Printing Technology & JK Paper Approach to Meet Modern Printing Requirements

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Abstract

Printing is an act of reproducing a design on a surface or transfer of image from one medium to another. The four basic methods of multiple reproduction or printing are:

1. Typographic / Letterpress / Relief printing (Printing area raised over non printing area)
2. Intaglio / Gravure printing (Printing area is below the non printing area).
3. Plano graphic / Lithography / Off set printing (Printing & non printing area are in the same plane)
4. Silk screen or Screen Printing (ink is squeezed through a stencil mounted on a screen to get the image)

All the above are called contact printing and Offset printing industry enjoys undisputed leadership with almost 45-47% share of printing, publishing and packaging production since last 2-3 decades, where as the gravure printing industry stands around 25-27% followed by letter press whose shares are in a down ward trend in last few decades. Screen printing has distinct advantages for short runs because of the simplicity of the equipment needed but for longer runs the advantages is soon lost as the other printing methods are much faster and more economical

Non-contact printing is the category where no contact is made with the substrate by a printing plate. In recent years, a substantial amount of research and development efforts have focused on imaging systems that produce paper copies through non contact systems which are far economical and user friendly with a manageable speed starting from photocopying to digital printing via inkjet printing & laser jet printing. Presently Digital printing is the most new arrival in the scenario with extra ordinary print results and reproducibility in comparison to other printing methods available. It requires certain tailor made features on the paper to give the desired results.

All these printing processes are paper specific. Normally non contact printing method is the source of instant, quick & in plant prints industries which are now threatening the use of traditional printing process (contact printing) but printing of news paper, magazines, and the other products requiring large quantity of consistent reproduction, the confidence shifts towards conventional printing i.e. contact printing. Presently offset is the best-appreciated printing technology adopted allover the world for such kind of job.

JK Paper being the leader in quality for Surface Sized Maplitho & Photo Copy Grade Papers for last few decades in India entered in to the coated paper market in 2004-05 and introduced coated papers ranging from 130 gsm to 300 gsm in both Matt and Gloss variety meant exclusively for Offset printing. Initially, JK Paper faced a few quality issues while printing at the jobbers end such as uneven surface patchiness, surface mottling and picking while printing. JK Paper along with technical experts in this filed has taken no of initiatives to improve the quality of Coated Paper to match the demand of modern printing machines. In addition to this, JK Paper has also taken few steps in order to cater to the digital printing paper market and have performed some modification in existing products to match the requirement.

The paper highlights various Printing Process, their advantage, disadvantages and various steps taken at JK Papers towards adopting, stabilizing & optimizing the coating process to make the coated paper suitable for printing as per the demand of modern printing era.

About a decade or halfback, with the advent of electronic media with its fast and far-reaching potentiality, the print media took a step back and paved way for this seemingly invincible technology. However, the ever creativity in man did not loose time to bounce back and since then, there has been a sea change in the printing technology and its process. If electronic media could reach the mass instantly, the print media brought out the creativity, imagination, fantasy and the brilliance of thought which could create a lasting impression on the customer.

Printing is basically transfer of image from one medium to another and reproduce the original in its true form and in large numbers. The substrate can be paper, plastic, cloth, screen etc. Of all these, paper is still regarded as the major substrate and the one which brings out the best print results, close to the original, and runs trouble free while taking out multiple numbers of print is regarded as the best in business. However, the substrate characteristics, in this case paper, vary widely depending on the printing process employed. To understand the substrate characteristics one need to know printing technology and process that it is intended for.

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A. Printing Process

It can be broadly classified in to two major categories

1. Contact /Impression Printing
2. Non Contact printing

1. Contact printing

Here an inked printing plate /image carrier is used to produce numerous reproductions of an original image on paper/other substrate on which pressure is exerted to transfer the image. In this process, the image carrier/printing plate consists of two areas i.e. printing area & non-image area. Normally printing area is inked to reproduce the image while the non-image area remains clean. This mechanism of contact printing process can be further classified in to 4 major categories.

a) Letter press (Relief/Flexography)
b) Gravure (Intaglio)
c) Offset Planographic/Lithography)
d) Screen (Porous/Stencil)

a. Letter Press/Flexography- Here the image area is raised and the non-image area remains below the raised surface and the high laid area will be inked from the ink roller and transfer

Advantages	Disadvantage
Process simplicity Can print from Metal type Uses variety of presses Prints with Ink mass tone Good color uniformity through out the run Mechanical separation between Image & Non Image area Good print Quality	High cost of engravings Chances of ink trapping on multicolor presses Differential pressure requirement Thick ink in use, hence problem of poor trapping

Advantages	Disadvantage
Process Simplicity Uses Solvent type ink Less tension problems No trapping problem High speed Mechanical separation between Image & Non Image area Prints varying amounts of ink resulting in brighter colors with cheaper pigments Good color uniformity	Very High cost involvement for cylinder design. Requires very smooth surface for printing to prevent highlight skips Excess discharge due to solvent based ink use, which in to day's environment is undesirable.

to paper as per requirement. In other words, the printing & non printing areas form a geometrical profile in the Z direction on the plate surface as per need of the out put.

Letterpress is one of the oldest of the printing processes in use since 1468 AD has widest variety of printing equipment. With time, the process has been revamped to match up with the increasing demand as well as competition from other types of printing technology with respect to the plate making as well as types of ink used etc. Letter press technology has a good growth, primarily used for printing packaging cartons, packaging material for deep frozen materials, wall covering products etc. It has its own advantages & disadvantages.

b. Gravure printing-

Here the image consists of tiny wells in a plate or cylinder which holds the ink and the non image area are scrapped by a well positioned doctor blade that consists of smooth out surface of the cylinder.

Gravure also known as intaglio printing is done from recessed plates or rolls where the printing area is cut / etched below the surface of the plate or roll. During printing the engraved plate rolled up with a heavy film of intaglio or plate ink such that the ink completely fills the engraving and the excess ink is wiped out followed by polishing of the plate to remove any ink that remains on the non-printing area. The sheet of paper to be printed is saturated with water and placed over the inked plate, which is then run under the impression roll where the paper is pressed into the engraving in close contact with ink. The ink adheres to the paper and is pulled out of the engraving producing characteristic engraved impression.

This printing is widely used for newspaper, magazine supplements, magazines, mail order catalogs, cartons, printings cellophane, plastic films, foils, floor coverings etc.

A serious problem in gravure printing has been the necessity for very smooth paper to prevent skips in the printing.

c. Offset Printing/Lithography: -

Both printing and non-printing area are on the same plane but differs in their surface chemistry with respect to receptivity to ink and water.

The process is known as offset because the ink and watered plate print on a rubber blanket cylinder which in turn, off sets this ink and water impression on to the paper which is held on a third cylinder.

The ink used here is much like letterpress w.r.t viscosity. The water used is actually called fountain solution which contain special materials such as desensitizing gums, cleaners, buffering agents etc .The plate used is an aluminum plate base with a special olephillic (grease loving) coating that becomes the image area. A dedicate balance between ink and fountain solution must be achieved during printing.

There is a need of proper ink water balance, as the water or the fountain solution is transferred to the plate before

Advantages	Disadvantage
Low preparatory cost Uses a variety of press Prints on rough papers also. Both sheet fed and web fed presses an be used Easy both side application As paper is non in direct contact of printing plate, hence, reduces the wear and tear in large in comparison to others The image on an offset plate is straight reading instead of reverse thus facilitating both preparations of plate and correction errors. Good print Quality	Needs water ink balance Need for tacky ink Need for blanket Wet printing causing trapping problems, paper pilling, poor register t Comparatively high wastage generation Moisture &pH balance of paper and printing environment is very critical to avoid color variation

it contacts to the inking rollers and very little moisture is required to accomplish proper dampening on plate. Hence the amount must be properly balanced to form a continuous film over the non-printing area as a barrier against transfer of ink.

Similarly the moisture adhering to the image areas is discontinuous so it does not interfere seriously with the transfer of ink. But if too much fountain is used, its composition is incorrect or its pH value is too low, then moisture will transfer to the image are causing interference resulting quality problems in the printed image. Because of critical ink water balance, this process produces more waster than the earlier discussed letter press & gravure. But Offset has many more advantages to make up for the above disadvantages with the use of proper technology.

Over all Offset printing accounts for approximate 47% of all printing done today followed by Gravure25-27% and letterpress 15-20%.

d. Screen Printing: -

This printing technology has advanced from hand technology to fully automatic printing. Screen work can be reproduced on almost any material if the inks are formulated to meet the requirement

Here the ink is processed through a screen covered with stencil. The stencil treated photo chemically becomes porous in the printing area but remain opaque in the non-printing area.

This process is used for art prints, posters, greeting cards; program covers, printing of textiles. And it is practically adoptable when printing on leather, metal, glass, wood, ceramic materials & plastic both flat and finished molded form.

Screen printing has distinct advantages for short runs because of the simplicity of the equipment needed but for longer runs the advantages is soon lost as the other printing methods are much faster and more economical. However, for most of the applications listed, screen-printing is the only most practical process and with an over all 9% volume increase.

2.Non-Contact Printing

Here, there is no involvement of any types of plate or support material to the printing job done. The basic ingredient for this is the ink source and substrate on which paper to be printed. The rest of the printing process is carried over electronically or thermally. Major practice followed now days in this segment are photo copying/Xerography, ink jet printing and also digital printing which is slowly capturing the market.

In commercial printing segment, the trend is shifting towards web offset and also towards use of coated paper for better aesthetics & appeal. Off all the fields of printing, in general commercial field, off set printing process is the most favored one.

Some other printing which come under non contact printing segment such as copying, duplicating identified as reprography which make the basis of instant, quick and in plant printing industries that are threatening the use of traditional printing processes through methods such as inkjet printing, electronic printing & Digital printing to record various types of information such as sequential coding, marking, addressing, personalizing and computer letters. However, for printing of newspapers, magazines or others requiring large quantity of consistent production, the confidence shifts to wards the process using an intermediate plate such as letterpress.

From above discussion on basic principles of each printing technology, it can be summarized that the final print quality largely depends on followings.

Substrate i.e. paper
Ink quality
Operating conditions of printing.

The quality & operating conditions of printing can be summarized as below.

Being a paper manufacture, we are more interested to learn about paper quality parameters that affect printing quality. The general paper quality parameters that affect pint quality can be discussed as follows.

B. Paper properties

i. Physical strength of paper

During printing, paper is subjected various stress and strain of the printing process as well as subsequent finishing process to get the final product of paper to be folded, stretched or served must have sufficient strength to withstand the operation with out tearing .In case of web feeding, tensile strength of paper is

	Offset	Gravure	Flexo	Electrophoto-graphy	Ink jet
Principle					
Printing plate	flexible (rubber blanket)	hard	flexible	hard	-
Ink	tacky	liquid	liquid	powder	liquid
Ink layer	1-2 µm	2-30 µm	3-10 µm	10-30 µm	1-15 µm
Pressure	rather high	high	low	very low	no pressure
Demands on paper	smooth, good surface strength, water-resistant	very smooth, compressible	varies	smooth, electri-cal properties	absorption properties

critical.

ii. Formation

It is the measure of uniformity of distribution of fibers and fillers on a sheet of paper, more especially the fiber part. Many printing characteristics depend on uniformity in formation as printing process are designed to give an uniform impression across the printing surface.

A wild formation is the results of long fibers lumping together to produce high & low spots. During calendaring high spots take the presence of the roll and develop a polish white rest of the sheet remains dull. With too much presence of calendaring or with too high moisture of paper, it tends to became transparent & darkens in color. The sheet gets crushed & shiny at high spots leading to patchy surface. These spots do not accept printing ink readily and it does not penetrate with the paper. The ink dries slowly with a complete gloss hold out and may offset in printing.

The low spots are not calendared fully and remain as dull areas between the shiny spots. They accept ink readily & absorb it into the paper. The ink sets readily and will not offset, but because of penetration it appears flat & dull. The combination of penetration & transparency may be responsible for show through of the printing. A solid print on the paper dries with a mottled finish of glossy spots.

iii. Smoothness

Smoothness is a relative term and is closely related to the uniformity of surface. A sheet is said to be smoother than the other when more points on this particular sheet surface are more nearly in one plane compared to on surface of the other sheet. The smoother the sheet, the better is the contact between the printing plate & paper.

iv. Compressibility (Printing softness)

Softness in paper represents the ability of the sheet to compress and conforms to the shape of the printing surface under printing pressure. A soft sheet conforms more easily and takes a better impression than does a hard sheet. The soft paper does not require as much pressure to print, as does a hard sheet.

v. Porosity

Porosity of paper is an indication of the capillary action of the pores and fibers in the uncoated paper and the relation to the absorption of the printing inks. But in case of coated papers though, the porosity is too low, the absorption of ink is very high because of the capillaries formed between the particles of pigments.

vi. Opacity

Opacity is an important factor where the paper is used for both side printing. Presence of mineral fillers improves the opacity, smoothness & printing quality of the printing papers.

vii. Grit

Abrasive particle in the paper wear the plates & produce scratches during printing. In typographic printing, ink does not reach the bottom of the scratches, so they appear as white lines. Scratches in Gravure plates fill with ink & print. In off set printing, the grit may be picked up by the off set blanket and work back to the printing plate where scratches take ink & print. In case of coated paper with low water resistance, fountain solution of Off Set printing softens the coating and the blanket where they accumulate and gradually wear the plate then picks up particles of coating.

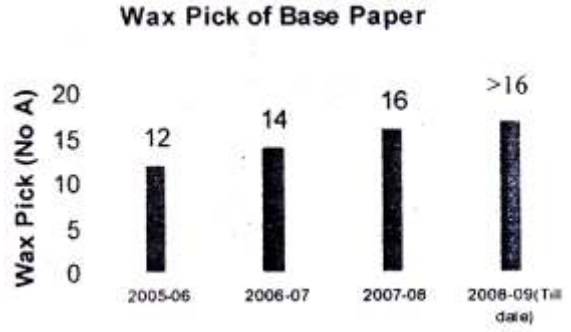
viii. Surface Strength

Surface strength of the printing paper is always important in case of all printings. Particularly in case of Off set printing, it is more important to have surface strength in dry as well as moist condition because the ink used is of highest tackiness & paper is subjected to repeated exposure to water & ink for each color printing. Generally it is measured as Wax pick value in case of uncoated papers & dry IGT pick value in case of coated papers.

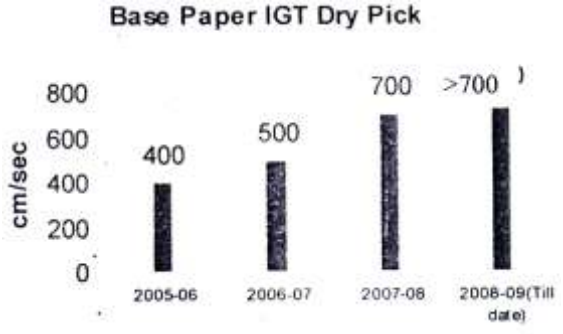
ix. Moisture

Moisture of the printing paper plays an important roll in printing. Paper gives up & takes up moisture to stay in equilibrium with the atmospheric condition. When the paper takes on moisture the edges lengthen, are wavy in the pile and are called "Loose". When printed, the image across the back edge of the sheet is wider than that across the front edge, a situation called "Fanning". In extreme conditions, a wrinkle may start at the centre of the sheet & extended to the back.

When paper gives up moisture the edges shrink & are called "tight". Paper sheet with tight edges show a baggy middle. When printed, the image across the back is shorter than that across the front & said to be "Draw in". In extreme conditions, wrinkles just back of the front edge & tend to curve towards centre. The baggy part shows smudges in the solids & exergated half tone dots. In dry weather the very action of press creates static current in the paper (due to low moisture). Static is responsible for double feeding, poor registration at the guides, hang deliveries & poor jogging in the delivery plate. If static current is present, the delivery of pile attracts the sheet & draws it down in to he pile with considerable force. The ink on the previous sheet does not have sufficient time to set properly and the force of attraction brings the two sheets to such close that the ink offsets on the back of the top sheet. If the paper contains sufficient moisture, the static current leaks off with out causing any difficulty.



Graph No-1



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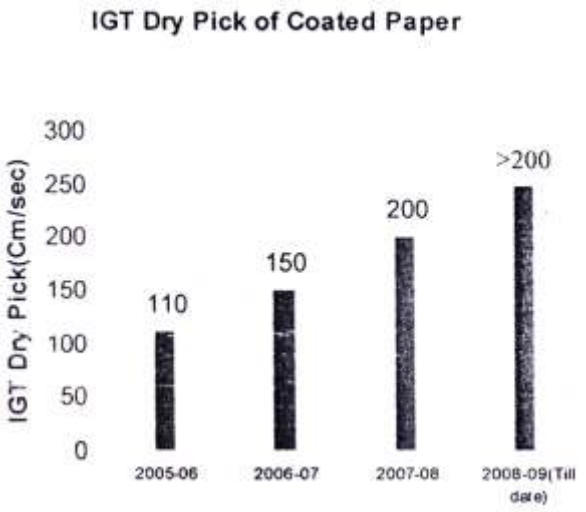

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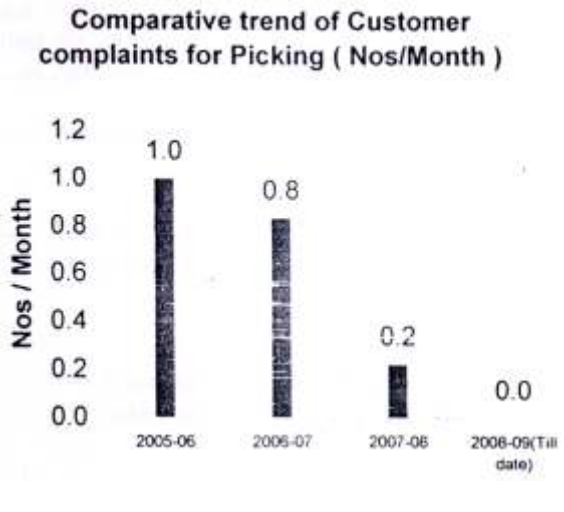


Graph No-4

Having the paper sheets to attain the equilibrium with the press atmospheric conditions is helpful in eliminating tight & loose edge.

x. Dimensional Stability

This property relates to the stability of dimension in the machine and cross direction under conditions of varying relative humidity. It also covers dimensional changes that are due to mechanical stresses imposed during printing operation. Good register between colors can be maintained if the paper has good dimensional stability.

xi. Grain

The grain of paper is also one of the major criteria to be considered during printing operation. The grain should be always lie along the length of press cylinders, as the paper is flexible in cross direction so that the sheets hugs the rolling cylinders closely other wise the sheet resists the rolling pressure as expansion in Machine Direction is less than Cross Direction.

xii. pH

Very high pH of paper around 8.5-9.0 does not give satisfactory results during off set because of its acidic fountain, which may cause following abnormalities.

Foaming
Become neutralized
Make the printing plate dirty.

Hence, it is desirable to keep the paper pH around neutral to get the best of the results.

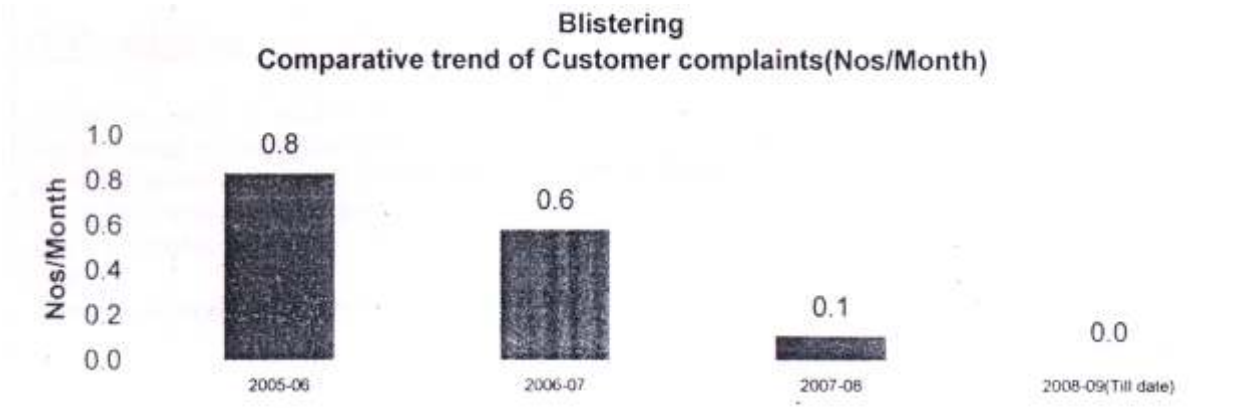
C. Experience of JK Paper Mills

J.K. Paper Mills entered into coated paper manufacturing in 2004 by installing an off line Blade Coating Machine of 100000 TPA with super Calendar. Base paper is manufactured by JKPM on one of its paper machines.

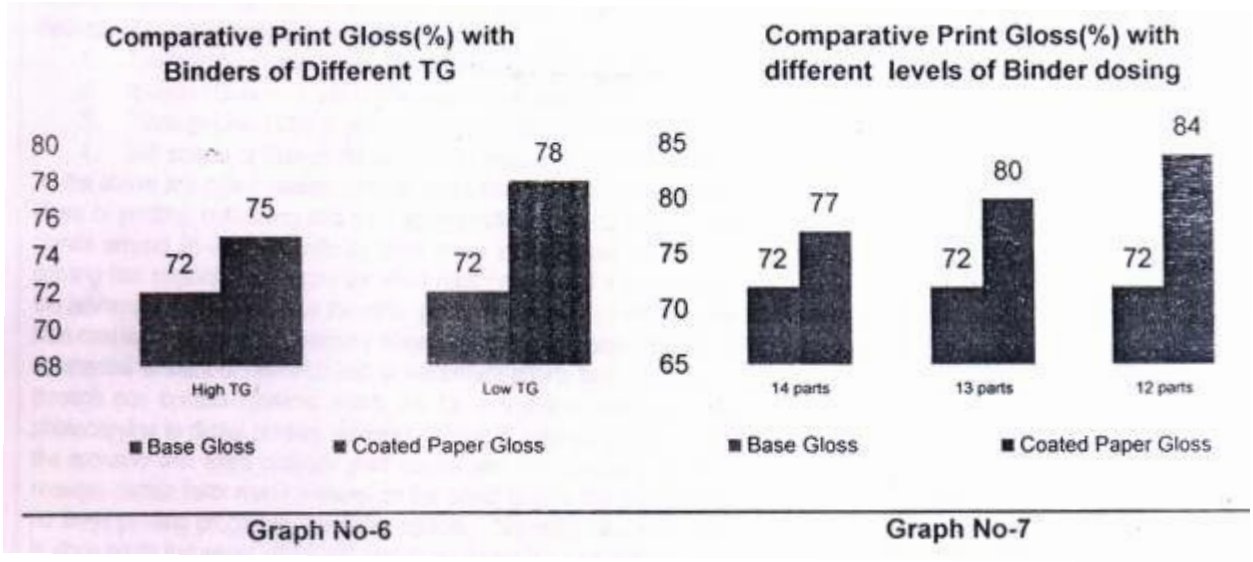
During initial production stage, the loss on account of defect, quality deficiencies etc was to the tune of 75% and the balance 25% did not fare well at the printer end on account of following problems.

a) Picking
b) Blistering
c) Patchiness / Mottling
d) Low Print Gloss

JK Paper Mill studied the problems in detail to out find the possible causes to the problems and initiated corrective actions in the following manner to eliminate those one after the other. Gradually, it developed the confidence of the printers /customers and gradually enhanced its market share. Now JKPM is manufacturing Matt, Gloss and Chromo varieties of coated paper in the range of 125 to 300 Gsm at a rate of 4500 to 5000 Mt/month with a loss of 14-15% only.



Graph No-5



Analysis of defects and action taken

a) Picking

After analysis, the probable poor causes for picking while printing are listed as Poor Surface Strength, Low Z directional Strength of the paper and presence of hard wood vessels in the base paper. On digging further in to the root for the above, we could trace following causes pertaining to above problems such as Low Refining, Poor Surface sizing and use of hard wood as the Furnish in its base paper. Based on these findings, following actions initiated at pulp mill and as well as Paper Machine area:

1) Percentage of Bamboo increased from 10/15% to 25% in the raw material to increase long fibre content in the fibre furnishes.
2) Con flow (Tri conic) refiner provided in place of Tri Disc Refiner & freeness maintained at 32°SR against 30°SR.
3) For improving surface sizing, surface sizing aid (acrylic polymer based) used in starch formulation in the size press there by increasing Base wax pick from 12 A to 14A minimum (Graph -1). By this IGT in coated paper ensured minimum 110 cm / sec.
4) Starch changed from a mixed starch combination to 100 % esterified starch there by increasing Base wax pick to 14A minimum. By this IGT in coated paper ensured minimum 150 cm / sec.
5) Later on the acrylic based surface sizing aid replaced with SMA based surface sizing aid and starch concentration increased from 6 - 7% to 8- 10% with esterified starch. Though we could get better Dry pick in final coated paper with this formulation, but continuous running of size press with such formulation was problem & we have changed to Oxidized Tapioca starch with which minimum 16A wax pick in base paper could be ensured with 200 cm/sec Dry IGT pick in final coated paper(Graph-3).
6) Drying pattern of coating process optimized with respect to IR lamp temperature, temperature of Hot air blower which in operation. With these combinations, we could comfortably manufacture coated paper with out any picking problem. The year wise trend of customer complaints for picking is represented graphically below (Graph-4).

b) Blistering

Steps taken for printing could help us addressing the blistering problem to a great extent. In consultation with experts in the coating technology, the binder quantity reduced by 20-22% which also helped reducing slip cost in addition to taking care of blistering.

The year wise trend of customer complaints for blistering is represented graphically below.

c) Patchiness / Mottling:

The patchiness / Mottling were basically due to presence of lumps, poor formation and Cross directional profile variation. For this following steps have been taken at JKPM.

1) Existing Pneumatic pressurized Head Box changed to Ractifier Roll air Pressurized tapered (Sym flow) type head box. This resulted better CD profile and good fiber & ash distribution along Z-direction.
2) Base Paper Formation has been improved further by increase in refining and increase in Ash content. Coated broke circulation in the system was optimized to maintain uniform fines content in the system.
3) Also installed ceramic tops in the drainage elements for better drainage & fibre distribution.

d) Low Print gloss

The problem was due to usage of incorrect binder quality. Binder of higher TG was resulting in low print gloss and it was changed to low TG binder improving the print gloss drastically. This was also helped us in reducing the binder quantity in formulation

D. Conclusion

There has been a rapid change in printing technology and likely to change further as well. The paper maker needs to understand the technology deeply and transfer the requirement to the paper. In JKPM, there has been a constant interaction with the reputed printers, printing technologists and also the people in this business to get an inkling of the things to emerge. Digital printing is the order of the day. JKPM has already geared up to cater this segment so that the customer does not have to look or search for other resources.

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