TAMPERE POLYTECHNIC -
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Paper Technology
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Final thesis

Janne Heinilä

A COMPARISON OF THE PAPER LINTING AND DUSTING MEASUREMENT METHODS USED IN THE POLYTEST -PROJECT

Supervisors MSc Arto Nikkilä, MSc Pasi Arvela
Commissioning company TAMK, POLYTEST -project, PhD Jarmo Lilja
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ABSTRACT

The target of the POLYTEST -project was to develop laboratory and on-line scale measurement methods for paper linting and dusting. The aim of this thesis work was to compare the measurement results obtained with the POLYTEST laboratory device with the results from other methods.

Nowadays, increasing quality demands for printed products are setting higher requirements for paper, and production efficiency is the key factor. The linting and dusting of the paper has to be controlled because it causes problems in the offset printing houses and increases their costs.

Confidential

TAMPEREEN AMMATTIKORKEAKOULU
Paperitekniikka
International Pulp and Paper Technology
Heinilä, Janne

POLYTEST hankkeessa käytettyjen pölymittausmenetelmien vertailu
Tutkintotyö
55 sivua + 9 liitesivua
Työn ohjaajat
DI Arto Nikkilä, FM Pasi Arvela
Työn teettäjä
TAMK, POLYTEST -hanke, TkT Jarmo Lilja
Toukokuu 2007
Hakusanat
linting, dusting, paperipöly, polytest

TIIVISTELMÄ

POLYTEST hankkeen tavoitteena oli kehittää laboratorio ja on-line menetelmä paperin pölyävyyden mittaukseen. Tämän tutkintotyön tavoitteena oli vertailla POLYTEST laboratoriolaitteella saavutettuja tuloksia muiden paperin pölyävyyttä mittaavien menetelmien tuloksiin

Painotuotteiden kohoavat laatuvaatimukset asettavat nykyisin korkeat vaatimukset myös paperille, ja tuotannon tehokkuus on teollisuudessa avainasemassa. Paperin pölyävyys täytyy pystyä hallitsemaan, koska se aiheuttaa ongelmia offset-painotaloissa ja nostaa heidän tuotantokustannuksiaan.

Luottamuksellinen

FOREWORD

I would like to thank teachers Arto Nikkilä, Jarmo Lilja and Pasi Arvela for their professional guidance and advice throughout the POLYTEST -project. I would like to acknowledge laboratory technician Juhani Pitkänen for his assistance in the construction work of the measurement devices. I would like to thank Metso Automation for their co-operation and financial support to the project. I would like to thank also the other members of the student research group, Teemu Aittamaa and Antero Haapaniemi, for the co-operation during the POLYTEST -project. I would like to acknowledge also the personnel of Tampere Polytechnic, especially the teachers in the paper technology department. In addition, I want to thank my family and my girlfriend for all of their love and support during the time I have studied in Tampere.

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May 7, 2007

Janne Heinilä

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1 ABBREVIATIONS AND SYMBOLS

A_{ef} = effective paper sheet area

BS = bottom side of the paper

CD = cross machine direction

C_m = mass concentration

C_N = number concentration

D_{ave} = average particle diameter

DI_{PMM} = dusting index

ELPI = electrical low pressure impactor

m = mass

MD = machine direction

PMM = particle measurement method

q_v = flow rate

t = time

TAMK = Tampere Polytechnic - University of Applied Sciences

TS = top side of the paper

ρ = density

2 INTRODUCTION

Nowadays, the increasing colour content and quality demands for printed products are setting higher requirements for paper. Printing houses are demanding clean and flawless papers and at the same time the use of recycled fibre has been increasing steadily. Also the filler contents are rising. Printing presses are getting bigger and faster and production efficiency is the key factor. As a result of these trends, the linting and dusting resistance of the paper has become an important property. /3;12/

Linting is usually described as the paper's tendency to shed fines, fibre fragments and other loosely bound material in the offset printing. Linting means the accumulation of fibrous material on the printing cylinder's surface and the dusting material is coating or filler pigments. Ray cells are clearly the dominant component of the lint. Nowadays the offset printing method is widely used when printing newspapers and other grades containing mechanical pulp. The lint and dust accumulate on the offset printing blankets and disturb the transfer of ink from the inking system onto the blanket, and thereby decrease the quality of the printed product. The production efficiency starts to suffer when printing presses have to be stopped during the run in order to wash the blankets before continuing. This action reduces the available production time for the printing houses and increases their costs. Also the paper mills' costs may increase if they constantly receive customer complaints about their paper's linting and dusting properties. Linting and dusting are mainly considered as a problem for offset printing, but also flexographic printing is to some extent sensitive for linting. Mechanical pulps are often accused for their tendency to cause linting, and mainly newsprint is used as an example of the problem. This final thesis concentrates on the linting and dusting problems of newsprint grades. /2;5;8;13;14/

The goal of the project was to develop a laboratory-scale measurement device for evaluating the linting and dusting tendency of papers. Also the possibilities of developing an on-line application were studied during the work. The research was done in a group which consisted of three students. The subject was divided into

three individual parts; the development of the laboratory device, the comparison of methods and results, and the development of the on-line application. The research work was done in the facilities of Tampere Polytechnic (TAMK) and the tested paper samples were obtained from the TAMK paper laboratory and UPM Kaipola paper mill.

3 AIM OF THE WORK

The POLYTEST project was launched to evaluate the existing measurement methods for paper linting and dusting and to develop the measurement method. There had already been some preliminary background research about the subject. The primary goal of the project was to develop and design a prototype of a laboratory device for paper linting and dusting measurement. The secondary goal was to adapt the method used in the laboratory device into the on-line scale measurement. The project was divided into three separate subjects for final theses. The project is also continuing in the future and these final theses offer a good introduction to the subject and they can be used as manuals for the further research.

The aim of this final thesis was to evaluate the methods used for paper linting and dusting measurement and also to compare these methods to results obtained from the measurements with the POLYTEST laboratory device. The goal of the thesis work was to compare the correlation between the results from four different methods; the POLYTEST laboratory device, the Heidelberg GTO method, the Veitsiluoto device and the IGT Fluff tester.

4 PAPER LINTING AND DUSTING IN GENERAL

4.1 Linting and dusting

In offset printing, lint means the fibrous materials and particles which accumulate on the blankets and may even travel along to the inking system, as seen in figure 1. Linting is a significant problem with uncoated grades and it is a cumulative problem, which starts to cause more interference in the longer printing runs. The problem increases with higher ink tack levels. The linting can be seen as fluffy material, mainly in the first units of the offset printing machine, and it can occur on both printing and non-printing areas of the blankets. Also the edges of the web are one problem area, because they can contain lint and dust from the slitter winder. Linting causes variations and decrease in the print density and it may also cause fibre shaped voids on the printed image. The lint material is easy to wash off from the blankets but still it takes quite a lot of time away from the production, especially if the lint has travelled to the inking system. /14/

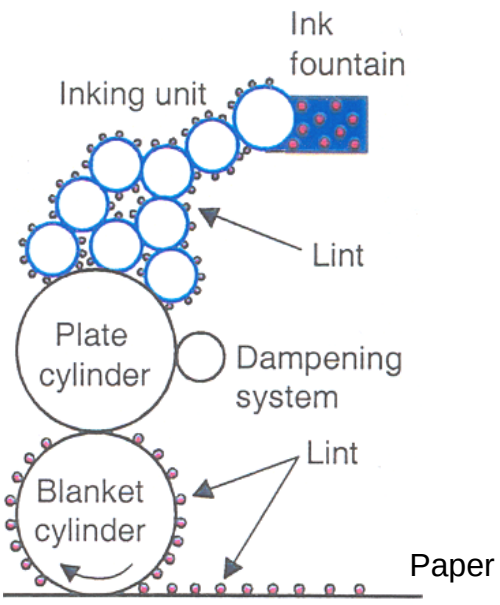

Figure 1. The lint material can travel along even to the inking system. /14/

Dusting means the loose or weakly bonded filler or coating pigment particles which are removed from the surface of the paper. Dusting is considered a problem with coated grades, but also with uncoated grades with high filler content. It usually

occurs in the first printing units and mainly on the non-printing areas of the blanket. The pigment and coating dust can be seen all over the non-printing areas as white accumulation. Like linting, it is a cumulative problem, and it might glaze the blanket which generates ghost images on the printed product. The dust is hard and time consuming to wash off from the blankets. The difference between linting and dusting is not very clear and therefore they are often both referred to as linting because filler dust is usually also present if fibre lint removal from the surface of the paper occurs. /13;14/

4.2 The factors affecting linting and dusting

Linting and dusting are mainly affected by variables in the printing press and in the paper. Common paper-related issues are the pulp quality, raw material composition and the paper machine's wet-end chemistry, for example the use of retention aids and lint reduction aids. The printing press variables, such as blanket and plate cylinder properties, nip pressure, ink tack properties, ink temperature and viscosity, and the basic design of the printing press also have a major effect on linting and dusting. Also the paper machine type is important, as paper made with a gap former machine has shown a lower tendency for linting. /1;5;7;13/

Linting resistance and high surface strength became more important when offset started to be the dominant printing method for newsprint. The offset method requires good surface strength properties because the offset inks have much higher tack level compared to the inks used in other methods. The flat surface of offset blankets and plates does not offer any places for lint and other contaminants to hide. Therefore the printing cylinders have to be washed when they have collected too much contamination material and the print quality is starting to weaken. The water-containing fountain solution causes problems, because it weakens the paper surface and therefore increases the removal of loose material. One factor which also affects the linting and dusting is the filler content of the paper; high filler content interferes with the bonding ability of fibres and therefore results strength losses and high dusting tendency. /2;5;7/

The mechanism of linting is a combined effect of the forces that are present in the ink film splitting and the bonding energy of fibres in the paper surface. Also the ink flows in the printing press nip affect the linting; the flow of ink under high pressure may cause forces that drag particles from the paper surface. It has been suggested that different intensities of the force which is generated to the paper surface results in different types of linting. If the generated force is low, the unbound material, like pigment and filler dust, is removed from the surface. The medium force level removes the weakly or loosely bonded linting material. At higher forces also well-bonded fibres can be removed from the paper surface; this is usually called picking. /13/

4.3 Measurement of linting and dusting

The measurement and prediction of paper's linting and dusting properties has generally been quite a complicated and time-consuming process. Usually the paper mills have to wait long times for the results from printing laboratory trial runs or ask their customers to do those trials. These trials are often not so precise and the result depends on the press operator's opinion. Also the huge amount of different variables in offset printing affects the result. The evaluation usually requires the printing of large quantities of paper to obtain realistic results. Some paper mills have also developed their own specific measurement and evaluation methods for paper linting and dusting. The evaluation and prevention process of linting would get much easier if the paper mill could do those measurements on the mill site and have the results faster. /3;8;12/

5 LINTING AND DUSTING MATERIAL

In the past, linting material used to contain coarse and stiff particles in the past. Nowadays, as the pulp producing and screening techniques have developed, the linting material is much finer and it doesn't contain such a high proportion of coarse particles. The lint material mainly consists of ray cells, fines, filler and fibre fragments, poorly fibrillated whole fibres, mini-shives and other debris. The different types of softwood fines can be seen in figure 2. The main part of the linting material is ray cells, which are known for their inability to form strong interfibre bonds. /5;7;13/

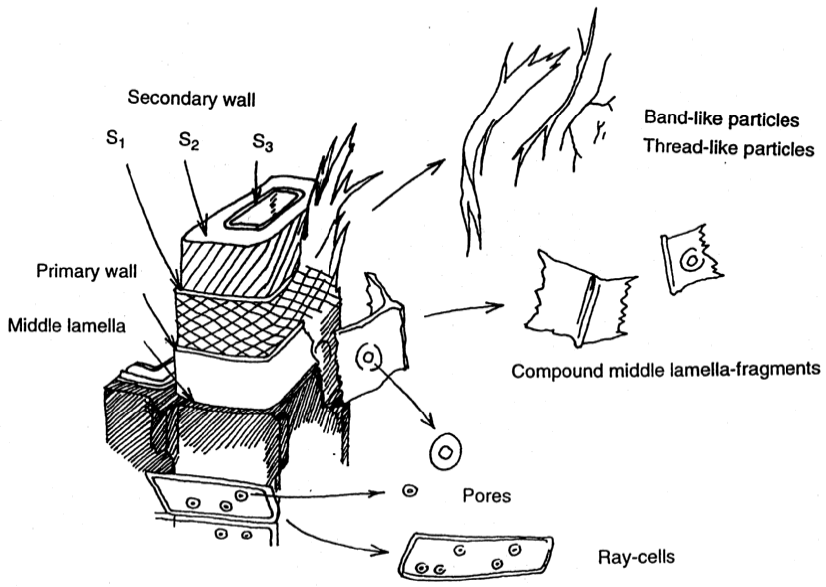

Figure 2. The different types of fines from softwood fibre /10/

5.1 Mechanical pulps

The linting problem is most severe with the papers containing up to 100 % mechanical pulp. Mechanical pulp fibres are recognized as the main source of linting material. The reason for that is their tendency to have a low specific surface area. The majority of lint particles are shorter than 1 mm. The other common nominators are that these particles are stiff and they have relatively smooth surfaces, which have not been greatly affected by the mechanical refining actions. Their bonding potential is therefore weak. These characteristics show that these

particles lack the high specific surface area which is required to develop strong interfibre bonds. The proportion of low specific surface area particles present in the pulp, determines the linting propensity. /1;10/

Usually mechanical pulps contain significant amounts of lint candidate particles, that is, particles which have the potential to become lint. Latewood fibres usually have low specific surface area, because of their thick fibre walls and therefore they are one linting candidate. Only a small fraction of these fibres will actually become lint material and be removed from the paper surface; the removal of these particles depends on the given conditions in the papermaking and printing. The lint candidate can become lint particle if it is located on the surface of the paper and the force which is bonding it to the paper is lower than the force which is trying to attach it to the ink film. The cohesion forces which bond the fibre to the paper are mainly a function of the fibre's own properties, like length and specific surface, and also the surrounding fibre network. The adhesion forces which are trying to attach the fibre onto the ink film are dependent on the printing conditions and variables. The fibre orientation might have some effect also. The lint candidate amount can be reduced already in the pulping plant by increasing the specific energy used in the pulp production. Another way is to run the centrifugal cleaning at a high reject rate, and then use high consistency reject refining to increase bonding capacity. /1;5/

Also the wood quality and tree species have been shown to have some differences concerning linting propensity. Pulp which is produced from fresh, high-quality wood raw material has lower linting tendency. The spruce species has generally been found to be the best raw material for mechanical pulp. For example high quality pulp manufactured from black spruce showed low linting tendency, whereas jack pine increased the linting as its proportion of the wood blend grew. The wood chips must be stored properly and the chip storage times should be minimized in order to produce high quality pulp. Uniform refining is always required to produce high quality pulp with low linting potential. Also the wood blend should be controlled, because then it is easier to control the refining result also. /1/

5.2 Ray cells

Ray cells are claimed to be the main source of linting material, because of their poor bonding ability. Ray cells are short and they contain less cellulose and more lignin as long fibres. The length of a single ray cell is about 100 µm. The proportion of ray cells is about 5 % in the whole wood, and about 15-20 % of the amount of total fines are ray cells. Ray cells can be seen in figure 3. /10/

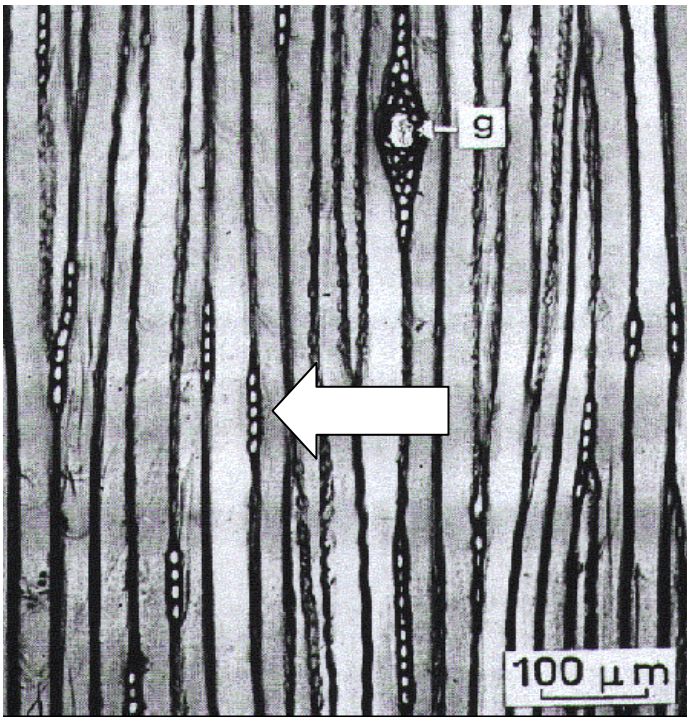

Figure 3. Section of spruce with radial ray cells (arrow) and resin canal (g) /10/

The rest of the final thesis is confidential.

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