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STUDY OF SURFACTANTS IN THE DEINKING OF OFFSET PRINTED PAPER

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SUMMARY

This work presents the results of the recycling using two ionic surfactants of offset printed papers with two different inks: one using a conventional mineral oil based ink and other using a vegetable oil based ink. The recycling of the material followed a standardized method for evaluating recyclability of printed papers (INGEDE - Method 11). For comparison purposes, two recycling procedures were performed: a standard procedure with oleic acid (OA) as a surfactant and another that used sodium dodecylbenzenesulfonate (LAB) as surfactant instead. The goal was to evaluate the use of a more accessible surfactant as the standard surfactant in the recyclability evaluation of printed papers. The pulp produced from both deinking processes have low recyclability index, but the pulp obtained in deinking with LAB presented better results than the pulp deinked with oleic acid, for both types of inks.

KEYWORDS: oil based ink; offset paper; paper; pulp; recycling.

INTRODUCTION

According to the Brazilian Environmental Ministry [1], the Brazilian law 12305/10 establishes the National Policy on Solid Waste that creates ways for the prevention and reduction in waste generation, and proposes the practice of sustainable consumption habits and a set of tools to facilitate the increase of recycling and reuse of solid wastes (that which has economic value and can be recycled or reused) and environmentally suitable disposal of waste (that which cannot be recycled or reused).

This law establishes the shared responsibility of the waste generators: manufacturers, importers, distributors, traders, citizens and owners of management services of municipal solid waste in the reverse logistics of waste and pre-consumer and post-consumer paper and packaging. Hence, the National Policy of Solid Waste is demanding the development of new methods and the increase of knowledge of solid waste disposal and recycling.

According to Martin (2014) [2], the daily production of waste in Brazil is about 160 thousand tons, 80 thousand tons are dry waste, of which 60% are composed of recyclable raw material. Of these, most are paper and cardboard, while the rest is divided between plastic, glass, cans and carton packages.

There is a good prospect for the use of paper as a raw material for recycling as incentives for the installation of new plants from cuttings should grow by increasing the opportunities to develop new technologies and new markets.

In the recycling of paper, the most important factor is the assurance of a good quality of the products made with recycled paper in order to maintain their competitiveness with products made with primary sources. In this sense, the increase of knowledge of the deinking process - the main part of the paper recycling process – and of the interface between printing inks and paper are of great importance.

The present study aims to provide data to the industries of printing inks and printing on the recyclability of printed papers with different types of paints, which can assist in the direction of development studies of new products. For this, this work will compare the recyclability of papers printed with traditional ink (mineral oil based ink) and new, more environmental friendly, vegetal oil based ink.

MATERIALS AND METHODS

An A3 size paper with 75 g/m^2 was printed by an offset process using a black mineral oil ink and the same pattern was printed with a black vegetable oil ink. The pattern used for printing is presented in Figure 1.

The paper was characterized and the ink printing quality was tested using an IGT equipment in five different levels of applied ink.

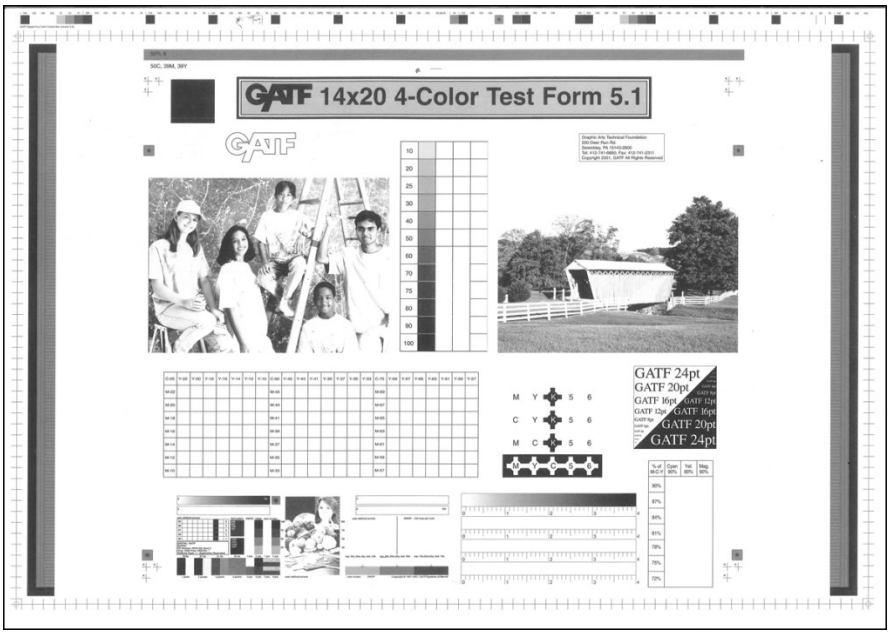

Figure 1. Optical density of the prints

The recyclability of the printed papers was evaluated based in the method 11 of the INGEDE (International Association of the Deinking Industry) [3]. According to this procedure, oleic acid shall be used as surfactant. For testing other types of surfactants, the method 11 of INGEDE was modified and the oleic acid was changed for LAB (dodecylbenzenesulfonate). Therefore, for each type of ink, there were three samples analyzed: one reference samples, one deinked with oleic acid and one deinked with LAB. Table 1 summarizes the samples codes and descriptions.

Table 1. Samples identification

Sample code	Description
MO_REF	Printed with Mineral Oil, not deinked and used as reference
MO_OA	Printed with Mineral Oil and deinked with Oleic Acid as surfactant
MO_LAB	Printed with Mineral Oil and deinked with LAB as surfactant
VO_REF	Printed with Vegetal Oil, not deinked and used as reference
VO_OA	Printed with Vegetable Oil and deinked with Oleic Acid as surfactant
VO_LAB	Printed with Vegetable Oil and deinked with LAB as surfactant

The procedure for the determination of the deinkability score is described in the assessment of printed product recyclability of the European Recovered Paper Council [4]. The calculation of the score is based in the parameters of the deinked handsheets, described in Table 2.

Table 2. Parameters for deinkability score calculation

Sample code	Description
Y	Luminosity
a*	Colour a* (green – red) of the CIELAB system
A50	Dirt particle area for particles larger than 50 μm
A250	Dirt particle area for particles larger than 250 μm
IE	Ink elimination (difference between observed ERICs – Effective Residual Ink Concentration)
ΔY	Filtrate darkening

RESULTS AND DISCUSSION

1. Paper properties

The 75 g/m^2 paper was tested for basic, strength and optical properties, but for the aim of this work, only the grammage, ash content and optical properties are presented in Table 3.

Table 3. Main paper properties

Property	Result
Grammage (g/m^2)	74.6 ± 0.7
Ash content at 525 ºC (%)	23.17 ± 0.05
Brightness – without UV filter (%)	95.41 ± 0.76
Brightness – with UV filter (%)	85.11 ± 0.81
CIE Lab Color	
L*	91.88 ± 0.75
a*	4.84 ± 0.75
b*	-11.37 ± 0.76
Fiber composition	Bleached sulphate hardwood pulp

The properties of the paper used as based for printing are comparable for a commercial printing paper in Brazil, with high brightness, high optical brightener agent and pigment content and made with entirely with hardwood pulp. Therefore, this paper represents well a typical commercial printing paper.

2. Optical density of the applied ink

The quality of the prints was measured by the optical density in five different levels of ink applications. The results of the optical density determinations are plotted in Figure 2.

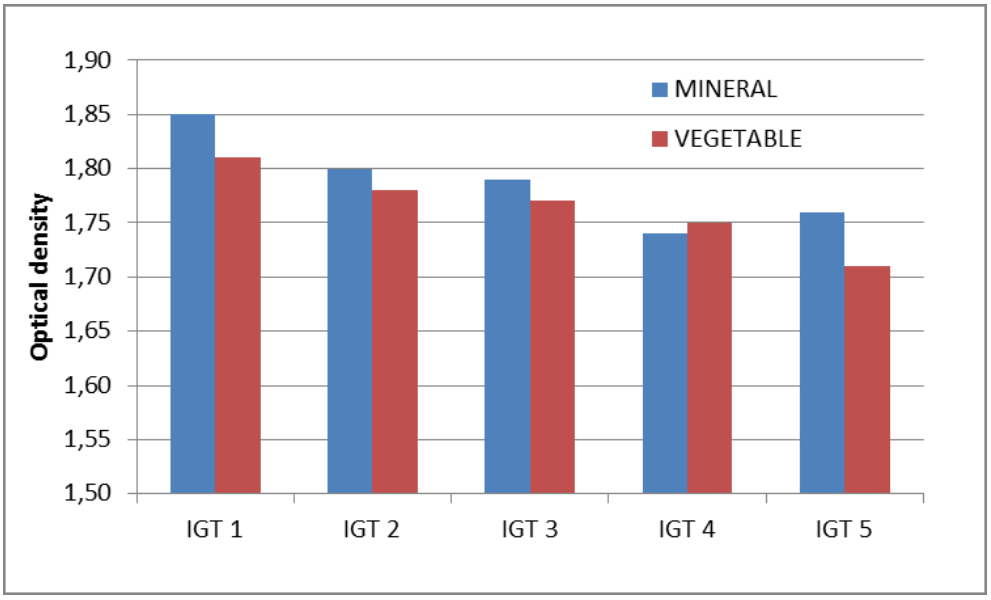

Figure 2. Optical density of the prints

The results show that the print with mineral oil based ink is better than the print with vegetable oil ink, in average, by 1.3 %.

3. Optical characteristics of the handsheets and filtrates

The evaluation of the deinkability by the ERPC´s method is entirely based in the optical properties of the handsheets produced with the deinked pulp and the darkening of the filtrate. The results are presented in Table 4.

Table 4. Optical properties

Sample code	Y	a*	A50 (mm^2/m^2)	A250 (mm^2/m^2)	ERIC (ppm)	IE (%)	ΔY
MO_REF	68.5 (0.1)	2.8 (0.1)	11,930	6,923	329 (7)	-	-
VO_REF	68.2 (0.3)	2.7 (0.1)	18,257	13,053	343 (8)	-	-
MO_OA	67.1 (0.2)	2.7 (0.1)	1,528	227	329 (5)	0	23.2
MO_LAB	67.6 (0.6)	3.1 (0.1)	1,167	192	250 (34)	24	28.4
VO_OA	66.6 (0.1)	2.7 (0.1)	1,929	252	345 (6)	1	29.7
VO_LAB	67.1 (0.1)	3.2 (0.1)	1,191	219	272 (12)	26	28.9

The deinkability score of each sample was calculated and the results are shown in Table 5.

Table 5 – Score by parameter and total deinkability score

Parameter	Y	a*	A_{50}	A_{250}	IE	ΔY	Denkability score
Lower threshold	47	-3.0	-	-	40	-	-
Upper threshold	-	2.0	2,000	600	-	18	
Target value	≥ 70	-2 / +1	≤ 600	≤ 180	≥ 70	≤ 6	
Maximun score	35	20	15	10	10	10	
MO_OA – Printed with Mineral Oil and deinked with Oleic Acid as surfactant							
Result	67.6	3.1	1,167	192	24.0	28.00	**-3**
Score	31	-20	9	10	-5	-8	
MO_LAB – Printed with Mineral Oil and deinked with LAB as surfactant							
Result	67.1	2.7	1.528	227	0.0	23.00	**-3**
Score	31	-14	5	9	-10	-4	
VO_OA – Printed with Vegetable Oil and deinked with Oleic Acid as surfactant							
Result	67.1	3.2	1,191	219	26.0	29.00	**-3**
Score	31	-20	9	9	-5	-9	
VO_LAB – Printed with Vegetable Oil and deinked with LAB as surfactant							
Result	66.7	2.7	1.929	252	0.0	30.00	**-3**
Score	30	-14	1	8	-10	-10	

The rating of the deinkability score is made by the range of the result, as shown in Table 6.

Table 6 – Rating of the deinkability score

Score	Evaluation of deinkability
71 to 100 pontos	Good
51 to 70 pontos	Fair
0 to 50 pontos	Poor
Negative (failed to meet at least one threshold)	Not suitable for deinking (may be recyclable without deinking)

The results show that all samples have a deinkability score of -3. Thus, the samples are not suitable for deinking, according to ERPC´s method.

Despite these results, is still possible to compare de deinkability by the individual score for each parameter. In this case,

CONCLUSION

One of the purposes of this work is to compare the recyclability of the new vegetable oil based offset inks with the conventional mineral oil based inks. Considering the optical density as an indication of the quality of the prints, the o.d. of the mineral oil based ink prints is better when printed in a standard commercial offset 75 g/m^2 paper.

The recyclability of the paper printed with mineral oil is slightly better than the one printed with vegetable oil. The values of the optical parameters of the references samples (MO_REF and VO_REF), that were not deinked and were only disaggregated, suggest that the vegetable oil might have a greater penetration in the fibers, resulting in a print with lower optical density and in a recycled

paper with greater values of dirt area and ERIC.

The other purpose of this work was to compare the use of oleic acid and LAB as surfactants. Despite the low recyclability score of all the deinking processes and inks used in this work, the utilization of sodium dodecylbenzenesulfonate (LAB) in the deinking of offset printed papers had a better efficiency, considering the results of the dirt area (A50 and A250), IE and ΔY.

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