Stickies Related Research During the Recycling of Waste Paper

Turrado S., J.; Gonzalez T.; O.G.; Vazquez C.; L.M.; Saucedo C. A. R.; Rivera Prado J. J. and Sanjuan D. R.;

ABSTRACT

The paper industry in order to reach all paper quality requirements is using as by products more and higher quantity chemicals products in the furnish. The behaviour of all these materials specially those with adhesive properties are the source of trouble during the new paper production.

This work is related to quantifying micro and dispersed stickies generated by two paper samples specially the behaviour of adhesives in relation to an hydrophobic Polyethylene surface "Low Density Polyethylene, LDPE film" placed in an stirred pulp sample (2%C) at 50°C, etc. in this relation the surface tension of both compounds is important.

It was used a 2^K Mathematical Model in order to optimize the action of each parameter. The analysis of particles adhered to the LDPE film was made using an image Analyser, this work was developed in order to look for a quick and reliable method to help the Paper Industry. The mean area of stickies of both paper samples (31724 and 8722 $\mu m^2/m^2$) was detected and related to the weight to waste paper O.D. ($16.9x10^{-3}$ mm^2 stickies/kg waste paper O.D. $4.29x10^{-3}$.

KEYWORDS

Waste paper, Stickies, Image Analysis, Adhesives.

INTRODUCTION

In many countries the paper industry is growing up using paper as raw material. All papermakers that are working with waste paper know the kind of trouble that are generated by the presence of adhesives in raw material. Since some years ago the Department of Wood, Cellulose and Paper of the Guadalajara University/ Mexico is working on waste paper and one interesting study subject on this area is the stickies.

All people, who works with stickies agree that one of the underlying difficulties lies in the quantification of adhesive materials since the chemical natrue of adhesives, Internationally is accepted that stickies can be classified in two groups based on their size; the limit lies under and over 150 µm [1]: thus many papers have been publised in relation to this

DEPARTAMENTO DE MADERA, CELULOSA Y PAPEL
UNIVERSIDAD DE GUADALAJARA
Aparta Postal 52-93
Km. 15.5 Autopista Guadalajara-Nogalcs
Zapopan Jal 45020, Mexico.

subject and on properties of polymers on adhesives [1-9]. Others authors refer to adhesives as primary and secondary stickies. The primary group include the hot melts and a very important part of the pressure sensitive adhesives, in the second one you will find out almost all other adhesive compounds and some new products generated by the action between them.

In order to understand the adhesives behaviour, in this work selected two papers quality, namely: **mailbox envelopment paper** and **coated paper.** In the first sample it is aceepted that there is only one kind of adhesives, whereas in the second one there are more adhesives in relation to quality and quantity.

The experimentation was run according to a 2^K experimental Design Mathematical Model [10], both samples were studied separately, in order to make adhere (to stick) the higher quantity of adhesive particles on the surface of a Low-Dnsity Polyethylene (LDPE) film. The particles adhered to the surface of the LDPE film were analysed with an Image Analizator.

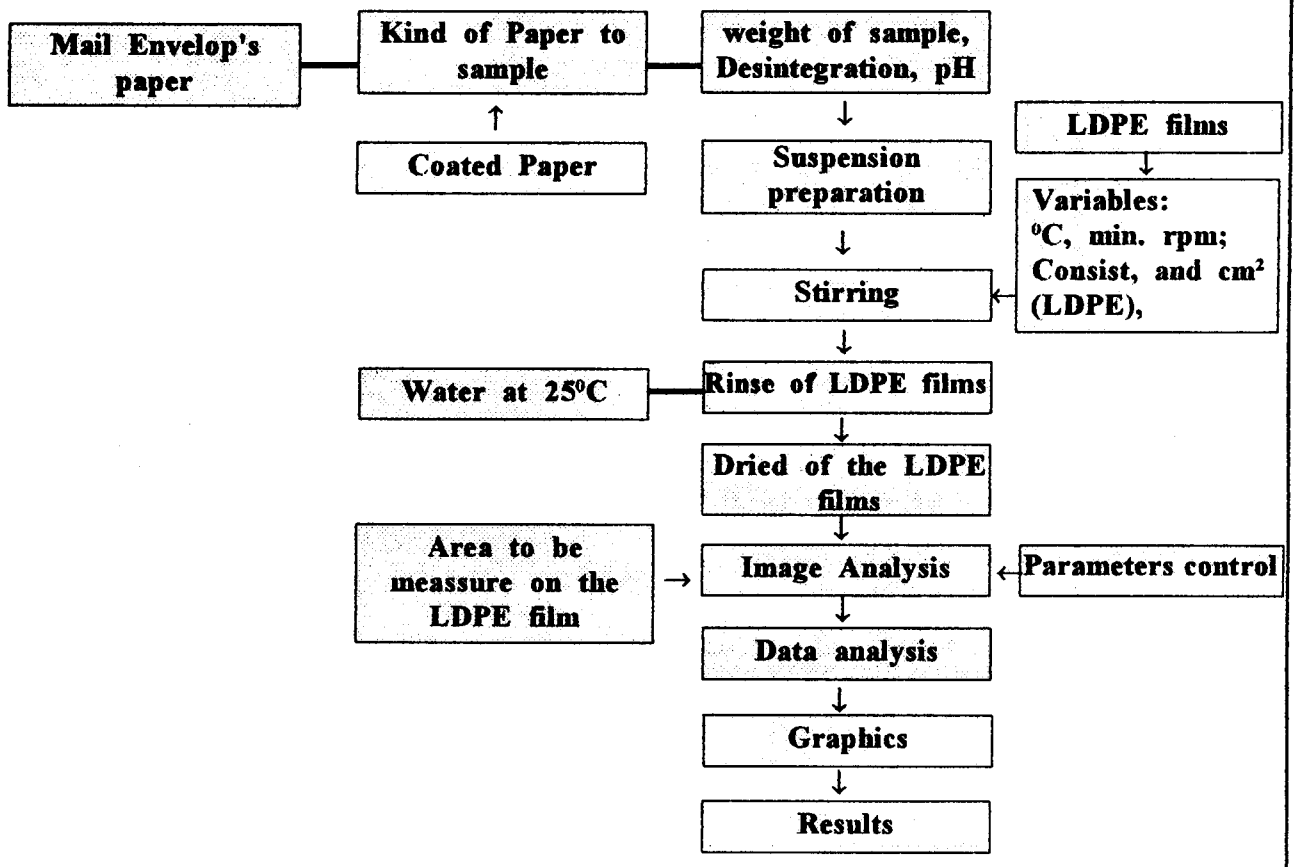
Image analysis is an useful tool for the detection and quantification of microscopical particles that have response to light. It can be used for detect particles included in paper furniture, whereas this particles have optical contrast between them and with fibres.

PROCEDURE

Studied samples were worked separately in order to count and measure the stickies in every sample. Both papers were previously soaked in tap water for 5 h to ensure adequate defibering during the disintegration, which was run using a standard Karl Frank disintegrator (1.5% C) for 5 min.

The limits of the studied variables were: Temperature, °C (40 - 60), Consist., % (1.5 - 3.5), speed, rpm (320 - 2800), Contact time, min (5-25), Surface of the LDPE films, cm^2 (16 - 80). The procedure was according to the schedule working plan, Fig. 1. As a next step the LDPE films were

The Schedule working plan is the following: Fig.1



taken out of the suspension, then the films were rinsed with cold water and prior to count with the Image Analyzator the adhered particles to the film's surface, they were dried at room temperature. On the surface of every film there were carried out tree measurement in order to reach higher precision.

The main components of the Image Analyzer are: [11]

Image Source- Microscope/Macroviewer

TV Camera- Standard resolution CCD TV Camera providing monochrome, RGB and low-light Images

Image Capture- An image capture board installed in the PC converts the camera image to electronic form, with user selected resolution.

PC-Hosted Computing-

Modular Software Suite (Win)-

Image Analysis is carried out using an Image Processing and Analysis Software for Quantitative Microscopy LIECA QWIN 550. The repeatability of the image analysis has high confidence level, in this equipment once objects have been selected, it is possible to define a routine, so in the subsequent measurements, the operator has no more influence.

Between other characteristics it is possible to obtain as answer. *Area, Length, Breadth, Perimeter, etc. and the Equipment registers: Total of every property, Mean, Std. Dev., Std. Error., Max., Min., 2.s Range, and Features.*

RESULTS

The FIVE variables introduced during the procedure using a 2^K Mathematical Experimental Design were: **Temperature (°C), Speed (rpm), Consistency (%), Contact time (min), and Surface of the LDPE (cm^2).**

The methodology developed allows the quantification of stickies found in recycled paper. However, further experiments are carried out in order to optimize the procedure.

The pieces of LDPE were taken out from the suspension and rinsed in water at room temperature; later on, they were dried at approx. 25°C.

In this work were meassured the number, size, colour response and area ($\mu m^2/m^2$) of the adhesives sticked on the surfaces of the LDPE films. Image 1- allows to see the every adhesive material has specific

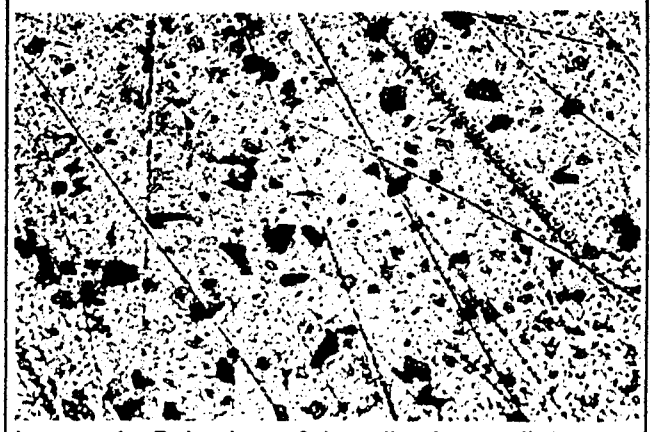


Imagen 1.- *Behaviour of the adhesives to light*

light response in function to its chemical composition.

The Information of the image analysis was proceed by the Statgraphics softwere, in order to evaluate the influence of the variables in the process.

As shown in Fig.-2 for coated paper, the consistency has the most important influence on

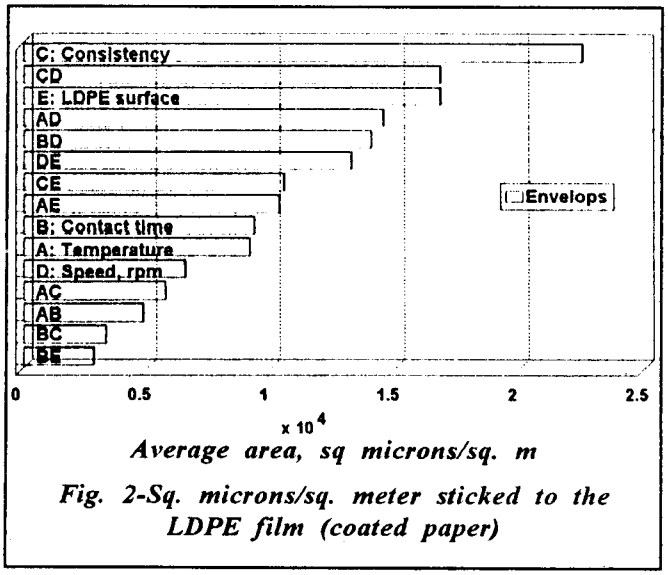


Fig. 2-Sq. microns/sq. meter sticked to the LDPE film (coated paper)

particles number stuck on the LDPE surface, whereas in the second position of influence was found out the surface of the LDPE films and in third position contact time (LDPE and fibre suspension) and

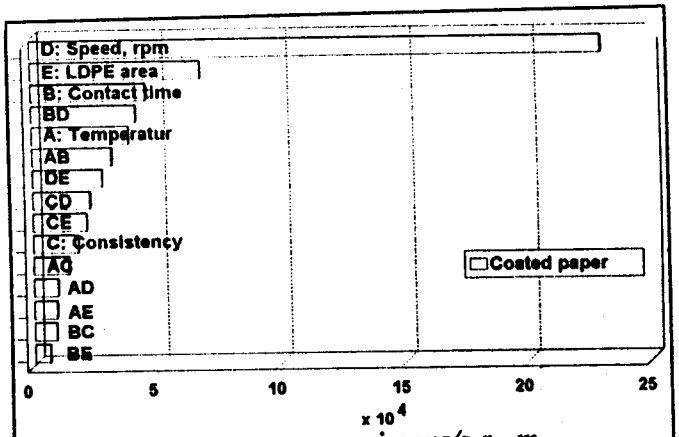


Fig. 3-Sq. microns/sq. meter sticked to the LDPE film (envelop's paper)

Temperature, finally the movement of the suspension, this variable has the lowest influence in relations to variables included in this study. Whereas for envelop's paper there was another order, which is to see in Fig.-3.

The adhesives used in envelopes have different behaviour on the surface of the LDPE in relation to adhesives used in a paper to be coated and those used in the furniture of coated material. Fig.-4.

The measured stickies area ($\mu m^2/m^2$) on the LDPE can be correlated to the weight of the original Raw Material.

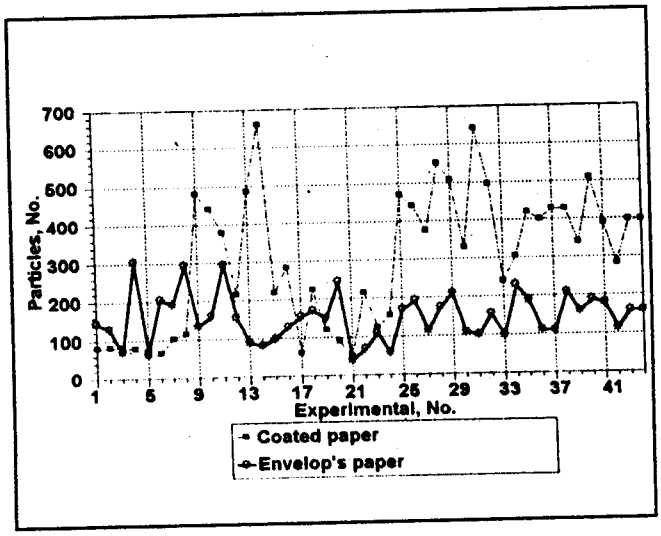


Fig. 4-Adhered particles on the LDPE film in relation to experimental conditions.

$$\text{Average of Stickies area} = \frac{Y,\ \frac{\mu m^2}{m^2}}{\frac{1000^2\ \mu m^2}{mm^2}} = \frac{mm^2}{kg}$$

$$\frac{(Wm,\ g)(10000,\ \frac{cm^2}{m^2})\ kg}{(z,\ cm^2)\ 1000,\ \frac{g}{kg}}$$

Where:

Y = Information of the Analyser, sq. Microns/sq. Meter

Wm = Weigh of the sample (O.D.), g

z = Surface of the LDPE, normally, 64 cm^2

CONCLUSION

Probe No,	Total area of the adhesives, $\mu m^2/m^2$	Adhesive's Surface /kg waste paper mm^2/kg
Envelop paper	8722	4.65×10^{-3}
Coated paper	31724	16.92×10^{-3}

With this methodology and capability of the Image Analyser its possible to quantify the presence of micro stickies in waste paper or fibre suspension, there is no doubt that with the parameters of the process, the most adhesives stickies are adhered on the LDPE films, Nevertheless it is not very easy to be sure that all adhesives were caught. However, further experiments are carried out in order to optimize the procedure.

The parameters included in this work like: type of paper, area of LDPE films, consistency, contact time, movement of the suspension and Temperature have shown that some kind of adhesives have developed better that others their adhesive properties in relation to the LDPE area under specific conditions.

This work is an effort to help the paper industry to understand a little more the behaviour of stickies under different parameters and to quantify them, at least those that are more active under the parameters of the study.

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