Enzymatic Strength Development in OCC

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Agenda

- Introduction to Enzymes
- Enzymes in the Pulp and Paper Industry
- Fiber Modification Enzymes
- Strength development in OCC furnishes
Enzymes

- Protein catalysts
  - not used up
  - specific
- Non-living
- Reduce energy barrier for specific reactions
- Non-hazardous
- Biodegradable
Enzymes are true catalysts

- They are effective in very small amounts
  - Only a few molecules of an enzyme will catalyze the conversion of thousands of molecules of substrate to product each second.
- They are unchanged by the reaction
- The do not affect the ultimate equilibrium concentrations, but reduce the required activation energy and thereby the speed of reactions
- They are very specific with respect to substrate and reaction
Enzyme activity is influenced by several factors

- Extreme pH, temperature and harsh chemicals can denature/unfold enzymes so that they lose their activity (reversible/irreversible).
VARIABLES IMPACTING PERFORMANCE OF ENZYME

- Contact time
  - Good mixing at application point
  - More contact time better efficiency
- Temperature
- pH conditions
- Interfering chemicals
  - Oxidants
Enzymes in the Pulp and Paper Industry
Pulp & Paper’s Use of Enzymes

- The P&P industry, in general, has been fairly slow to accept enzymes for many uses.
- ROI vs. Cost was not significant
- Enzyme manufacturing methods
  - Monocomponent vs. mixed enzymes
  - Raw enzyme costs
- Now, the industry is looking to these types of products
Current Paper Industry Enzyme Applications

- Deposit control
- Stickies control
- Pulp pre-bleaching
- Pitch control
- Boilouts /cleanups
- Starch conversion
- Drainage
- Deinking
- Charge control
- Fiber modification
Examples of Enzyme Uses

- Proteases - microbio & biofilm cleaning
- Amylases - starch system boil-outs
- Esterases - stickies control
- Lipases - pitch control
- Cellulases - fiber modification
- Xylanases - bleach reduction / brightness increase
- Pectinases - charge reduction increase
Fiber Modification Enzymes
Refining Model

- Cellulase degrades cellulose in fiber wall structure, initiates wall stripping & fines generation
- Refining then delaminate cell walls and cause cell wall to collapse and starts fibrillation which provides the strength of fiber with more bonding sites
Fiber Fibrillation During Refining

- Create microfibrils on the fiber surface through fiber wall delamination.
- Fibers flatten or collapse and micro-compressions are induced.
- Fiber breaks result in decrease in fiber length distribution.
Enzyme Treatment

Relative Strength vs. Applied Energy

- Blue line: Untreated
- Green line: Enzyme Treated
EFFECT OF BEATING ON PULP PROPERTIES

Increase in Value
- Breaking Length
- Burst Index
- Double Folds
- Shrinkage
- Density
- Air Resistance

Decrease in Value
- Tear Index
- Opacity
Fiber Modification Enzymes

- Working with a broad variety of enzymes.
- Working primarily with relatively “pure” enzymes.
- This enables us to tailor products to various circumstances.
- Still in the experimental stages for most applications
Enzymatic Fiber Modification
Current Target Applications

- Strength modification
- Improved softness
- Drainage improvements
- Vessel segment modification
- Opacity variation
- Porosity changes
- OCC Ring Crush Improvement
Strength Development in OCC
Laboratory Data: Mill A

- **FIBER:** 100% OCC
- **GRADE:** Linerboard
- **GOAL:** Increase ring crush
- **METHODS:**
  - Enzyme treatment of 1, 2 and 3 lb/ton
  - Duration 45 min at 140 °F
  - Prepared 3 gram TAPPI handsheets
Tensile Index (Nm/g)

- Control (Blank): 2.0 lb/ton BLX-13090
- 1.0 lb/ton BLX-13090: 29
- 2.0 lb/ton BLX-13090: 33
- Bubond 387 6#/ton: 31
Laboratory Data: Mill B

- **FIBER:** 100% OCC
- **GRADE:** Linerboard
- **GOAL:** Increase ring crush
- **METHODS:**
  - Enzyme treatment of 2#/ton for 1 hour at 55 °C
  - Refined for 2500 revolutions in a PFI Mill
  - Prepared 3 gram TAPPI handsheets
OCC RING CRUSH

Ring Crush Vs Enzyme Treatment

- Control
- Buzyme 2522
- XP04-487W
- XP04-562W
Case History – Mill A

- Grade: Kraft packaging (bag and sack)
- Furnish: OCC/DLK
- Fourdrinier: 1200 fpm
- Production: 100-140 tpd
- pH: 7
- Temperature: 130 – 140 °F
Case History – Mill A

- Additives
  - AKD: 2 lb/ton
  - Fixative: 0.5 lb/ton
  - PAM: 1 lb/ton

- GAP: Reduce DLK usage and supplement with OCC

- Critical Tests: Mullen
Case History - Application

- **Product**: BLX 13090
- **Dosage**: 1 lb/ton
- **Feed Location**: pulper
- **Contact time before refining**: 1 hour
Results

- Increased Mullen
- Increased drainage
- Eliminated DLK usage

Reduced tear, which was negated by:
  - Reduced refining energy applied
  - Tear was brought to spec without negating the increases in Mullen
Thank you

Any Questions?