case of a high filter mass and low flake content, negative results for the flake content can occur due to scales accuracy. In such cases, the use of filters with lower mass (e. g. with smaller filter diameter) is recommended.

7.6 Ash content determination

From the homogenised accept of the coarse screening, filters for stock consistency measurement should be prepared and incinerated (525 °C) for ash content determination, following the conditions of ISO 1762:2001(E) [4].

7.7 Fibre Yield calculation

By a combination of yield and ash content the fibre yield could be calculated as following:

$$Fibre\ Yield\ [\%] = \frac{(100\ \% - \ Ash\ Content\ [\%]) \cdot Yield\ [\%]}{100\ \%}$$

7.8 Determination of macrosticky area

The homogenised accept of the coarse screening has to be tested for macrosticky area according to INGEDE Method 4 and to be determined as macrosticky area per kg of packaging material [2]. Therefore, four suspension samples of 10 g oven-dry material are screened over a 100 µm slotted plate.

The screening period per sample is 5 min. The screening is performed in a Haindl device with 480 double strokes per minute. Prior to screening, the suspension samples have to be diluted to a stock consistency of max. 1 %. The complete sample is filled into the Haindl device continuously within the first 5 seconds of the screening.

The reject on the screening plate is then transferred to a paper filter following INGEDE Method 4, stained and visualised. If an overlapping of the residue occurs on the filter, the test has to be repeated, and the residue has to be divided and transferred to several filters. Alternatively the suspension mass can be reduced. In that case more than four samples have to be prepared to maintain sufficient sampling mass. After that the filters have to be finished and evaluated using image analysis, as described in INGEDE Method 4. Also a microscopic inspection of the samples prior to the measurement is necessary. White particles or plastics which are definitively no stickies must be detected and removed or painted over in black so they are not visible any more for the macrosticky image analysis system.

The accept of the macrosticky screening step is used to prepare handsheets.

7.9 Handsheet preparation

An appropriate volume of material for a preparation of handsheets with 60 g/m² should be taken from the accept of the macrosticky screening. As the screening is done with 10 l/min water flow and using 10 g oven-dry pulp, it can be enough to collect the first 10 l accept for the consistency measurement and the two handsheets. After standard laboratory handsheet formation according to ISO 5269-2 [3], drying takes place in the Rapid-Köthen dryer between carrier board and a cover sheet. The

drying time should be 7 minutes. In total, a minimum of two handsheets has to be produced.

Afterwards the handsheets are inspected visually for optical inhomogeneities. The observations should be noted.

8 Report

The results for the reject of the coarse screening step, the calculated yield, the flake content test, the macrosticky area test, the ash content and fibre yield calculation as well as the handsheet observations are summarised in a report. The report must consist of the single results as well as the arithmetical means. All results have to be scaled per kg packaging material. Additionally, the mass of the packaging material, the adherend ratio report and the observations of the handsheets have to be mentioned in the report. If deviations from the above mentioned procedure are conducted, reasons and type have to be noted.

9 References

1. Prüfmethode: ZELLCHEMING Merkblatt V/18/62. (Fachausschuss für Physikalische Halbstoff- und Papierprüfung). Prüfung von Holzstoffen für Papier, Karton und Pappe: Gravimetrische Bestimmung des Stippengehaltes von Stoffsuspensionen.
2. Prüfmethode: INGEDE Method 4. (INGEDE e.V.). Analysis of Macro Stickies in Deinked Pulp (DIP).
3. Norm: ISO 5269/2: Pulp - Preparation of laboratory sheets for physical testing, Part 2: Rapi-Köthen Method.
4. Norm: ISO 1762:2001(E): Paper, board and pulps – Determination of residue (ash) on ignition at 525 °C.
5. Brecht, W.; Holl, M.: Stippengehaltsbestimmung und Faserfraktionierung in einem Gerät. In: Das Papier, 2(1948) Nr. 5-6, S. 85-91
6. Prüfmethode: ZELLCHEMING Merkblatt V/1.4/86. (Fachausschuss für Physikalische Halbstoff- und Papierprüfung). Prüfung von Holzstoffen für Papier, Karton und Pappe: Gleichzeitige Bestimmung des Gehaltes an Splittern und Faserfraktionen.