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Chemical Engineering Journal 105 (2004) 21–29

Chemical Engineering Journal

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Development of a methodology to predict sticky deposits due to the destabilisation of dissolved and colloidal material in papermaking—application to different systems

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Received 31 March 2003; received in revised form 20 July 2004; accepted 21 July 2004

Abstract

Due to trends in papermaking like closed water systems or higher use of recovered paper (RP) as a raw material, a large number of contaminants are accumulated in the system as dissolved and colloidal material (DCM). When the DCM is destabilised by a sudden change in the system conditions, it produces sticky deposits, called secondary stickies that affect the papermaking processes and the quality of the final product. The existing laboratory methods to predict DCM destabilisation have limitations such as low reproducibility or they do not distinguish between sticky and non-sticky materials or high volumes are necessary to perform the test. In order to solve these problems, a methodology to predict the depositability potential of DCM has been developed by the Complutense University of Madrid. The methodology incorporates the destabilisation of the DCM by polymer addition, DCM deposition on collector surfaces and the quantification of the formed deposits by image analysis. Results show that the methodology has good reproducibility with a margin of error less than 10%. The methodology was applied to study: the potential of different formulations of adhesives to form stickies; the formation of deposits with different contaminant types and several concentrations; the efficiency of deposit control agents and the behaviours of different recovered paper grades.

Keywords: Stickies; Secondary stickies; White pitch; Dissolved and colloidal material; Papermaking

1. Background

Recovery and recycling of paper is recognised as being an efficient raw material source for paper and board production and having a desirable effect on reducing the volume of waste. The paper industry is now one of the most sustainable industries in Europe with almost 95 million tons of paper and board production and a consumption of 42 million tons of recovered paper (RP), representing a reutilisation rate as high as 51.6% [1].

The use of recovered fibres as a raw material in the paper industry presents many environmental and economic advantages. However, it also has serious drawbacks due to the high number of contaminants that are introduced into the system [2–4].

To solve the problems associated with the use of recycled raw materials, a higher number of process chemicals are used during papermaking. These additives become potential contaminants when they are introduced again in the system with the recycled paper or with the reused water. The excess of chemicals, the interaction with the contaminants already present in the water and the incompatibility between different additives represents a potential problem that has to be considered when chemicals are selected because they may destabilise the dissolved and colloidal materials (DCM) and form deposits known as secondary stickies. These problems are worse when the water system is closed due to the accumulation of contaminants in the process waters [5–10]. Furthermore, DCM not only interacts with organic substances but also with inorganic and microbial compounds forming combined deposits that favour foaming, scaling, corrosion, etc. [11]. In this case, it is necessary to know the origin of the deposit to be able to control its effects. During paper-

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doi:10.1016/j.cej.2004.07.013

Table 1
Methods for the determination of sticky deposits

Method	Deposit collector	Quantification	Mechanism
Static			
Impinging-jet	Methacrylate surface	Gravimetric microscopic analysis	Collision
Doshi	Spheres or polystyrene foam films	Gravimetric	Undefined
Berol	Polyethylene films	Gravimetric	Undefined
CTP	Polyester wires	Image analysis	Undefined
Mobile			
Vibromixer TAPPI UM223	Stainless steel surfaces	Gravimetric	Undefined
Buckman	Plastic bottles	Gravimetric	Undefined
PIRA	Polyester wires	Gravimetric image analysis	Undefined

making the problems associated with the accumulation and destabilisation of DCM are of great importance because of the following detrimental effects:

- Effects on machine productivity: lower retention and drainage, presence of deposits, scaling, holes and breaks, increase of cleaning downtime, etc.
- Effects on additive efficiency: retention aids, sizing agents, wet-end and dry strength additives, optical aids, etc.
- Effects on product quality: formation problems, lower optical properties, holes, spots, lower strength, lower printability performance, etc.

The composition of recycled paper is very heterogeneous and therefore, the presence of contaminants in secondary fibre pulp is highly variable. Potential DCM pollutants include pressure sensitive adhesives (PSA), hot melts, ink binders, coating binders and additives. Additives can include fillers, starch, sizing agents, wet strength additives, deinking chemical agents, pigments, drainage and retention aids, formation aids and pH control agents [6]. In general, DCM is anionic and is known as anionic trash.

DCM is only considered as a potential deposit former until it is destabilised, forming secondary stickies [12–14]. This may occur at any point in the machine where a physicochemical shock occurs. The most common destabilisation mechanisms are electrostatic shocks, temperature shocks and evaporative destabilisation. Electrostatic destabilisation mainly results from the use of cationic polyelectrolites as retention, dewatering or wet strength aids. These chemicals may react with anionic colloids and dissolved materials present in the process water forming precipitates. Electrostatic destabilisation may also occur by a conductivity or hardness shock. Evaporative destabilisation results from the evaporation of water in the dry section. In this case, any DCM present in the water, not only anionic material, may precipitate. When free water is present between fibres, as in the first part of the drying, water will move towards the paper surface and will take the concentrated DCM with it. Since the temperature is above the softening temperature for many of the synthetic polymers, they will aggregate forming sticky deposits that may remain with the paper or stick to the driers or to the felts [15–18].

Determination of the contaminants present in different pulps and their potential depositability, monitoring of potential stickies accumulation along the process and the conditions for its destabilisation are very important for the paper industry due to the economical impact of stickies [19]. This justifies the interest of many research groups in trying to develop methods to predict DCM. With this aim several deposition testers summarised in Table 1, have been proposed in the literature to quantify deposits [20–29] In general, reproducibility, the distinction between sticky and non-sticky material, the need of a higher contaminant concentration to perform the test than the normal contamination level present in paper mills and the possibility of extracting the deposit if a further analysis is needed, are key issues for this type of method.

The industry is still looking for a reproducible and easy method to determine the adherent material contained in a pulp suspension, responsible for the sticky deposit formation, such as the deposition rotor patented by the UCM [30]. This method is characterized for: reliable and accurate results, reproducible data, easy to use in the mill, representative for the fluid-dynamics of the system, formation of deposits by both collision and transference mechanisms, it differentiates sticky and non-sticky material contained in the suspensions and it is possible to extract the deposits if a further analysis is needed.

Therefore, the purpose of the present work was firstly to evaluate the methodology to quantify the destabilisation of the DCM with a system based on an image analysis technique and, secondly, to apply the methodology to different cases.

2. Experimental

2.1. Description of the methodology

The methodology developed to determine the tendency to form deposits because of the destabilisation of DCM contained in white water, has three stages:

1. preparation of the white water containing DCM to study in the same conditions as in papermaking;

Table 2
Disintegration conditions for the raw materials

Consistency (%)	3.5
pH	10
Temperature (°C)	50
Time (min)	20
Speed (rpm)	3000
Water volume (L)	2

2. depositability test to determine the tendency of DCM to form deposits;
3. quantification of the collected deposits.

The raw material is soaked for 10 min in tap water to facilitate the defibration of the furnish. Disintegration was carried out in a lab disintegrator ENJO-D-33.73/D. Table 2 shows the disintegration conditions used to reproduce mill conditions [15,22,29]. Alkaline pH conditions, as used in most of the mills, were reached by adding 1% NaOH o.d. fibres.

The pulp obtained was diluted to 0.5% consistency and it was homogenised by a gentle agitation. Finally, the white water was obtained by filtering the diluted pulp through a dynamic drainage jar (DDJ) with a mesh of 100 μm.

Destabilisation of DCM was carried out by an electrostatic shock with a cationic polymer. The polymer dosage selection was based on the cationic demand of the white water. The cationic demand, defined as the equivalent of a cationic polymer necessary to neutralize the anionic charge present in a sample, was measured in the supernatant of the white water, after centrifuging at 3000 rpm for 10 min, by a colloidal titration with the polymer used for the DCM destabilisation e.g. poly(ethylenimine). The titration of the white water was carried out by an automatic titrator CRISON connected to a particle charge detector, Mütek PCD 03, which determines the final point of the titration when the isoelectric point is reached [34]. From this value, the theoretical volume (V_{th}) of the cationic polymer that is necessary to add for the destabilisation of DCM contained in the 1800 mL of white water used in the deposition experiment is determined. Fig. 1 shows a scheme for white water preparation for depositability tests.

The UCM deposition rotor consists of a rotor, a collector and an axial flow propeller as shown in Fig. 2 [30]. The rotor has holes on the top, on the bottom and on the side in such a way that the pulp suspension enters through the top and bottom surfaces and goes out through the side holes due to the centrifugal force. Therefore, if a surface is placed in front of the side holes, the sample hits it and the sticky material is deposited by a collision mechanism. At the same time, the fluid-dynamic of the system allows us to have a parallel flow on the outside surface of the collector that favours the formation of stickies by a transference mechanism.

The lab equipment consists of:

1. The *rotor* consisting of:
   - A 15 W and 12 V electric drill of continuous current with a reduction of 5.34:1, allowing a maximum turning speed of 750 rpm.
   - A stainless steel shaft, with a length of 210 mm and a diameter of 8 mm, is connected to a PVC axial flow propeller in the bottom consisting of three blades with slope 25° and radius 30 mm from the centre of the axis to the end of the blades.
   - A cylindrical disc (height 20 mm and diameter 50 mm) having four holes on the top, four on the bottom and

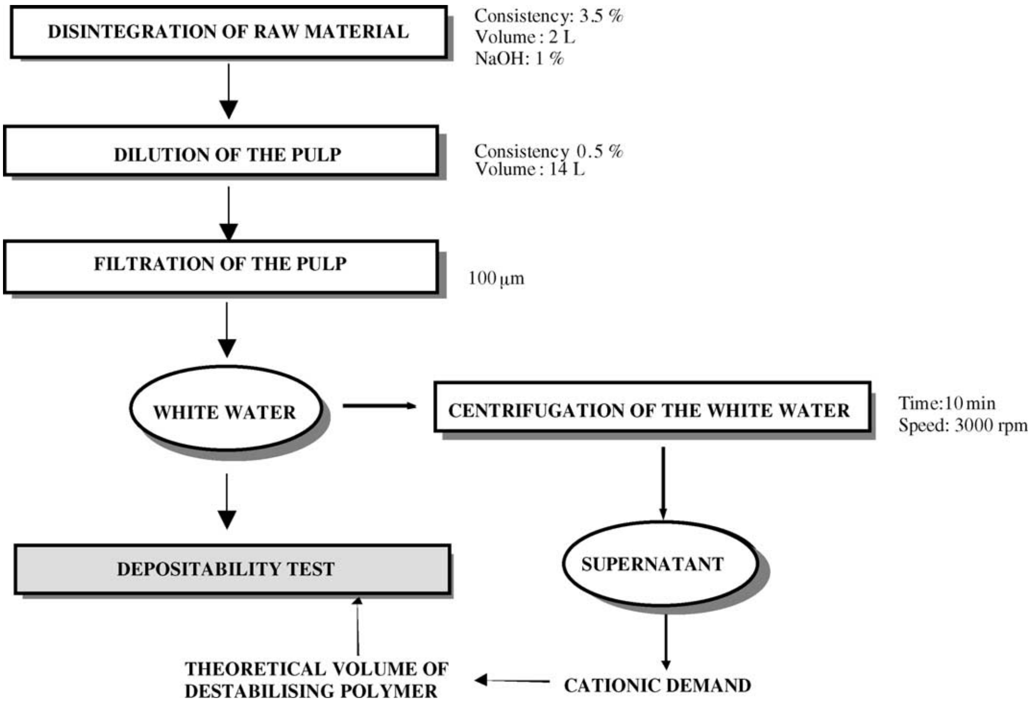

Fig. 1. Scheme for the depositability test.

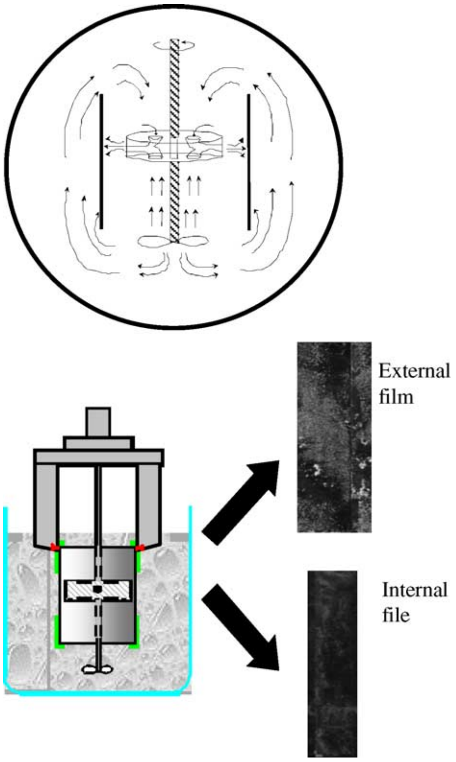

Fig. 2. Deposition rotor tester and fundamentals.

four on the side, with diameter 10 mm, interconnected through inner conducts. The disc is made of Teflon because of its low deposition potential.

2. The *collector* formed by:
    - A stainless steel tube-support (height 90 mm, diameter 65 mm and thickness 1 mm) where collector surfaces are fixed 2 cm away from the Teflon disc.
    - The collector surfaces are two stainless steel films with a thickness of 0.05 mm. These are fixed to the tube-support by the attachments: one film is located centrally inside the tube-support and the other on the outer side of the tube-support. The attachments are designed to secure both films. The dimensions of the external stainless steel film are 90 × 225 mm and the dimensions of the internal one are 50 × 220 mm.
3. The stainless steel *baffles*, with width 23 mm, height 114 mm and thickness 3 mm are joined to the tube-support and to the stainless steel structure that supports the electric drill by screws.

The time of the experiment and the agitation speed are very important variables to take into account in order to obtain enough deposits. A short experimental time and/or too low agitation speed would produce a low amount of deposits. On the contrary, a high experimental time would produce too many deposits, which would come unstuck from the collector, and a too high turbulence would remove the deposits from the surface, in both cases a low amount of deposits would be obtained. Therefore, previous experiments at different times and at different agitation speeds were carried out to define a compromise situation and to determine the optimum operational conditions [31]. Optimal conditions are shown in Table 3. The deposition temperature was fixed to 50 °C because it is a typical temperature of white waters in paper mills with closed water systems and it is above the softening temperature of synthetic polymers, favouring deposition on the collector surfaces.

Table 3
Operating conditions of deposition rotor

Agitation speed (rpm)	250
Time (min)	60
Temperature (°C)	50
Volume (mL)	1800

Quantitative determination of the deposits depends on the characteristics of the deposits and on the required precision. The films from contaminants that produce a high amount of deposits may be analysed gravimetrically e.g. to study wood extractives. However, when contaminants produce a low amount of deposits e.g. recycled paper, adhesives, coating binders or deinking soaps, it is not possible to use gravimetric methods because of the relative error of the results. In these cases image analysis is more precise. There are numerous studies in the bibliography based on image analysis of deposit collectors [35–42]. In this case, the deposit image is taken with a flatbed scanner HP Scanjet 6100C.

When the deposition experiment is finished, the stainless steel films with the deposits are withdrawn from the tube-support and dried in an oven at 105 °C for a few minutes (they may be also dried at room temperature overnight). Then, stickies are covered by a transparent plastic film and the image of the collector surface is taken. The image is analysed using the “Stickies Measurement System”, developed by the British Research Centre PIRA International and UCM. The SMS relies on the contrast differences between the deposits and the background [43]. The programme suggests the grey level or “threshold” usually relative to the average grey scale value, at which the deposit is considered. It can also be selected by the user depending on the type of deposit. Results are given as: covered area of deposits expressed as mm^2, mm^2 of deposits per m^2 of surface (ppm) and percentage of covered area of deposits (%).

As the sizes of the external and internal films are different, the percentage of deposits can be assessed taking into account the size of the stainless steel films. This is possible calculating the pondered deposits retained on each surface. These results, called *pondered areas* (PA), are obtained using the expressions (1) and (2). According to this, it is possible to add the results, as the expression (3) shows, to give one deposition value for each experiment as the sum of the two pondered areas (external and internal) [31].

$$\begin{aligned}\text{EPA (\%)} &= \frac{\text{mm}^2 \text{ of deposits}_{\text{EA}} \times \frac{\text{EA}}{\text{TA}}}{\text{TA}} \times 100 \\ &= \frac{\text{mm}^2 \text{ of deposits}_{\text{EA}} \times 0.65}{\text{TA}} \times 100 \qquad (1)\end{aligned}$$

$$\text{IPA}\ (\%) = \frac{\text{mm}^2\ \text{of deposits}_{\text{IA}} \times \frac{\text{IA}}{\text{TA}}}{\text{TA}} \times 100 = \frac{\text{mm}^2\ \text{of deposits}_{\text{IA}} \times 0.35}{\text{TA}} \times 100 \quad (2)$$

$$\text{TPA}\ (\%) = \text{EPA} + \text{IPA} \quad (3)$$

where EA is the area of the external film (20,250 mm^2), IA the area of the internal film (11,000 mm^2), TA the total area of the films (31,250 mm^2), EPA the external pondered area covered by deposits, IPA the internal pondered area covered by deposits and TPA is the total pondered area.

2.2. Raw materials

Different raw materials were used for the deposition tests:

1. *Deinking soap:* Deinking soaps are additives used as collectors to remove the inks in the flotation stage [32]. In this case, the deinking soap was a sodium soap of fatty acids soluble in water because it is one of the most commonly used in paper mills. This system was chosen because when calcium ions are present in the medium, calcium soaps are formed, which are practically insoluble in water and have a high tendency to deposit on the surfaces. To carry out the deposition experiments a 1.0 g/L of the deinking soap solution was prepared. The soap was destabilised by adding the stochiomentric amount of calcium (60 ppm Ca^{2+}), from a commercial CaCl_2 solution.
2. *Adhesives:* Recovered paper grades contain high amount of adhesives (0.5% on average), so they are considered to be the main source of stickies in paper recycling. Five adhesives were tested as sources of DCM: three of them supported on labels with a 20% concentration of adhesive (a conventional adhesive, a 100% acrylic hydrodispersable adhesive and an acrylic based hydrodispersable adhesive) and two of them as commercial solutions (polyvinyl acetate with plasticizer and polyvinyl alcohol).
   Acrylic hydrodispersable adhesives are the basis of the pressure sensitive adhesives applied in labels and tapes. These adhesives are designed to break up into fine particles or virtually dissolve under pulping conditions [33]. Therefore, they have a strong tendency to form secondary stickies. The conventional adhesive used was an acrylate based adhesive, containing 70% 2-ethyl-hexylacrylate (which is extremely tacky) and 30% tackifier. The commercial polyvinyl alcohol is a totally water-soluble adhesive, which is an important source of DCM in papermaking. The polyvinyl acetate, the base for the common household “white glue”, is a non-water-soluble adhesive, which is generally available as solvent solution or emulsion.
3. *Coated papers:* Coated papers are responsible for a specific stickies problem known in the industry as white pitch. A silk-coated paper (37% coating on dry fibre) was used for the study of the reproducibility of the method. Its formulation contains calcium carbonate, clay, latex and pigments. This coated paper was selected because of its high depositability trend [44].
4. *Recovered papers:* The recovered paper grades, used for this study, are an Ordinary Grade (1.05) and a Medium Grade (2.05) from the “European List of Standard Grades of Recovered Paper and Board” published jointly by the Confederation of European Paper Industry (CEPI) and the Bureau of International Recycling (BIR). The grade 1.05 (called RP 1) is composed of boards and it is used as raw material for packaging paper. The grade 2.05 (called RP 2) mainly consists of office paper and it is used as raw material for deinked pulp. In this case, it is necessary to add deinking chemicals during disintegration to reproduce mill conditions.

In all cases, the cationic polymer used for destabilising the DCM contained in the white waters was (poly)ethyleneimine (PEI). PEI has high molecular weight and very high cationic charge.

The talc used in the study of the efficiency of stickies control agents was a commercial product used in papermaking, from Talc of Luzenac.

All other chemicals CaCl_2, NaOH, HCl, etc. were of analytical grade.

3. Results and discussions

Reproducibility is defined as the value below which the absolute difference between two single test results obtained with the same method with the same material under different conditions (operators, apparatus, laboratory and/or different times) may be expected to lie. *Repeatability* is defined as the value below which the absolute difference between two single test results obtained with the same method with the same material under the same conditions (operators, apparatus, laboratory and/or a short interval of times) may be expected to lie. The reproducibility and repeatability of the method were estimated based on the error of the experiments calculated statistically from the confidence interval (CI) using the expression (4). The confidence interval (CI) was determined from both arithmetic mean and standard deviation for a confidence level of 95% ($\alpha = 0.05$) with the Eq. (5) [45].

$$\varepsilon\ (\%) = \frac{|(\bar{X} \pm \text{CI})| - \bar{X}}{\bar{X}} \times 100 = \frac{|\pm \text{CI}|}{\bar{X}} \times 100 \quad (4)$$

where $\bar{X}$ is the mean value and CI is the confidence interval

$$\text{CI} = \pm t + \frac{\sigma}{\sqrt{n-1}} \quad (5)$$

where t is the t-student for confidence level of 95% and $(n-1)$ degrees of freedom; σ the standard deviation of the sample and n is the size of the sample. Table 4 shows the experiments carried out to asses the reliability of the methodology.

Table 4
Set of experiments to assess the reliability of the method

	Reproducibility		Repeatability	
Conditions	High deposition	Low deposition: samples from pulps prepared each time	Low deposition: with samples from the same pulp	
Raw material	Deinking soap	Labels	Labels	Coated paper
Contaminant concentration	1 (g/L)	20% conventional adhesive	20% conventional adhesive	37% coating
Destabilisation agent	Ca^{2+} (60 ppm)	PEI (V_{th})	PEI (V_{th})	PEI (V_{th})
Number of experiments	5	3 pulps × 3 = 9	5	6

The *reproducibility study* was carried out with high and low deposition conditions. Deinking soap was used as an example of *high deposition* conditions because their high tendency to form sticky deposits in the presence of calcium is well known in papermaking. A set of five experiments was carried out with the deposition rotor with the 1.0 g/L solution of deinking soap. After destabilising the soap with calcium, deposits were formed and the TPA covered by deposits was 22.2%. The obtained error was 8.6%.

As an example of *low deposition* labels, raw material containing 20% conventional adhesive was used. In this case, the amount of deposits is lower than that with deinking soaps but they are more spread out on the collector films. In this case, three different disintegrations were carried out to obtain three white waters and a set of three deposition experiments was carried out for each white water. The average TPA was 3.0% and the error of the method was 9.1%.

The *repeatability studies* were carried out in *low deposition* conditions. A set of five deposition experiments with white waters obtained from labels, and a set of six deposition experiments with white waters obtained from a coated paper were carried out. In all cases, the DCM was destabilised using the theoretical volume (V_{th}) of PEI in the deposition rotor. For the labels the TPA was 2.9% and for the coated paper that was 3.9%. The error of the method was 9.0 and 8.8%, respectively.

As summary, the results of the TPA and the error for all reproducibility and repeatability experiments are shown in the Table 5. In all cases the errors are below 10% that shows the reliability of the developed methodology to study the potential of DCM to form stickies deposits.

The methodology was applied to study: the potential of different formulations of adhesives to form stickies; the formation of deposits with different contaminant types and several concentrations; the efficiency of deposit control agents; and the behaviours of different recovered paper grades.

Table 5
Deposited area and error of the methodology for different conditions

	Reproducibility		Repeatability	
Raw material	Deinking soap	Labels	Labels	Coated paper
TPA mean (%)	22.2	3.0	2.9	3.9
Error (%)	8.6	9.1	9.0	8.8

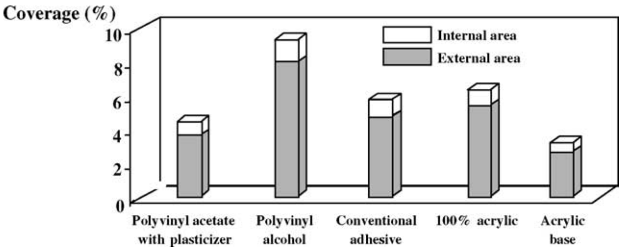

Fig. 3. Depositability potential of white waters obtained from papers containing different adhesives.

3.1. Depositability potential of different adhesive formulations

Five different adhesive formulations have been studied. White waters obtained from papers containing 0.5% of adhesive were studied using the proposed deposition methodology. Results show that, from the point of view of deposit formation, polyvinyl alcohol is the most problematic adhesive (Fig. 3). However, the measured values of cationic demand and turbidity (Fig. 4) show that there is no relationship between these parameters and the depositability potential of these contaminants. During recent years, these parameters have been measured in the process waters of the mills in order to predict the possible problems of secondary stickies. However, nowadays, these correlations are being questioned since some DCM present in white waters do not contribute to cationic demand or turbidity values but do have a high tendency to form deposits. This is, for example, the case of polyvinyl alcohol, which forms the largest amount of deposits when it is destabilised but contributes to the cationic demand and to the turbidity less than other adhesives.

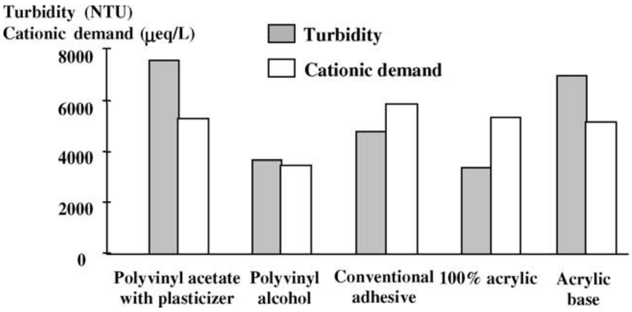

Fig. 4. Parameters measured in white waters obtained from papers containing different adhesives.

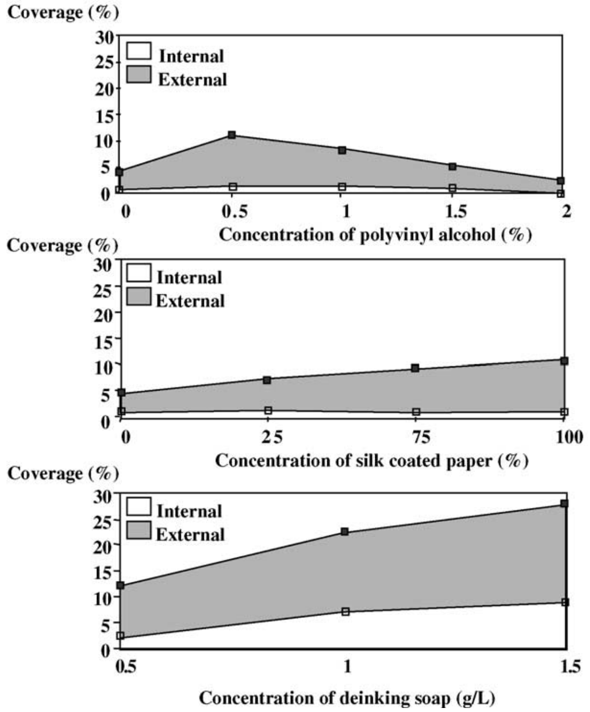

Fig. 5. Depositability results of waters containing DCM from different sources.

3.2. DCM from different contaminants

Different types of contaminants were studied using different concentrations in the raw materials. The contaminants compared were: an adhesive, the polyvinyl alcohol applied at different concentrations on a base paper, a coating formulation from the mix of the different ratios of the silk-coated paper with a base paper and a deinking soap dissolved in distilled water at different concentrations. The DCM was destabilised in the first two cases by PEI and, in the last case, by $CaCl_2$. Fig. 5 shows the different behaviour of each contaminant as a function of its concentration.

While DCM from the polyvinyl alcohol presents a maximum depositability for a 0.5% concentration of adhesive in the raw material, when the coating and the deinking soap concentration increase in the raw material the deposit formation increases proportionally. The decrease of deposition at high adhesive concentrations may be due to the formation of macrostickies during disintegration of the pulp which are retained by the DDJ filter, to the formation of non-sticky aggregates or to the formation of three-dimensional deposits. According to the collector images and the appearance of both the destabilised waters and the DDJ filter, the first hypothesis is occurring in this case. As it has already been mentioned, DCM from deinking soap forms the highest amount of deposits. In this case, a 28% coverage area is obtained for a concentration of 1.5 g/L of soap.

For the adhesive and coating formulations destabilisation of DCM mainly occurs by a transference mechanism, which gives a higher deposition in the external collectors of the deposition rotor. This means that the adherence between the formed stickies and the collector is weak and the high turbulence drags the deposits from the surface. However, both collision and transference deposition mechanisms are important when deinking soap is studied. In this case, around 25% of deposits are obtained in the internal surfaces.

3.3. Efficiency of deposit control agents

Talc is a common additive used in papermaking as a control agent of the DCM, because of its adsorption properties that involve the removal of adhesion characteristics, frequently associated with potential secondary stickies formers [46,47]. Talc is a mineral with a layered structure, large hydrophobic surface and hydrophilic edges. The hydrophobic surface interacts with the tacky material surface, which is also hydrophobic [2], reducing its potential to form deposits. Therefore, it is possible to stabilize DCM and to avoid its agglomeration with the use of talc. In order to study this behaviour, deposition tests were carried out with white waters from paper containing 0.5% polyvinyl alcohol and from coated paper, adding different talc concentrations. Fig. 6 shows how the talc decreases the tackiness of the deposits at low concentration (0.1 g/L).

From 0.1 g/L of talc concentration, the amount of deposits increases due to the adhesion of talc particles to the deposits. An over dosage of talc increases the deposit formation considerably due to the accumulation of the talc on the formed stickies deposits. This fact confirms the deposit problems existing sometimes in paper mills that use talc as a control agent of DCM.

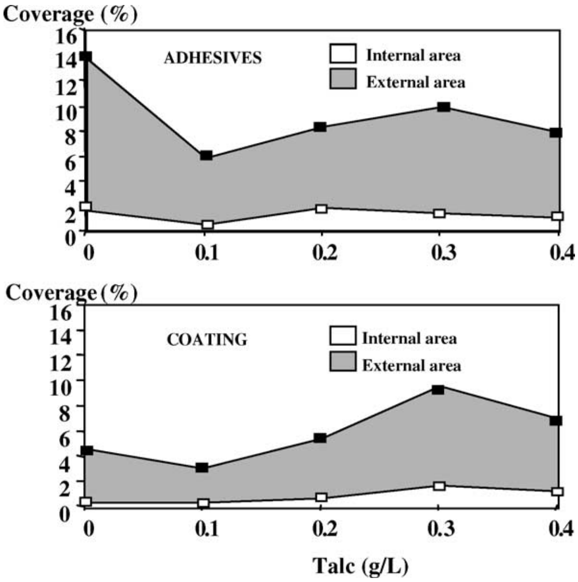

Fig. 6. Effect of talc concentration on depositability of white waters.

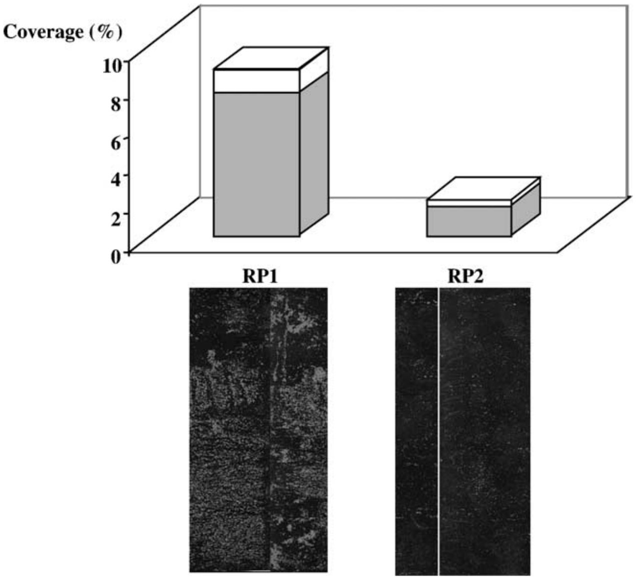

Fig. 7. Depositability of white waters from different recovered papers (RP).

3.4. *Behaviour of different grades*

Two different grades of recovered paper were tested with the developed methodology in order to study the potential of DCM, present in the different raw materials, to form deposits. Disintegration conditions were adjusted to reproduce the situation of brown grade and white grade paper mills. RP 1 was disintegrated at 35 °C while RP 2, a typical raw material for deinking mills, was disintegrated at 45 °C using deinking chemicals: 1% NaOH, 1% deinking soap, 1% H_2O_2 and 2.5% sodium silicate.

Fig. 7 shows the obtained results. It is observed that the white waters from the ordinary paper grade (RP 1) produce a higher amount of deposits. However, as is shown in Fig. 8, the cationic demand, the conductivity and the turbidity values of the waters obtained from medium grade (RP 2) are higher. Again, it is possible to conclude that it is not always possible to establish a direct relationship between the measured parameters in the white waters and the tendency of DCM present in the waters to form deposits.

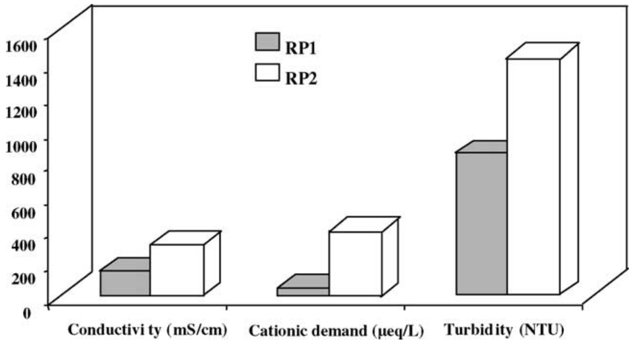

Fig. 8. Comparison between the parameters measured in white waters from different recovered papers.

Brown grade recycled paper presents a higher amount of stickies contaminants. It is estimated that the adhesive content of this grade may vary from 0.5% to 1.5% while in white grades the estimated amount of adhesive is 0.5% [2]. Brown grades have PSA from labels and adhesive tapes, hotmelts from boxes, starch from boards and coating binders while office paper contain PSA from labels and tapes, dispersion adhesives from envelopes and ink binders from printed papers. Since brown grades have a higher amount of stickies contaminants it is clear that they also form more deposits. Correspondingly, white grades form less deposits because of the lower initial concentration of contaminants in the papers.

On the other hand, the stronger disintegration conditions used for RP2 (higher temperature and presence of deinking chemicals) justified the higher presence of DCM in the waters. Furthermore, some of the contaminants from RP2 are specifically formulated to easily disperse in water.

4. Conclusions

- The deposition methodology developed to study the potential of DCM, present in white waters, to destabilise and to form deposits is reliable and can be used under papermaking conditions. It presents the following advantages:
  - a good reproducibility and repeatability, the error is below 10%;
  - easy to handle and to control the studied parameters;
  - it is possible to study collision and transference deposition mechanisms;
  - it differentiates between sticky materials and non-sticky materials;
  - it is possible to quantify the obtained deposits by image analysis;
  - if necessary the deposits may be extracted for further analysis.
- The methodology has been validated by studying the destabilisation of different types of DCM.
- With this method, it is possible to asses the recyclability of different formulations from the point of view of deposit tendency and to determine the efficiency of control agents.
- It is not always possible to correlate traditional parameters, such as the cationic demand or the turbidity of the white waters, with the tendency of DCM to form sticky deposits. These traditional measurements have to be complemented with deposition tests to predict problems at industrial scale.

Acknowledgements

The authors wish to express their appreciation to Raisio Chemicals Ltd. for the financial support to carry out the industrial validation of the deposition rotor, to the European Commission for the support to the project FAIR5-PL97-3993, and to UK Paper, SCA, Lucca, BASF ATOFINA and Tale of Luzenac for the supply of the chemicals and raw materials used in these studies.

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