Cause and Effects of Fluting in Heatset Web Printing

Sappi Printer Technical Service

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Problem

The printed web paper exhibits a series of uniform waves in grain direction that can vary in appearance from subtle to very pronounced and rigid depending upon ink coverage, layout, and paper basis weight.

Description

Fluting is a condition which is produced in the printing process and defined as a series of waves or corrugations which run in paper-grain and web-travel direction. The problem is exclusive to web heatset printing with objectionable intensities of fluting being most evident on lightweight papers. Although varying flute levels may relax and partially flatten-out after the printed signatures are trimmed and re-acclimated to ambient environment, the condition is considered to be permanent.

Fluting intensity can vary from run to run in both amplitude (wave height) and wavelength (distance between waves). The primary and variable factors which contribute to fluting are heat intensity, ink coverage, layout, and web tension in conjunction with the basis weight and differential moisture loss/retention of the paper.

The nuance of fluting in heatset web typically becomes objectionable when one or more of the following conditions are present:

Causes

— Insufficient or excessively high heat creates differential moisture loss/retention across the web between image and non-image areas. Relative to moisture absorption and moisture loss, paper fibers expand and contract more in diameter than in length. This is why fluting is always observed in paper grain direction.

- Higher moisture loss in non-image areas results in paper fiber contraction.
- Higher paper moisture retention and/or gain (ie: ink water pick-up) in image areas results in paper fiber expansion.

— Heavy Back-to-Back Ink Coverage

- Back-to-back, top-to-bottom ink coverage seals the web on both sides in isolated areas and traps the release of moisture. In these areas, where moisture content is higher from both retained paper moisture and ink water pick up, paper fiber expansion results in higher flute levels. With no release point, the expanded paper buckles under tension.
- Spot varnish in the image areas seals the web even tighter, further negating moisture release and accentuating flute levels.

— Lighter basis weight paper with less resistance to buckling (usually 60# text or lighter) typically demonstrates a higher proclivity for objectionable fluting.

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— High web tension can adversely stretch the web creating a “shower curtain” effect.

— When dried, heavy ink film can “set” the fluting in place. Specific factors accentuating flute intensity may include:

PRESS

— Insufficient dryer heat to fully flash-off ink water pick-up.

— Excessively high dryer temperatures resulting in chill-shock and adversely dry paper.

— Lower press speeds and extended dwell time in the dryer.

— Longer dryers with extended, unsupported web leads often demand higher tension for web control. Higher tension coupled with high heat exposure, inducing significant moisture loss, can cause excessive web shrinkage, which ultimately results in fluting.

— Cold chill rolls hard-set the ink film but can also hard-set fluting to where it has more difficulty relaxing through re-moisturization, re-acclimation, and final trim.

— Higher feed rates of dampening solution may increase moisture content of the paper through transfer and absorption in the printing units while increasing ink water pick-up in the image area.

INK AND INK COVERAGE

— Heavy ink film thickness with back-to-back coverage.

— Heavy mass-tone densities with back-to-back coverage.

— Solid, spot varnish over image areas with back-to-back coverage.

— Excessive ink water pick-up.

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— Unusually high moisture content.

— Lighter basis weights.

Although there is no simple solution for the reduction of fluting, there are some common-sense recommendations, which collectively, may reduce fluting to an acceptable level. Realizing that differential moisture loss/retention across the web is a key factor in fluting, the following considerations, in order of effectiveness, may offer some opportunity:

Options and Solutions

— **Recommend creative designing to eliminate or minimize heavy back-to-back spot ink coverage.**

— **Avoid spot varnish coverage and apply an overall gap-to-gap, edge-to-**

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edge, dry-plate, gloss varnish on both sides of the web. This will help create a uniform "seal" of the web, which will minimize differential moisture loss/retention from image to non-image. This consideration will usually offer the best results.

- If an overall solid gloss varnish is not an option, **consider an overall screened varnish.** Although not as effective, it will still help create an equalized surface for moisture loss/retention. To avoid moiré patterns in conflicting screen angles, it may be best to apply a 50–60% Stochastic screened varnish.
- **Wherever possible, fill gutters in non-live, unprinted areas with solid inked imagery to more uniformly seal the web surface.**
- **Optimize dryer temperatures to press speed.** Although it's never advisable to run excessively high dryer temps, heat must be adequate to fully flash-off ink water pick-up and ink solvent. If fluting is unusually objectionable, try increasing dryer heat and compare flute amplitudes. In most cases, web temps in the 260-280° F. (127-138° C.) range should be sufficient. Beware that excessively high dryer temps also increase the risk of blister, dry/non-flat paper, excessive web shrinkage, and low ink gloss.
- **Reduce excessive web tension if possible.**
- **Run higher box temp in the first zone.** This will help reduce chill-shock and improve chill roll efficiency. Multiple zone controls on older dryers can be programmed for differential box temps to achieve the desired pre-set web temp. Typically, the first zone runs 40 – 50° F. (4 –10° C.) warmer than the second zone, and the third zone, if equipped, is used exclusively for cool-down. The dryer preset temperature should be tracking actual web temp. (Note: An excessive zone temperature differential in this configuration could make blister a concern.)
- **Remoisten the web after the dryer.** Remoisturization will help the finished web signatures stabilize through re –acclimation by giving the moisture depleted non-image areas a greater chance to reach equilibrium with the image areas. This may help flute levels relax over time. (Note: If the silicone applicator is the only method of remoisturization, decrease silicone concentration with higher water to silicone ratio. Beware that excessive remoisturization can cause paper surface "welting".
- **Minimize plate moisture whenever possible and avoid running open "wet" units.** This will minimize unnecessary transfer and absorption of moisture to the web.
- **Assure adequate chill-roll efficiency.** Incoming chill-water temp should run approximately 55° F. (13° C.) and produce a web chill-exit temp of 72–75° F. (22–24° C.). Flute levels should decrease with warmer chill roll temps. However, to assure adequate ink set, avoid chill-roll web exit temps over 78° F. (25.5° C.) as chill-pick and/or ink set-off could occur.
- **Decrease mass-tone ink densities and ink film thickness whenever possible.**

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— **Try a different production run of paper or a competitive grade of paper with same basis weight and finish.**

Although it is difficult to quantify, fluting levels should lessen over time with full re-acclimation of the web signatures (usually within 48 hours). Remoisturization will expedite this process with some moisture re-equalization between image and non-image areas. We can also expect fluting to at least partially relax when the printed piece is finish-trimmed and released from unprinted borders and adjacent non-image areas.

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