WRINKLES & PIPING IN PAPER REELS

By: D K Singhal
Wrinkles & Piping

- Wrinkles and piping is often a serious problem, and needs immediate attention to real cause of the problem.
- If the real cause is not detected, it is generally impossible or very difficult to remove in later stages.
- Let us evaluate some possible causes of the same.
Basis Weight Variation

- As a first look, basis weight variation seems the main reason for wrinkles & piping.
- If this is a case, this is the easiest one to identify and correct on most machines.
- Check cross direction GSM, and identify the point where it appears less than adjacent points.
- If a standard sample of 40X25cm does not show gsm variation, try checking 10X10cm samples.
Basis Weight Variation

- But, if 10X10cm profile is not showing any abnormality?
- Many a times, the piping is present is just a few centimeters width.
- You have received a reel of paper for coating, lamination printing or any other operation; so you just cannot use scanners to check more accurate CD GSM profiles?
- Use surrogate technique for this.
Basis Weight Variation

- We know that for a particular grade and lot, the opacity of paper is (almost) proportional to its GSM; at least for a small piece of paper.
- Take a 20-25cm wide CD strip of paper, and check it against light.
- Any CD GSM abnormality may get visible to you.
No Basis Weight Variation

- If you cannot detect any CD GSM variation by now, you should believe that basis weight is not a culprit for this problem.

- Think differently.
Caliper Variation

- Caliper variation could be another reason for this problem.
- Caliper variation is relatively much easier to check and correct.
- You can have a conventional LVDT based micrometer and check caliper at small intervals to identify point of abnormality.
- But in case caliper profile is also satisfactory?
GSM & Caliper

- If both GSM and caliper show no significant caliper variation, it becomes important to look for some other reasons.
- What is that?
Dimensional Difference

- Take a sheet of paper from a reel which has severe piping, and lie it down on a flat surface.
- What do you see?
- The wrinkle or piping is still present.
- If you notice closely, the waviness indicates that the machine direction length of paper is more in that particular area.
- Does that mean, the paper has elongated more in that particular area?
Elongation

- Now, make another experiment.
- Take a good sheet almost of the same size as earlier, and use both hand thumbs and fingers to stretch it locally with a little force to elongate it?
- Now lie it down on a flat surface.
- Do you notice similar wrinkles appearing?
- Try more force, is the problem increasing?
Another Experiment

- Repeat the same local elongation experiment with a polythene sheet, a rubber sheet, a cellophane sheet and a polypropylene sheet.

- What do you notice?

- In case of rubber, the problem is not there, as rubber has good elasticity, and reaches to back shape and size as the force is removed.

- Only the materials that exhibit “permanent elongation” after applying some stress and removing it, show the problem.

Permanent Elongation

- In fact, behind most wrinkles and piping, permanent local elongation is the main cause.
- There are four main reasons for localized permanent elongation, which are discussed in the forthcoming slides.
1. Applied Tension

- Quite obviously, the more tension you apply, the more permanent elongation will take place.
- It is clear from the figure below.

2. Time

- Similarly, if you apply load (or tension) for more time, the permanent elongation will be more.
- This behavior (also known as creep) is present in most materials.
- If you put a piece of paper under tension for very long duration, it does not return back to its original size.
3. Intrinsic Properties

- Some material tend to permanently elongate more under same load and load application time compared to the others.
- For example, cast iron elongates much less while gold elongates more.
- Similarly, a sheet of tissue paper will elongate much more than a sheet of surface sized maplitho paper.
4. External Factors

- Many a times, external factors alter the load elongation behavior of materials. In case of rubber, permanent elongation is less, but at elevated temperatures, rubber may elongate permanently.

- Similarly, with more the moisture it contains, the paper will elongate more compared to a dry one.
Back to Our Problem

- You might be thinking now that probably this is the reason that a reduction in paper tension results in reduced piping.

- True, but can we make use of all of the four properties to reduce the magnitude of our problem?

- I think, let us look at stress strain behavior first.
Understanding Stress Strain Diagram

Stress Strain Diagram for Paper

Tension

- It has been observed that for most paper grades, the tension equivalent to 10-20% of paper tensile strength is adequate to make good reels on rewinder.

- If you see a typical stress strain curve for paper, you will notice that the curve tends from ‘elastic’ to ‘plastic’ limit at nearly 25% of tensile strength.
Tension

- So, ensure that the tension does not exceed this value.
- Furthermore, if not done already, get your paper tested to obtain stress strain curve for your paper. Only tensile strength or breaking length may not be enough.
Tension

- If you find that ‘elastic elongation’ (which is a reversible process) is less in your paper, or even after applying smaller tension, paper elongates permanently, explore possibilities to alter the curve by-
  - Altering machine parameters (consider reduced draw, alterations in vacuum and press loadings etc.)
  - Use of specialty chemicals

You may feel you cannot do anything about time for which the stress (load) has been applied on paper.

It is just the ratio of ‘length of path of paper from one section to other’ to the ‘speed of the machine’.

Well, you just cannot practically change the paper route to much smaller, nor you can speed up the machine too fast.

Is there something we are overlooking?
On machines particularly where smooth paper is wound on reels, and there is inadequate pressure on reels through say a rider roll, there remains a possibility that the entering reel tension gets transferred to and remains inside paper reel for a longer duration.

In fact, under such circumstances, you don’t see piping while the reels are being made, but it appears after some time when the reels are completed.

It is interesting to note that a mill found that most of the wrinkles and piping problems were confined to the innermost part of paper reels.
The accumulated stress which might have increased during the course of winding of reels may reach a level much beyond the acceptable one, and when this paper is rewound, you observe problems. That shows that measurement and control of paper tension during winding extremely important.
In reels, paper remains under tension. But, the problem appears only if the tension is too high to create slippage between to adjacent layers of paper in the reel.

Reducing tension while rewinding reels immediately yields good results in most of such cases.

Increasing rewinder rider roll pressure to restrict excessive tension being transferred to and being accumulated in reels, is also a good strategy.

TNT

- A common recommendations is to-
- **Reduce the tightness of the roll by decreasing any or all of the TNT (i.e. Tension, Nip, Torque) controls or by increasing speed.**

Paper Intrinsic Properties

- Fiber orientation in different CD locations in paper, strain (elongation) developed during the papermaking operations, different drainage patterns in CD all affect the behavior of paper in subsequent stages.

- You might have observed that such problems increase when wire or felt are older.
Paper Intrinsic Properties

- But, you cannot change wire and felt too early.

- Now, the question is-

“As a paper maker, what can you do?”
Head Box

- Take a close look at the head box flow.
- A wet streak, channeling from head box slice or by foreign material deposition on slice lip may be a cause of minor CD gsm variations in paper.
- Look at the flow landing from head box to wire. An uneven landing on wire could be possibly caused by something wrong with the bottom slice lip.

From the experience, “Problem increases as wire gets older.”, what can we conclude?

As wire becomes older, its threads wear out and burrs on the sides of wire threads reduce drainage. In case there is uneven wear, drainage profile is different in different CD locations.

Try to identify and remove the cause of uneven wear.
Wire Table

- Also, check if all nozzles of showers are in good health.
- A choked shower nozzle may result in locally dirty wire and create problems.
- Locally choked suction box tops could also be another point to investigate.
Wire Table

- Some papermakers tend to maintain higher vacuum than required. Due to this extra vacuum, you get evener web dryness, but the problem of piping gets somewhat hidden.

- In such cases, try to reduce vacuum as much as possible for a short while, and hopefully you will notice the CD location at which problem appears.
Locally choked uhle boxes, or any choked nozzle in the felt shower can also be the cause of the problem.
Now, this is the area where the converter himself needs to look at the problem.

Dimensional properties of paper do get changed on changing temperature or moisture content.

If the paper reels are wound at relatively elevated temperature cool down while storage, the dimensional change may result in uneven shrinkage and hence piping.
Many operations such as water based printing or clay coating require paper to get wet and dried again. In such cases, when the paper is wetted, the tensile strength decreases drastically. Similarly, elasticity increases significantly. In the next slide, a elongation at different moisture levels is indicated for a typical case.
Effect of Moisture on Tensile Strength

Grammage 48.8 g/m², Furnish: TMP 50%, PGW 40%, DIP 10%

Effect of Moisture on Elongation

Wet Operations

- Let us consider an example of a coater with hot air impingement drying in hood.
- We may divide paper path in three different sections-
  - Unwinder to Coater
  - Coater to Drying Hood
  - Hood to Winder
- We control the tension by applying brakes only at unwinder!
You may feel that tension in unwind to coater is satisfactory, but we should consider the next two as one.

In the first path after coating, paper gets wet even while it is in tension. Under the same tension but wet condition, it enters the drying hood, where, some stresses are relieved and others are created.

But after the hood, paper is dry again, and its stress strain properties are different from those just after the coater.
Coating Operation

- So, finally it is tension applied at the initial stages that is distributed across the three stages of coating.

- The first and last stages are OK, but the middle stage is very critical.

- That is why, it becomes extremely important for you to go in for a good tension control in coating system, particularly if you are facing frequent problems of piping.

Wet Operations

- Furthermore, while paper is wet, its stress strain behavior is different, and you observe more permanent elongation even at lower stress values.
- For such applications, don’t just rely entirely on conventional strength tests which are carried in dry state, evaluate effect of rewetting and drying also.
- Consider use of some suitable wet strength additive.

Thank You.
About D K Singhal

- Born in 1968, D K Singhal is B.E., M.E. (Pulp & Paper, 1993) from Dept. of Paper Technology, University of Roorkee (now IIT, Roorkee). He is a Chartered Engineer and Certified Energy Auditor also.

- With nearly 6 dozen publications, he has emphasized on development of low cost technologies and management practices for quality and profitability improvement. With publications on energymanagertraining.com and paperonweb.com, he has been constantly contributing to IPPTA (Indian Pulp & Paper Technical Association). He is also serving IPPTA as a member of Editorial Board.

- An initiative by D K Singhal, a cyber campaign initiated against unjustified targeting of paper industry by “Idea” mobile, in their “Sirjee” advertisement campaign, after which this advertisement was taken off air.

- He also moderated a Yahoo group, “PaperTechnology” with nearly 365 members from India and abroad to discuss problems related to pulp & paper making for more than 5 years.

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