PTS THE PAPER TECHNOLOGY SPECIALISTS

RECYCLABILITY TEST METHOD FOR MIXTURES OF GRAPHIC PAPERS WITH SMALL QUANTITIES OF PAPER-BASED COMPOSITE MATERIALS ON A PILOT SCALE FOR THE EVALUATION OF THE DEGREE OF RAW MATERIAL SEPARATION AND RECOVERY

Method Description

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1 GOAL

Background

Film-laminated and polymer extruded products based on paper or board products, also know as paper-based composite materials, such as liquid packaging board, ream-wrap paper, extrusion coated photographic paper, etc. can, due to the product constructions and paper composition (e.g. wet-strength additives) lead to difficulties during the repulping in standard recovered paper pulping systems if these systems are not technically optimized for these paper-based composite materials.

Using state of the art sorting technology, for instance with NIR sensors, for household mixed waste papers, these products can be sorted out of the graphic recovered paper stream using detection of the polyethylene film. These composite materials can then be recycled together with other composite materials such as liquid food packaging carton.

In poorly sorted recovered papers or even in state of the art sorting facilities, some of these products such as photo papers can, however, due to their small size, be sorted into the mixed graphic recovered paper stream.

Goal

This method describes a pilot-scale process for the repulping and deinking of paper-base composite materials in order to evaluate the degree of separation and recovery of the raw materials in these products when mixed in a mixed graphic recovered paper stream. The graphic recovered paper grade 1.11 is used as the reference recovered paper in this method.

The goal of this method is to evaluate the recyclability of the composite materials in a mixture with graphic deinking papers with respect to:

Recovering of fiber and filler materials from the paper portion of the composites for use in the production of recycled papers

Clean separation of the film-like, non-paper portion of the composites for use as a raw material, for further cleaning and recycling, or as a fuel for energy production

Possible impacts on the deinking efficiency in the process due to the presence of the composites

This pilot method is designed to closely simulate the conditions in and the results from a large portion of the industrial recovered paper pulpers and deinking equipment.

Repulping, Separation, Deinking and Recovery Criteria	Criteria for the repulping, separation deinking and recovery are: • Degree of separation of the paper base from the film-like, non-paper portion of the composites (mainly metal foils and/or polymer films) • Degree of damage or break-down of the film-like materials. Larger film sizes are generally preferable to allow effective removal in typical industrial screening after the repulping step. • Degree of break-down of the paper base material. A full breakdown of the paper base to individual fibers and fillers is desired in order to achieve the maximum recovery of this material. • Impact of the composite material on the deinking process

2 METHOD

2.1 Pilot scale method based on the industrial repulping of graphic papers

Starting Material	Recovered Paper Input: A mixture of graphic deinking papers and composite materials. Examples include: • Mixture A - 99% Graphic Deinking Paper: 1% Composite Material • Mixture B - 90% Graphic Deinking Paper: 10% Composite Material The ratio of graphic deinking paper and composite material should be chosen based on a realistic estimation of the maximum level of composite material which could be expected in one pulper charge.

Repulping, Deinking and Recovery System

Industrial simulation on a pilot scale:

- Repulping in a pilot-scale pulper
- Coarse screening
- Fine screening through a pressure screen
- Flotation (Pilot Scale Flotation Cell ECOCELL)

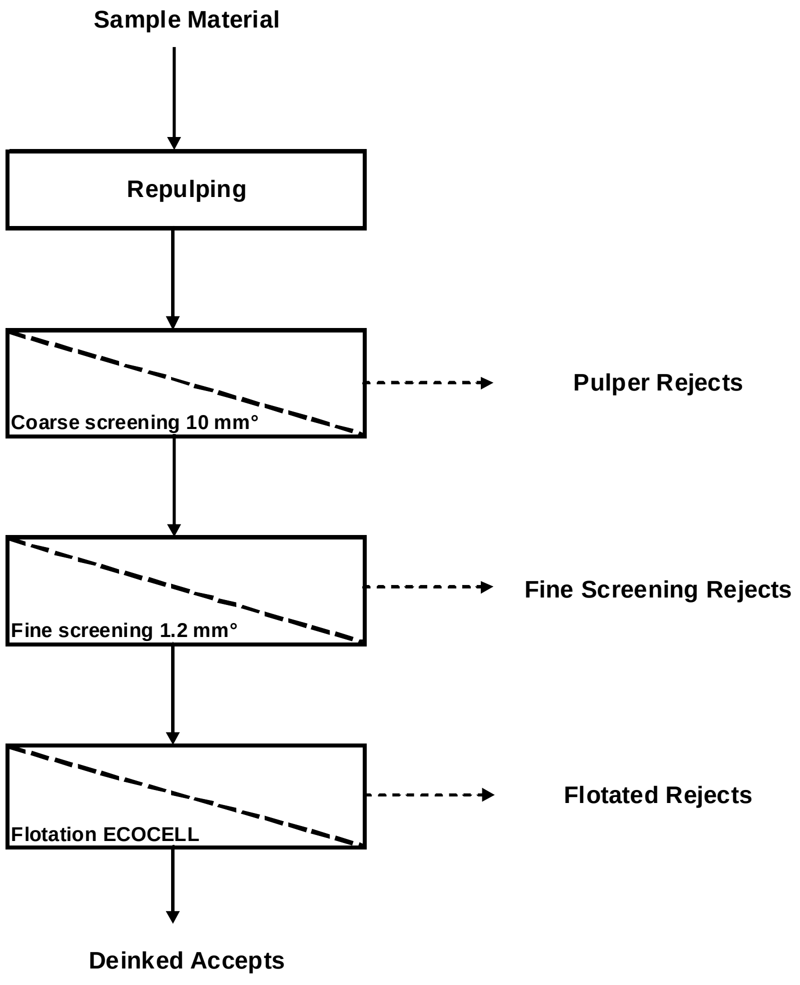


Figure 1 – Flow diagram for PTS pilot plant repulping, screening and flotation deinking

The recycling of the sample material is performed using the typical chemical additives which are used in industrial recycling equipment for deinking paper.

Addition levels based on dry sample material:

- 0.3% NaOH
- 0.8% Sodium silicate
- 0.4% Soap
- 0.8% H_2O_2

The sample material is repulped in a hydropulper at a stock consistency of 10%. In the standard repulping procedure, a pulping time of 20 minutes is used. In cases where a specific energy input is desired, the pulping time can be adjusted to achieve the target specific energy input. The resulting stock mixture is then coarse screened through the hole plate (10 mm) at the base of the pulper. In this screening step, any large material such as large film-like material is rejected. The rejects are named pulper rejects.

The stock accepts from the pulper are then diluted to a consistency of 1% and fine screened through a 1.2 mm pressure screen. This screening step removes smaller film-like materials as well as fiber bundles. The rejects from this step are named fine screening rejects.

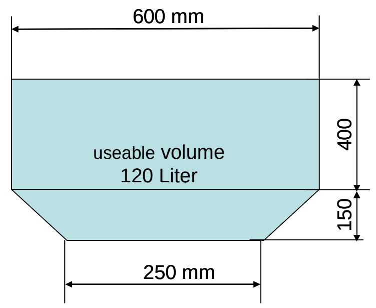
The accepts from the fine screening are then flotated in an ECOCELL flotation cell in order to remove ink and other hydrophobic material.

General Repulping, Screening and Flotation Conditions

Repulping	Unit	
Rotor		MC-Rotor
Hole plate hole size	mm	10
Rotor Speed / Sample Addition	rpm	800
Rotor Speed / Pulping	rpm	1300
Water Addition	dm^3	87
Target Stock Consistency	g/dm^3	100
Water Temperature	°C	45
Sample Addition Time	min	5
Pulping Time	min	20
Washing Water for Pulper Rejects	dm^3	174

Fine Screening	Unit	
Target Stock Consistency	g/dm^3	10
Volumetric Flow Rate	l/min	500
Surface Area of Filter Basket	m^2	0.28
Filter Open Area	%	2.97
Filter Slot Width	mm	1.2
Rotor Type		Foil
Pressure	bar	2
Rotor Speed	m/s	20

Flotation Cell	Unit	
Target Stock Consistency	g/dm^3	10
Volumetric Flow Rate	l/min	600
Dry Sample Weight	kg	<10



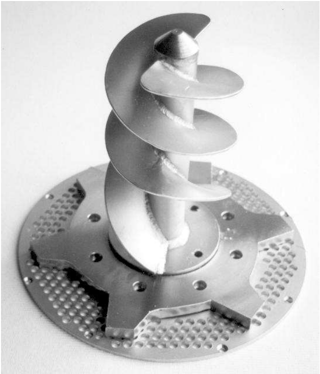


Figure 2 – *Left* - Pulper in the PTS pilot plant; *Right* - MC-rotor and hole plate in the bottom of the pulper (10 mm hole size).

Figure 3: Pressure screen, screen baskets and rotor with foils for the pressure screen in the PTS pilot plant.

Analyses

In order to determine the fiber recovery yield and to evaluate the quality of the accepts, the following analyses are performed:

- Evaluation of the film (non-paper) weight percent in the sample
- Ease of separation of the film portion from the paper portion of the sample

Stock Property	Standard
Water retention	DIN ISO 5267-1
COD	ISO 15705 ST-CSB
Average Fibre Length	Metso Fibre-Lab
Ash at 900 °C	DIN 54370
Ash at 525 °C	DIN 54370
Fibre bundle determination	ZM V/18/62

OPTIONAL TESTS

- Hand sheets of the accepts can be produced and the properties of the accepts can be determined

Paper Properties	Standard
Lab Hand Sheet Production	DIN 54 358-1
Tearing Resistance (ELMENDORF)	DIN EN 21 974
Tensile Strength	DIN EN ISO 1924
Modulus of Elongation	DIN EN ISO 1924
Burst Resistance	DIN 53 141 - 1
Short-Span Compression Test(SCT)	DIN 54 518
Concora Medium Test (CMT)	DIN EN ISO 7263
Internal Bonding Strength (Scott Bond)	TAPPI 833 pm 94

2.2 Mass Balance Calculations

Equations for Calculations

Stock Consistency **SD** [g/dm³]

$$SD = \frac{M(ovendry)}{V} * 1000$$

M = Sample weight (oven dry) [kg]

V = Water volume [dm³]

Pulper Accepts **A_Z** [kg]

$$A_Z = M - R_P$$

R_P = Pulper reject weight (oven dry) [kg]

Fine Screening Accepts **A_N** [kg]

$$A_N = A_Z - R_S$$

R_S = Fine screening rejects (oven dry) [kg]

Total Repulping Yield **FSA [%]**

$$FSA = \frac{A_N}{M} * 100$$

Maximal theoretical fibre and filler yield:

FSA_{max} = Fibre and Filler (Base paper) percentage – Film Material percentage

Paper Portion Yield **PA [%]**

$$PA = \frac{A_N}{FSA_{max}} * 100$$