PLYBOND IMPROVEMENT VIA AN ENGINEERED STRENGTH ADDITIVE ALONG WITH SPRAY STARCH

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CONVENTIONAL APPROACHES TO IMPROVE PLYBOND FOR A MULTIPLY SHEET

• Improve internal bonding:
  - Strength additives; cationic starch in wet-end is most commonly used
  - Stronger fibers

• Improve inter-ply strength:
  - Spray starch in between plies
  - Adding strength additives along with spray starch
THE EFFECT OF PSD ON SPRAY STARCH PERFORMANCE

Corn starch granule is much bigger than filler-grade pigments, thus, unlikely penetrate into substrate using low impact spray applicator!
EFFECT OF SURFACE APPLIED STARCH ON SCOTT BOND PERFORMANCE

- Starch migration deep into the sheet favors good Scott bond performance! Starch has less charge interaction with fibers, less viscosity buildup would help penetration deeply into substrate!

- Too much migration into the sheet can hurt interplay adhesion, thus reduce plybond!

- Higher starch dosage sometime help Scott bond! (But this often results in higher costs…)

  More bonding additives migrate along with starch can help strength!
GELATINIZATION OF STARCH – BASIC REQUIREMENTS

1. Enough moisture (water)
2. Drying temperature above gelatinization of starch
3. Extended period of drying time
4. Notes that drying at “high” temperature will result in rapid evaporation of moisture can cause incomplete gelatinization; this is especially true when excessive amount of spray starch in competition with a fixed amount of water
5. When a large amount of starch is sprayed, a blend of low and high gelatinization of starch can be more effective in building strength. (That is, better utilization of sheet moisture…)
WHAT AFFECT PERFORMANCE OF SPRAY STARCH

1. Web dryness: Spray before wet line, starch tends to migrate into the sheet; Less migration when spray after wet line

2. Higher Scoot bond when sheet moisture is low as better contact between lies

3. Poor fines content between plies gives lower Scott bond, could be caused by higher vacuum dewatering

4. High enough temperature is needed to fully develop good Scoot bond. Low temperature could end up ungelatinized starch granule, which acts like a filler and reduces strength.

5. Slow drying at 10°C higher than gelatinization temperature of starch can maximize strength
1. Low solids starch slurry is spray to wet web prior to web pressing. At this stage, starch is largely distributed on the surfaces due to low impact applicator and relatively large particle size of starch granule.

2. Press section can squeeze some starch out of sheet.

3. In the drying section, when reaching starch’s gelation temperature, starch is “cooked”.

4. The cooked starch will migrate and eventually immobilize and developing binding strength.
N. CHINA CASE STUDY:
CHALLENGES TO IMPROVE SCOTT BOND WHILE MAINTAINING BULK

**Challenges:** When producing “high-bulk” FBB, mill often needs to increase ratio of NBKP and broke to ensure Scott bond performance. But this practice results in…

- 1% NBKP increase gives 13 RMB costs increase
- higher ratio of NBKP reduces bulk

**Current Practice:** Today mill add 10-15 Kg cationic dry strength resin but Scott bond performance is only marginal!!!
CASE-1

230 g/m² FBB

Target: > 130 J/m²

Furnish:
- Top and bottom ply: NBKP25% + LBKP75%
- Mid-ply: BCTMP65%, NBKP3%, Broke32%
- Speed: 720 mp
- Dosage rate: 3Kg/T
Using the same furnish, HB1303 improves plybond.

- HB1303 Trial Start
- Reducing Broke Usage
- Going Back to Original Furnish
**DPD-669**

A NEWLY DEVELOPED POLYMER FOR PLYBOND IMPROVEMENT

Proprietary, differentiated spray starch strength additive

- Spray additive to boost spray starch adhesive performance between plies to achieve overall higher board strength
- Achieves higher direct dry strength than
  - Cationic wet end starch + spray starch benchmarks
- Fiber substitution and light-weighting potential
  - Allows replacement of Kraft with BCTMP or reduction of basis weight while maintaining strength properties
- Can reach higher strengths than traditional approaches for new grade development
- FDA compliant
PLYBOND STRENGTH NEEDS TO BE ENHANCED FROM BOTH INTERFACES AND INTERNAL OF PLIES

Spray Starch + DPD-669

Starch, DSR, or/and DPD-669
LIMITATION IN SPRAY STARCH

→ A high level of spray starch does not translate into a higher level strength

Spray Starch (Kg/ton) vs. Strength, GM(ZDT*SB)

Plateau Effect!

7.6 Kg/ton
DPD-669 IN SPRAY STARCH IMPROVES PLYBOND

When spray starch performance leveling off, adding DPD-611 can continue boosting strength!

Note: Comparison is made based on 7.6Kg spray starch
### DPD 669 PRODUCT PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>DPD 669</th>
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<tr>
<td>% TS</td>
<td>15 ± 2%</td>
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<tr>
<td>pH</td>
<td>~ 3.5</td>
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<tr>
<td>Brookfield Viscosity</td>
<td>~ 400 cPs</td>
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<tr>
<td>Appearance</td>
<td>Pale yellowish liquid</td>
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<tr>
<td>Ready-to-use</td>
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DPD 669 FLOW AND HANDLING PROPERTIES

- Low viscosity DPD 669 makes excellent spray additive
- No starch agglomeration, swelling or dispersibility issues noted
- 4% Casco starch dispersion + 1% DPD 669 < 60 cPs

![Viscosity of Spray Starch Dispersions](chart.png)
Z-DIRECTIONAL STARCH DISTRIBUTION

SPRAY STARCH ALONE – DIFFUSE STARCH LAYER

1 pass, 0.3 wt% spray starch
2 pass, 0.75 wt% spray starch
4 pass, >1.5 wt% spray starch

SPRAY STARCH W DPD 669 – SHARPER INTERFACE, LESS MIGRATION

1 pass, 0.3 wt% spray starch + DPD 669, 8:1 ratio
2 pass, 0.75 wt% spray starch + DPD 669, 8:1 ratio
4 pass, >1.5 wt% spray starch + DPD 669, 8:1 ratio
DPD-669 OPPORTUNITIES - SUMMARY

• Improve plybond strength when existing spray starch is running out of steam

• Allow a high level of BCTMP in the mid-ply for improved stiffness;

• Allow use a high level of BCTMP or cheaper fibers to reduce overall furnish costs
Thank You!