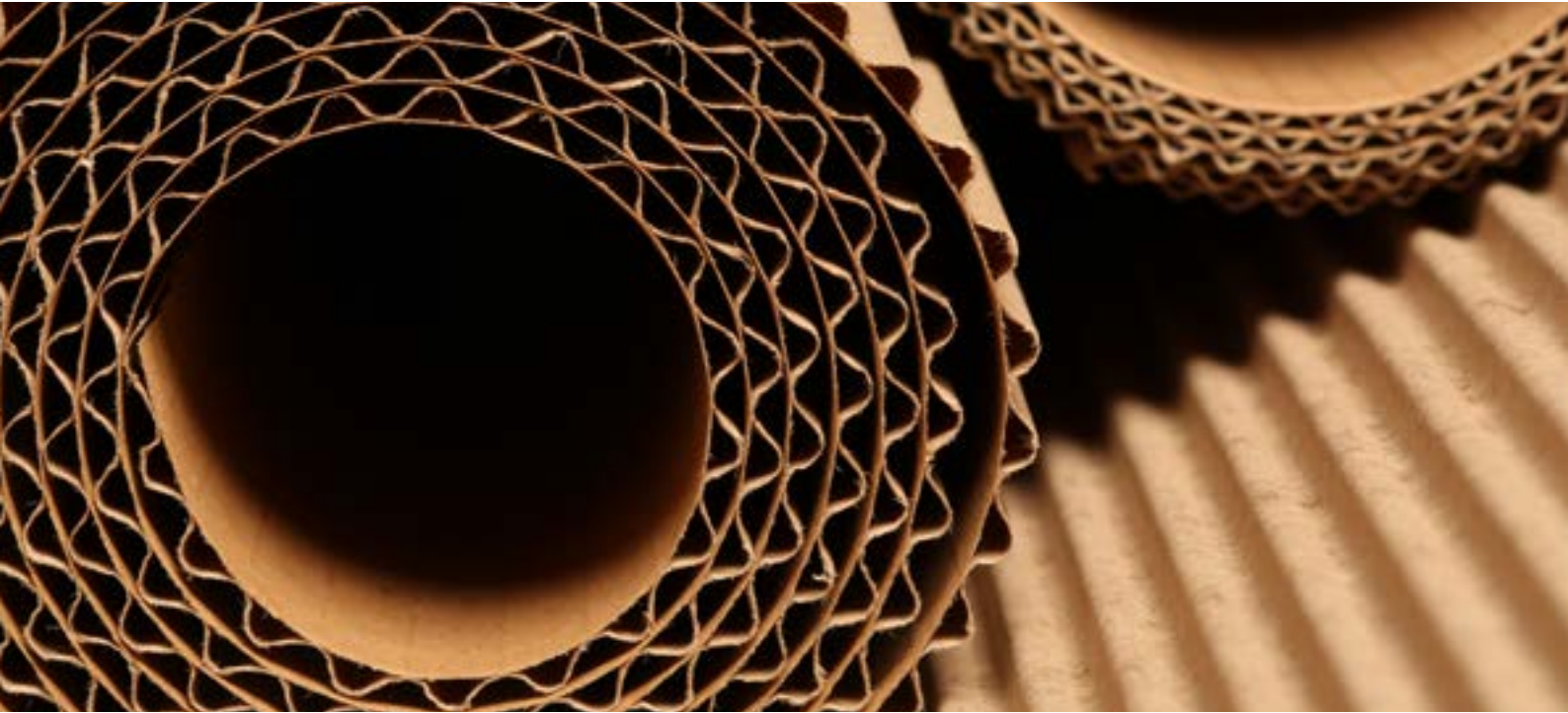




Ingredion[®]

Be what's next[™]



Ingredion's Specialty Modified Starch Solutions



Competitive Paper Production

In the highly-competitive paper-making industry, success is largely reliant upon cost savings, quality-focused solutions and production efficiency. Paper production strength is a key concern, and increasing environmental awareness concerns have led to the need for less wastage, together with a requirement for quality at a lower cost.

Starch Functionality

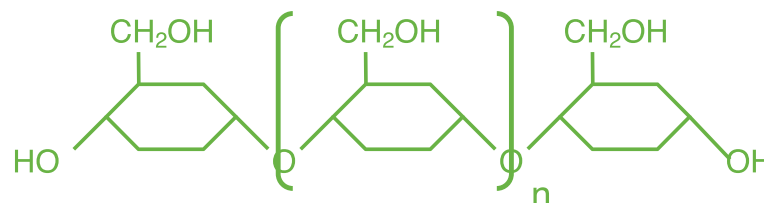
As starch and paper cellulose essentially share the same DNA, starches work very well to bond with fibers. The main function of wet end starches is to provide paper strength. With improved paper strength, manufacturers can create better grades of paper, or use it in place of more expensive fibers.

Modified wet end starches provide dry strength improvement, especially amphoteric starches, which carry a dual charge for better charge balance in the wet end system. Wet end starches reduce total production costs by having better reactivity, higher machine speed and chemical costs optimization, which could possibly lead to a lower total starch consumption.

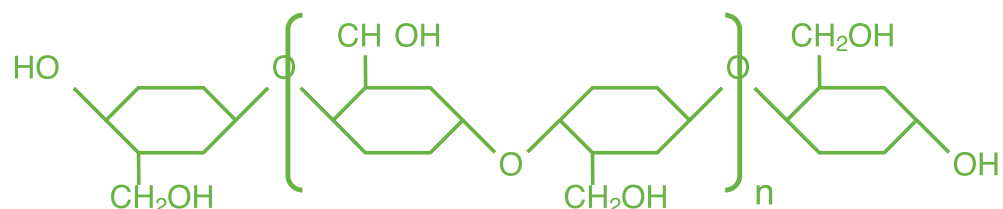
Since wet end starches are a natural polymer, they also provide retention of fibers and chemicals within the wet end system, as well as improve the drainage of the wet end system in the paper machine during the manufacturing process. This improved retention and drainage allows for less down time and increased machine efficiency.

Wet end starches are also able to replace synthetic polymers and resins. With the current trend that emphasises eco-friendly options and heightened environmental awareness, this also works in favour of manufacturers, as more consumers are looking out for the green movement logo when they purchase paper products.

Starch:
-1,4 linkage



Cellulose:
-1,4 linkage



Ingredion's Specialty Modified Starch Solutions

Our specialty wet end starches promote dry-strength development, allowing for reductions in total production costs without sacrificing performance. This means extra savings and efficiency improvements for your papermaking operations.

What can Ingredion's range of wet end starch solutions help you achieve?

- Boost incremental paper strength, chemical retention and drainage
- Replace synthetic polymers or resins with our nature-based ingredients
- Ability to substitute more expensive fibers with lower-cost alternatives
- Increase the efficiency of your chemicals
- Improve production capability by reducing machine downtime
- Reduced production costs
- Fewer paper breaks and less down time
- Higher machine efficiency

Amphoteric Starch Advantages

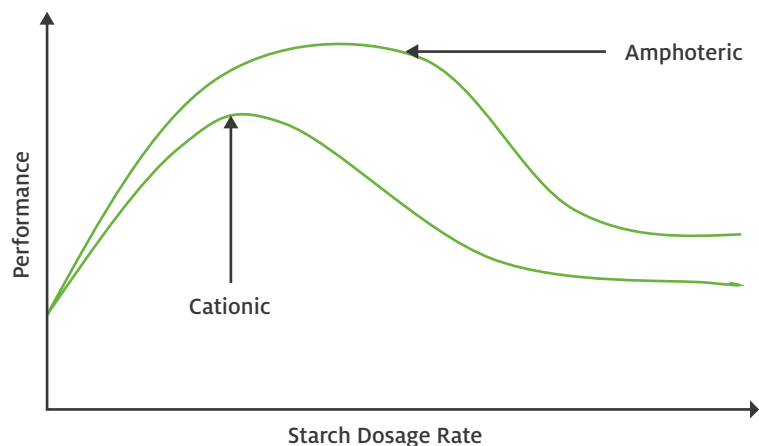
Cationic starches are a single-charge modified starch. The maximum dosage is in the range of 15-20kg/MT, and exceeding that will lead to over-cationization of the wet end system, resulting in poorer machine performance. This in turn causes lower paper strength, an increase in chemical usage and costs, poorer retention and drainage, and even higher water treatment costs.

In comparison, dual-charge modified amphoteric starches prove to be a significantly superior option. Being dual-charged means they are able to stabilize the charge, and achieve an optimal system charge level, which then allows the dosage to increase to a maximum of 25-30kg/MT, which is in accordance to industry guidelines. This means attaining marked improvements in the three key components - better paper strength, better retention and better drainage.

Therefore, amphoteric starch has the advantage to replace cationic starch by 50% less the dosage of cationic starch. To illustrate, you will only need 8 to 10 kg of amphoteric starch to replace 20kg of cationic starch to achieve the same effect.

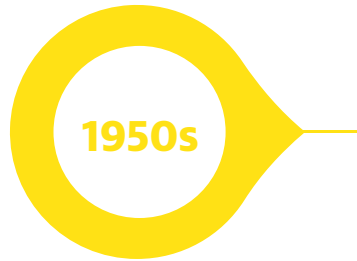


Amphoteric Starch - Better Control of Wet End Chemistry



| Product Series | Features | Benefits | Application |
|------------------------|--|--|--|
| CATO® | <ul style="list-style-type: none"> • Nature-based, green chemistry • Mid end performance • Good reactivity | <ul style="list-style-type: none"> • Replace synthetic resins • Good strength provider | <ul style="list-style-type: none"> • Mid end corrugated board • Moderate anionic system |
| UNIPLUS™ | <ul style="list-style-type: none"> • Nature-based, green chemistry • Mid to high end performance • Specifically made to suit customer's requirements | <ul style="list-style-type: none"> • Replace synthetic resins • Suitable for neutral to alkaline systems • Optimise overall chemicals' usage • Strength and drainage to system • Charge balance | <ul style="list-style-type: none"> • Mid to high end corrugated board • Closed water loop system • Moderate anionic system |
| OPTIBOND® | <ul style="list-style-type: none"> • Nature-based, green chemistry • Highly reactive • Robust chemistry | <ul style="list-style-type: none"> • Replace synthetic resins • Suitable for acid to alkaline systems • Cost savings with fibre substitution • Strength, retention and drainage • Excellent charge balance | <ul style="list-style-type: none"> • High end corrugated board • Closed water loop system • Highly anionic system |
| FIBERBOND™ PLUS | <ul style="list-style-type: none"> • Nature-based, green chemistry • Unique processing chemistry • Superior reactivity | <ul style="list-style-type: none"> • Replace synthetic resins • Suitable for wide pH range • Strength provider • Superior charge balance | <ul style="list-style-type: none"> • High end corrugated board • Highly anionic system • Challenging wet end conditions |
| REDIPRO® | <ul style="list-style-type: none"> • Nature-based, green chemistry • Enhanced ready to use additive • High reactivity polymeric density • Liquid polymer | <ul style="list-style-type: none"> • Excellent stability, no cooking facility required • Low to moderate addition rates • Productivity and strength aid • Fibres, filler and fines retention • Wet-end additive efficiency and simplification | <ul style="list-style-type: none"> • Specific corrugated board requirement • Challenging wet end conditions • Highly anionic system |

Ingredion's development of Amphoteric starch

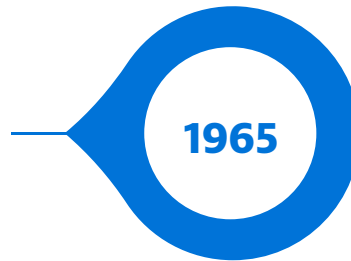


Cationic starches commonly used in paper machines for strength only

- CATO® 304, CATO® 306, CATO® 308

National Starch (now Ingredion) filed landmark patent for Amphoteric starch

- Able to replace 100% cationic starch with only 50% consumption resulting in significant costs savings
- Better fiber retention and dewatering or drainage



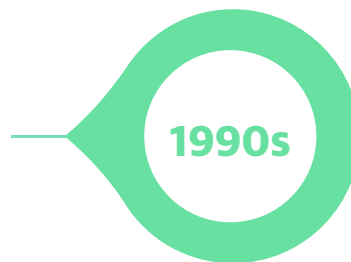
With the Amphoteric starch patent, National Starch (now Ingredion) promoted APAC's wide adoption of Amphoteric starches in combination with Alum dosage

- CATO® 3210



Developed better, performance enhanced products to meet market needs

- CATO® 3200 (low alum systems)
- CATO® 3250 (mid alum systems)
- NATIONAL™ 52-3429 (high alum systems)



An era of growth of high-speed paper machines, high conductivity system and more challenging wet end conditions

- OPTIBOND® series
- OPTIPRO® series
- UNIPLUS™ series
- FIBERBOND™ PLUS

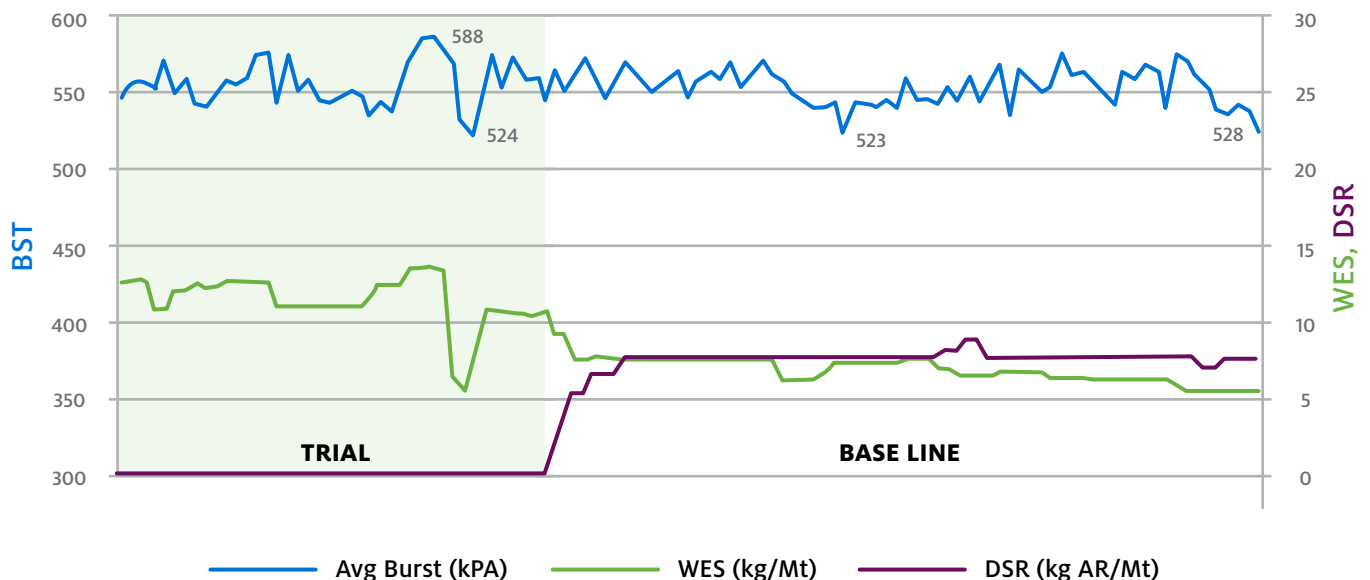


Case study 1 – Customer Cost Savings

Paper Grade: Kraft Liner and Testliner
Machine Speed: 400-600 m/min
Furnish: AOCC, DOCC
Basis Weight: 150-200 gsm
Chemicals: Alum, DSR, ASA, Retention Aid
Objective: Total chemical costs savings

| Kraft Liner 200gsm | Units | Base Line | Trial |
|--------------------|------------------|-----------|-------|
| Speed | mpm | 500 | 500 |
| Bursting Strength | kPa | 554 | 557 |
| RCT | N | 333 | 337 |
| Internal Bonding | J/M ² | 320 | 332 |
| OPTIBOND® 3920 | kg/MT | 7 | 11 |
| DSR | kg/MT | 8 | 0 |

The above table demonstrates the cost savings made possible to the customer in the process of manufacturing Kraft Liner paper using a 3-ply fourdrinier machine.



- BST is maintained while the chemical cost is lower during the trial phase

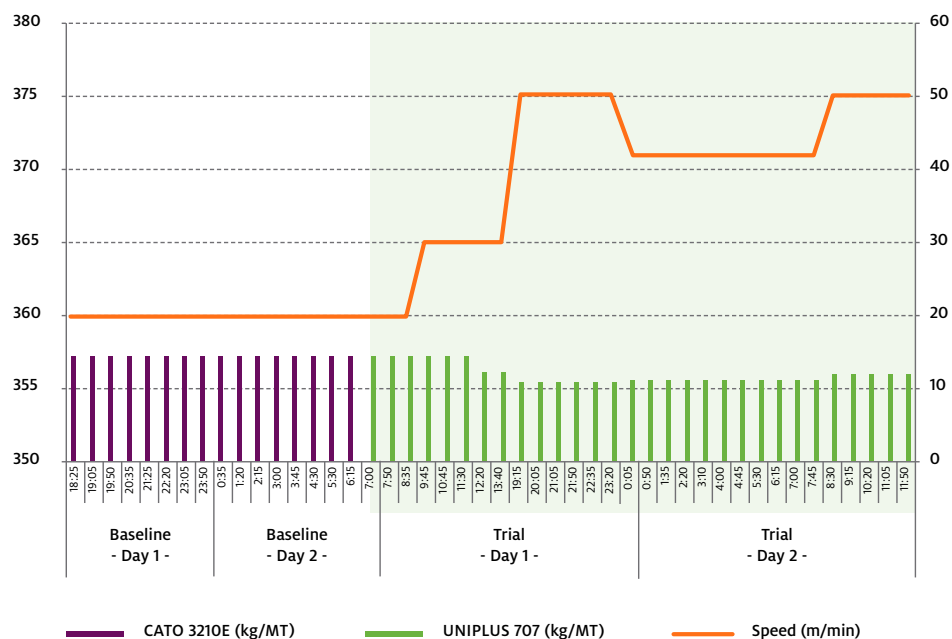
The Ingredion solution: with the use of 11kg of OPTIBOND® 3920, it becomes possible to eliminate 100% DSR dosage of 8kg, while achieving a similar bursting strength. This creates the equivalent of 20% cost savings for our customer in terms of chemicals consumption.

Case study 2 – Improved Productivity & Paper Strength

Paper Grade: Corrugating medium
Machine Speed: 350-450 m/min
Furnish: LOCC and Mixed Waste
Basis Weight: 125-150 gsm
Chemicals: Alum, DSR
Objective: Improve productivity and costs savings

| Corrugating Medium CM 150 | Units | Base Line | Trial |
|---------------------------|--------|-----------|-------|
| Speed | mpm | 360 | 375 |
| Production | MT/day | 228 | 245 |
| CMT | N | 280 | 288 |
| RCT | N | 210 | 210 |
| CATO® 3210E | kg/MT | 15 | 0 |
| UNIPLUS™ 707 | kg/MT | 0 | 12 |

The graphs below illustrate the improvement in both productivity and paper strength in the process of manufacturing corrugating medium using a 1-ply fourdrinier machine



The Ingredion solution: with the use of 12kg of UNIPLUS™ 707 and a corresponding 20% less wet end starch consumption, we are able to create an increase in speed by 15mpm to 375 mpm and achieve better Concora (CMT) while maintain Ring Crush (RCT), which translates into a significant five-digit cost savings per month for our customer.

Ingredion has what it takes to help you differentiate yourself from industry competitors in terms of product innovation, quality and consistency.

Get in touch to learn more.
apac@ingredion.com

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