MaxxLink® Resins for Corrugated Board – A Primer

2018

MCTRON TECHNOLOGIES

The **evolution** of solutions™

MCTRON Values

MCTRON Technologies is a *service-oriented* specialty chemical company with a broad range of products. We support these products in our customers' mills with our experienced technical support team.

- **MCTRON** values the opportunity to serve our customers.
- We believe that offering the most competitive, innovative and flexible solutions creates our value in the market.
- **MCTRON Technologies** adhesive products are designed to meet the specific requirements of our customers.
- **Let MCTRON Technologies raise your expectations.**

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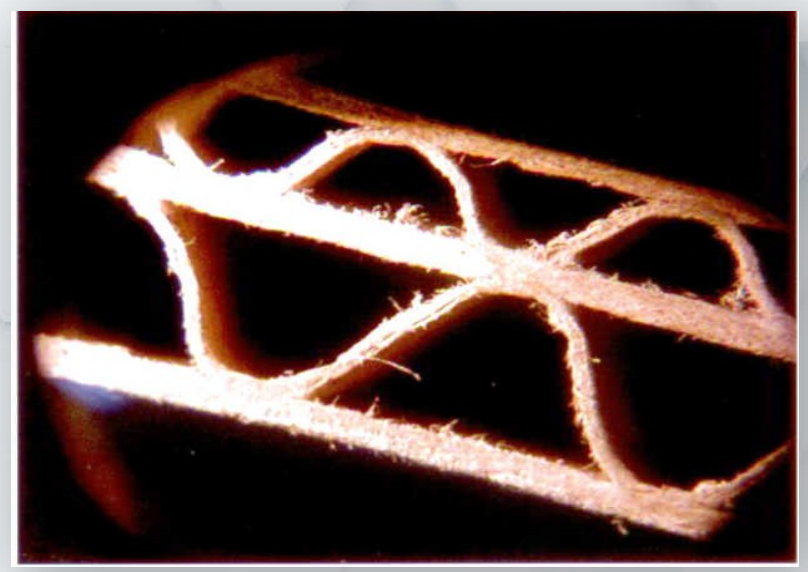
Corrugated "bonding points"

The strength of corrugated board depends on the strength of its bonding points:

- Glue formulation
- Type of starch
- Temperature
- Glue penetration
- Running speed



The quality of the bonding determines the final strength of the corrugated board.

Water Resistance

Starch glue, even if prepared properly, is water soluble.

Starch glue weakens in a humid environment.
In water, the board loses its strength until a total separation occurs.

Quick test: 1.4 minutes

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Water Resistance

Water resistant corrugated board is required in a variety of industries:

- Foods and beverages
- Frozen foods
- High humidity areas
- Tobacco
- Fruits and vegetables
- Flower packaging
- Outdoor storage
- Hi-Tech consumer products

Water resistance is advisable when there is exposure to a wet or humid environment at any stage of handling from plant to consumer.

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Water Resistance

The level of water resistance required from a corrugating adhesive varies depending on the application.

There are three levels of wet strength adhesives:

1. **Moisture Resistant Adhesive**
   Used for the least demanding applications
2. **Water Resistant Adhesive**
   Used for medium level of performance
3. **Water Proof Adhesive**
   Used for highest level of performance

Quick test: 6.1 minutes

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Green Bond + High Speed

The first corrugating machines appeared at the start of the 20th century.

The typical corrugating machine is:

- 100-150m long
- 2.5-5 m wide
- Running speed 200-360 m/min
- Fully automatic kitchens with high viscosity starch
- Glue solids are 25-32%

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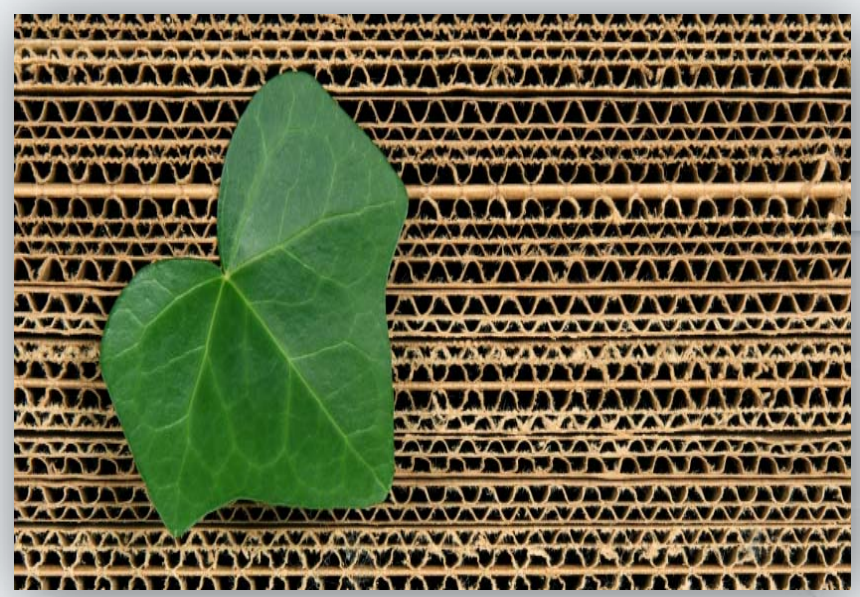
Green Bond + High Speed



MaxxLink has the lowest free formaldehyde levels in the industry

In many cases the running speed is limited by insufficient glue tackiness (green bond).

This green bond limit can be observed by the opening of the edges of the board – side delamination.

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Green Bond + High Speed

In order to prevent side delamination, we can decrease the corrugator speed. The result is lower productivity and line efficiency, and higher costs.

Side delamination can be overcome by increasing the tackiness of the wet glue, leading to better bonding that will allow working with higher speeds.

Thus productivity and line efficiency increase, and costs decrease.

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Additives

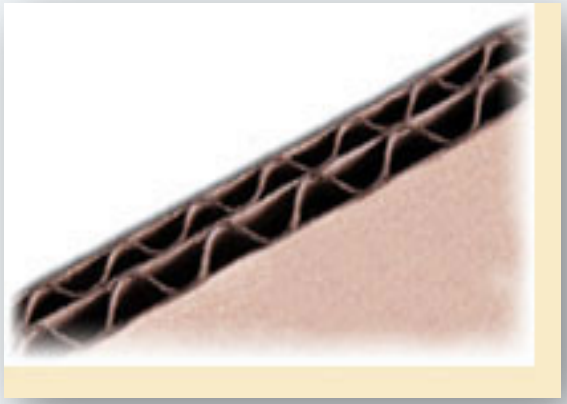
Additives - Compounds added to starch based corrugating adhesives that change and improve certain properties like water resistance and green bond.

We will discuss three kinds of additives:

1. **Green bond** *(PVOH Solutions)*
2. **Water resistance** *(Acetone Formaldehyde Resin)*
3. **Additives which impart both water resistance and green bond** *(Blended Products)*

Green Bond Additives

A group of synthetic polymers specifically designed to produce early green tackiness.



These synthetic polymers are film formers and possess a high concentration of polar chemical groups which cling to the cellulose of the board by hydrogen and physical bonds.

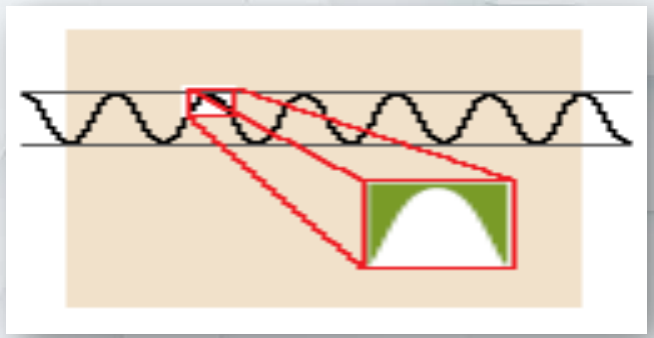
The strong bonds allow higher running speeds with less waste, and accelerate production.

Water Resistance Additives

Starch has been used as adhesive raw material for corrugated boards since the beginning of the industry.

Glue lines on corrugated board

The adhesive is applied on the tip of the fluting. After it dries it is hygroscopic and easily dissolved in water.



Water Resistance Additives

In order to incorporate water resistance in the dry starch adhesive, a thermosetting resin like ketone aldehyde is added to the glue (MaxxLink® 5000).

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Mechanism of Water Resistance

Water resistance is achieved by a cross linking reaction between the starch and the resin, in which a grid of covalent bonds is formed.

The grid is formed after gelatinization of the glue. This chemical bond is stable in water, and thus the glue acquires water resistant qualities.

The reaction is dependent on temperature, pH, and other parameters.

Mechanism of Water Resistance

Dry Starch Adhesive is water soluble
Resin is water soluble
Dry Starch Adhesive + Resin + pH >11 + temp 120°C =
Polymer which is insoluble in water

Optimum results occur after a required stacking period of 4-24h.

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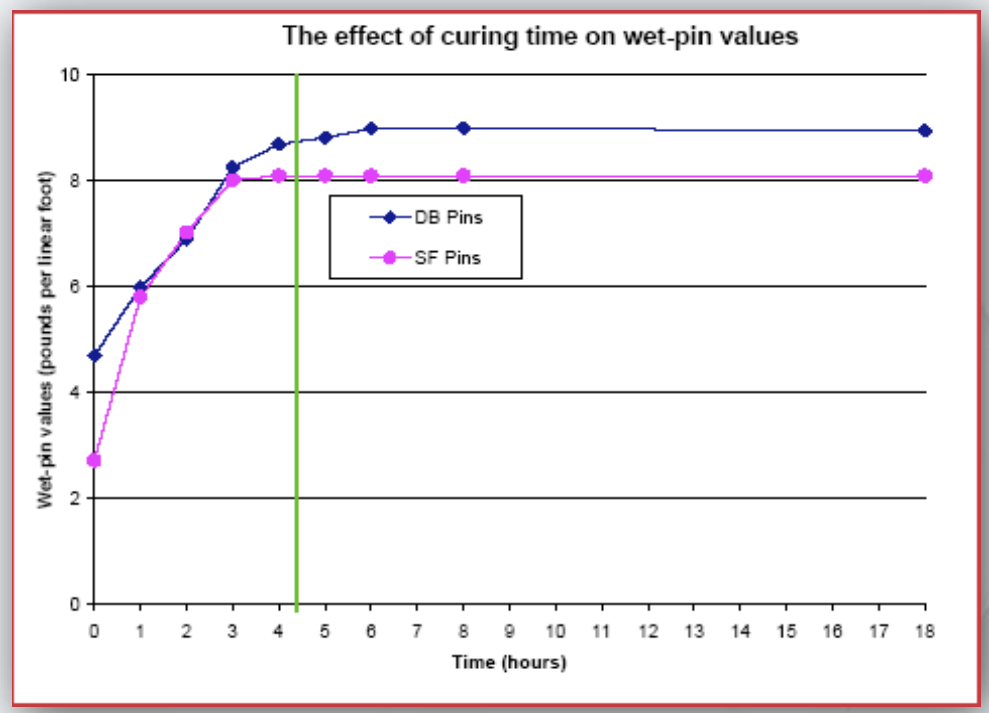
Mechanism of Water Resistance

Curing Time



This graph shows the results of wet-pin tests of stacked, wet-strength samples at various time intervals. It is clear that cooling stacked board too soon doesn't allow the bond to develop its water-resistant potential.

A corrugated board glued with adhesives containing ketone aldehyde resins needs to cool at least 4 to 5 hours to develop its final optimum mechanical and water resistance properties.

Cooling the stack with fans earlier than 4 or 5 hours can reduce water-proofing properties.

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Mechanism of Water Resistance

The Ketone aldehyde resin (MaxxLink 5000) reacts with the starch in an alkaline medium, the reaction starting at ~ 90^{O}C, and is completed at higher temperatures.

In starch adhesives with water resistant resins, the amount of KF Resin should be ~ 2% of the starch. (depending on the solid % of the resin that is being used)

Incorporation of ketone aldehyde resins might increase the glue surface tension and can effect penetration. This can be overcome by adjusting the borax and/or lowering viscosity.

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Mechanism of Water Resistance

Viscosity Effect

Stable viscosity is an important factor in obtaining a high quality board.

Often, when resins are added and properly stirred, viscosity drops a little bit, and then rises.

If viscosity drops too much, it can be elevated by altering the glue formulation, either by changing the ratio between the compounds, or by increasing the starch content.

Mechanism of Water Resistance

Viscosity Effect cont.

In order to maintain stable viscosity of the adhesive with additives like MaxxLink 5000, it is recommended to stir for five minutes every half hour until use.

When using MaxxLink 5000, the optimum results are achieved with starch adhesives containing 20-28% of dry solids.

Tests

Wet box crush test (BCT)

Wet pin adhesive test (PAT)

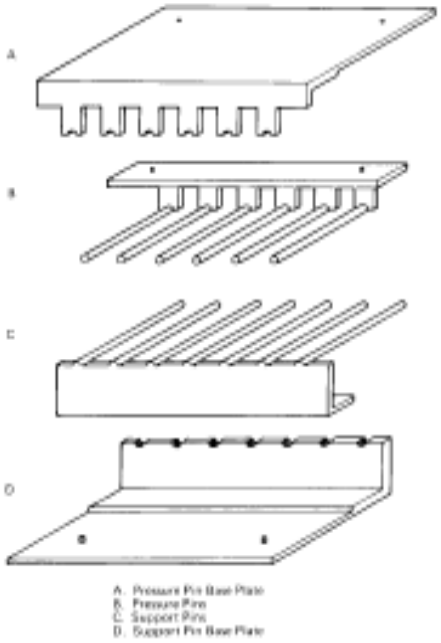
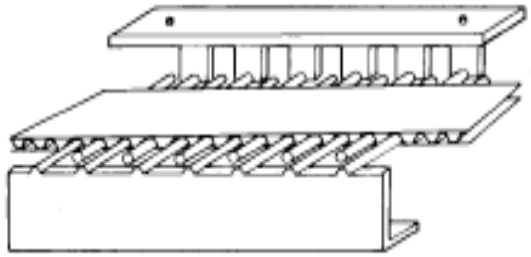


Fig. 1. Test apparatus before assembly.



Pressure Pins (Top) and Support Pins (Bottom)

End View of Pressure Pins and Support Pins

○ Pressure Pins

● Support Pins

Fig. 2. Pins inserted in a specimen.

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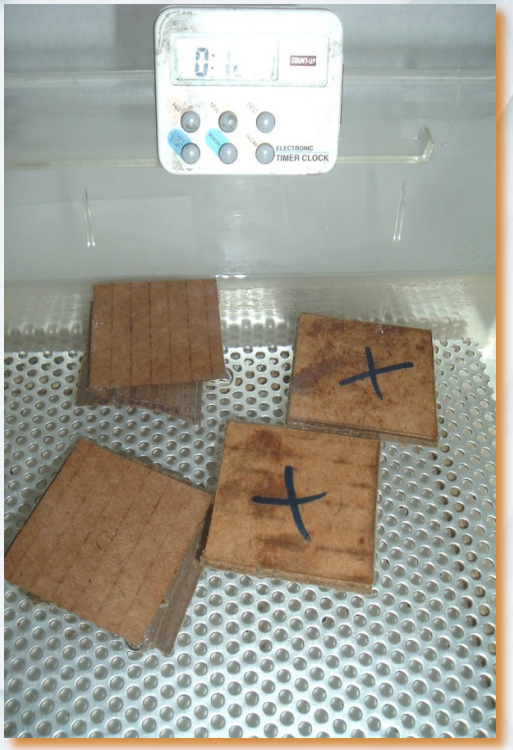
Tests

Quick test - quick testing of the water resistance of corrugated board.

Soak a piece of cardboard in water at 50°C.
The results relate to the time needed for it to open by itself with just a touch of the hand.

Opening period	Resistance Evaluation
up to 3 min.	no resistance
3-5 min.	low resistance
5-10 min.	medium resistance
over 10 min.	very good resistance



Quick test: 12 minutes

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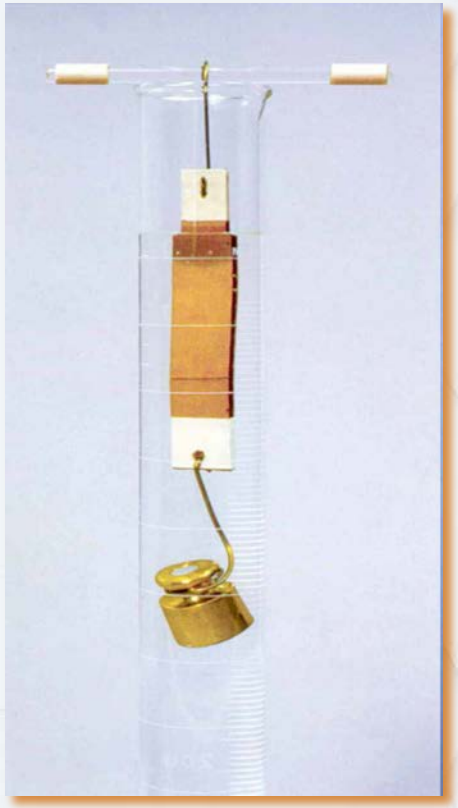
Tests

FEFCO No 9

The water resistance of the glue of corrugated fiberboard is measured by the length of time during which a predetermined combination of glue lines, immersed in water, resists the pull of a suspended weight in the plane vertical axis of the board, at a right angle to the glue lines.



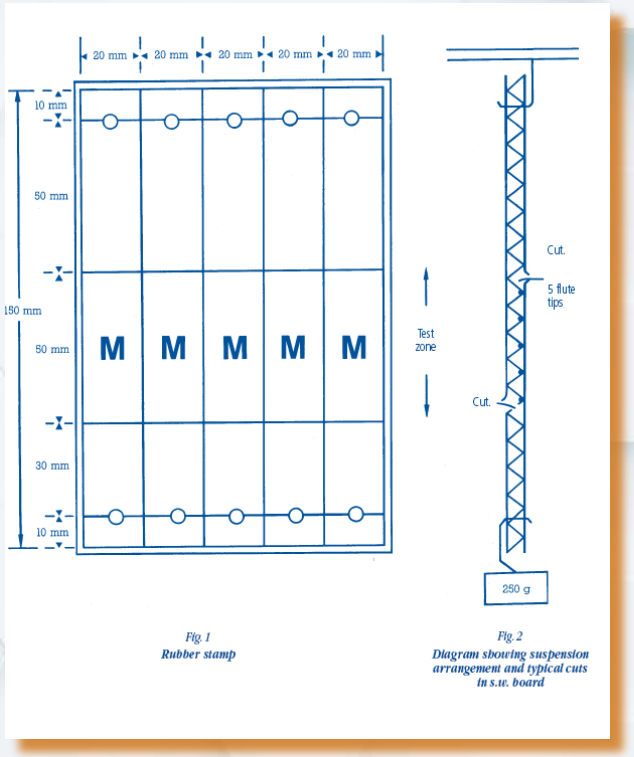


Fig. 1
Rubber stamp

Fig. 2
Diagram showing suspension arrangement and typical cuts in s.w. board

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Types of Additives

By application:

Water resistant (MaxxLink XL-5000 or XL-4000) - different levels of water resistant according to resin concentration. Curing time 4-24h

Green bond (MaxxSpeed 18) – increasing tackiness of the glue to allow higher speed for the corrugator.

A combination of water resistance and green bond (MaxxLink XL-8020) - incorporate water resistance and high speed.

- **Reduce curing time for optimum results**
- **Early or immediate converting**
- **Green bond increase**
- **Running speed increase**

Types of Additives

By appearance:

Liquid – Can be applied at the kitchen or at the line. Exists in different concentrations from 40%-60% solids (MaxxLink 4000 to MaxxLink 6000)
To ensure a uniform distribution of the resins in the adhesive, even with slow rotating mixers, it is recommended to pre-dilute the higher concentrated resins.

Powder:
MaxxLink OBM – Can be dry blended with starch to create dry mix (OBM – one bag mix).
MaxxLink DB - Can be applied by mixing with the ready adhesive.

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Types of Additives

free formaldehyde:

An important issue in considering additives and resins is the free formaldehyde remaining in the product.

International standards for amount of free formaldehyde in the working environment of the corrugators:

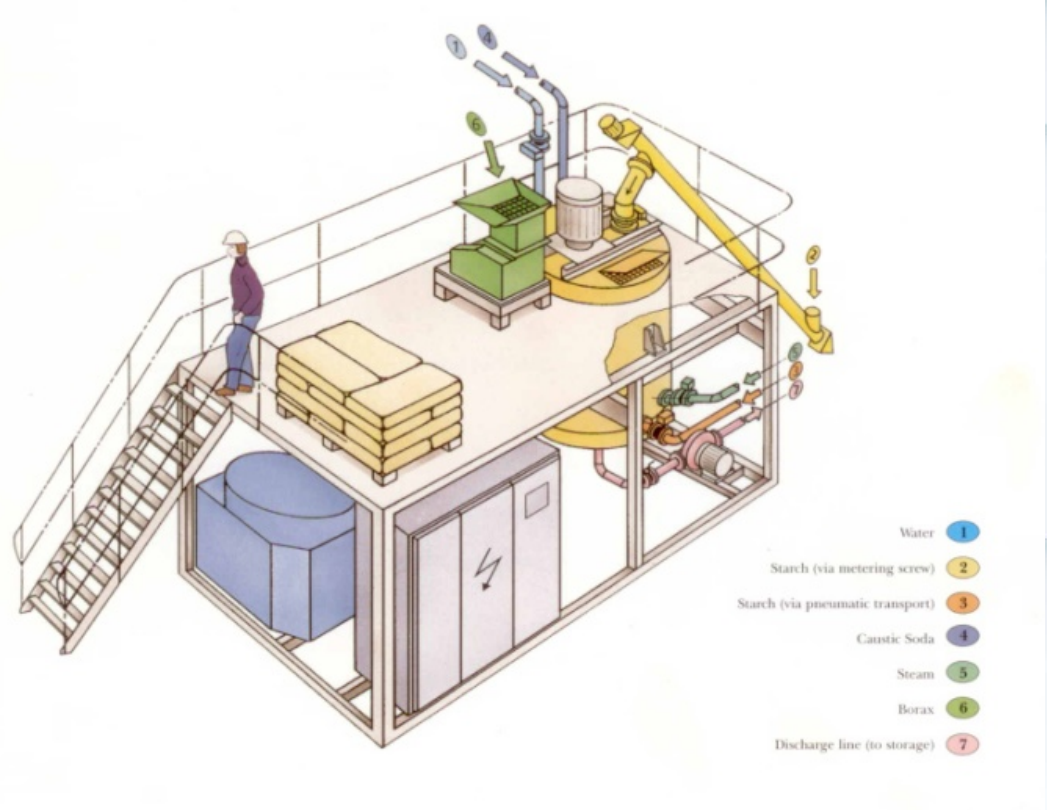
- **ACGIH – American Conference of Governmental Industrial Hygienists**
- **OSHA – Occupational Safety & Health Administration**
- **German standard**

International standards for amount of free formaldehyde in packaging that is in direct contact with food:

- **FDA applications (per Regulation 21 CFR 175.105)**
- **EEC directive**

Types of Additives

In order to meet the limitations, producers have lowered the free formaldehyde in the wet strength resins from 0.3% to <0.1%



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Waterproofing Resins and Bond Enhancers for the Corrugated Board Industry

Resin is used in starch adhesives to improve their water resistance. Below is a chart that gives the typical levels of 50% resin needed to achieve the various water resistant adhesive grades…

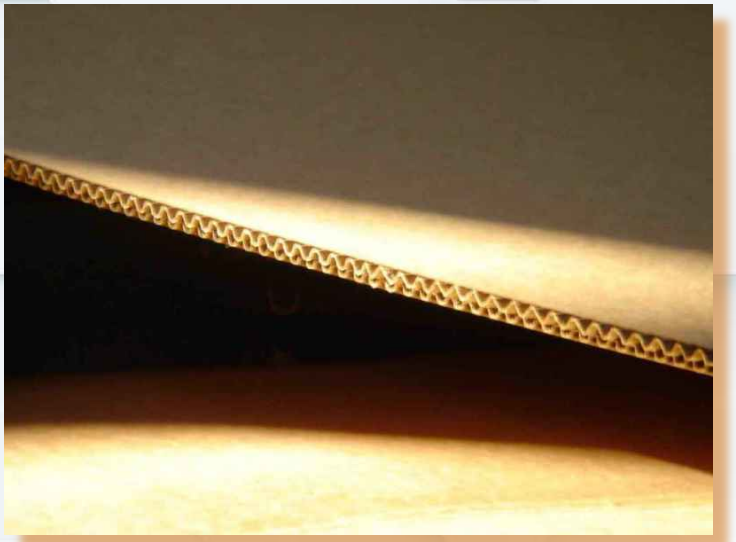
WR Standard	Percent	Soak Times
MRA	0.8 to 1.0	1 hour soak
WRA	1.0 to 1.2	3 hour soak
WPA	1.5 to 1.7	24 hour soak

MCTRON Corrugating Products

McTron offers a broad range of resins, polymers and additives for corrugating

Products

- MaxxLink Resins
  - Water Proofing Resins
  - Liquid Borate
  - Bond Enhancers
- MaxxSpeed
  - Green Tack Additives
- MaxxSurf
  - Penetrants
- Maxx Coat
  - Wax Replacement Coatings
- Maxxetate & MaxxVol
  - PVAc & PVA Adhesives
- MaxxBond
  - Dextrin Laminating Adhesive



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Cost

The cost of the resins and additives is ~1$ per 1,000 m^2 of corrugated board. This cost is recovered by gaining:

- **Improved board quality**
- **Waterproof board**
- **Increased green bond, allowing higher running speed**
- **Higher efficiency and less waste**

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MaxxLink® Products

MaxxLink XL-4000
- 40% solids KF resin

MaxxLink XL-5000
- 50% solids general purpose KF resin

MaxxLink XL-6000
- 60% solids KF resin

MaxxLink 7200
- 72% solids KF resin
- Wide solids range available

MaxxLink XL-8020
- 55% solids bond enhanced resin

MaxxLink XLB-3000

MaxxVol PVOH Bond Enhancers

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MaxxLink® KF Resins

Not all KF Resins are the same

Use of low cost fillers will result in lower wet pins

- Test for total nitrogen

Methanol Content (a Poisonous VOC)

- MaxxLink is the lowest VOC KF resin available in the market

“Formaldehyde Free” resin

- No such thing as a “formaldehyde free” ketone formaldehyde resin
  - (A pear contains 60 ppm of free formaldehyde)
- Formaldehyde can be checked down to less than 1 ppm.
- All products have a detectable level depending on analytical method.
- ***Zero Formaldehyde*** traditionally means ***not detected***.
- **All MaxxLink products are *certified under 1000 ppm***

MaxxLink KF Res

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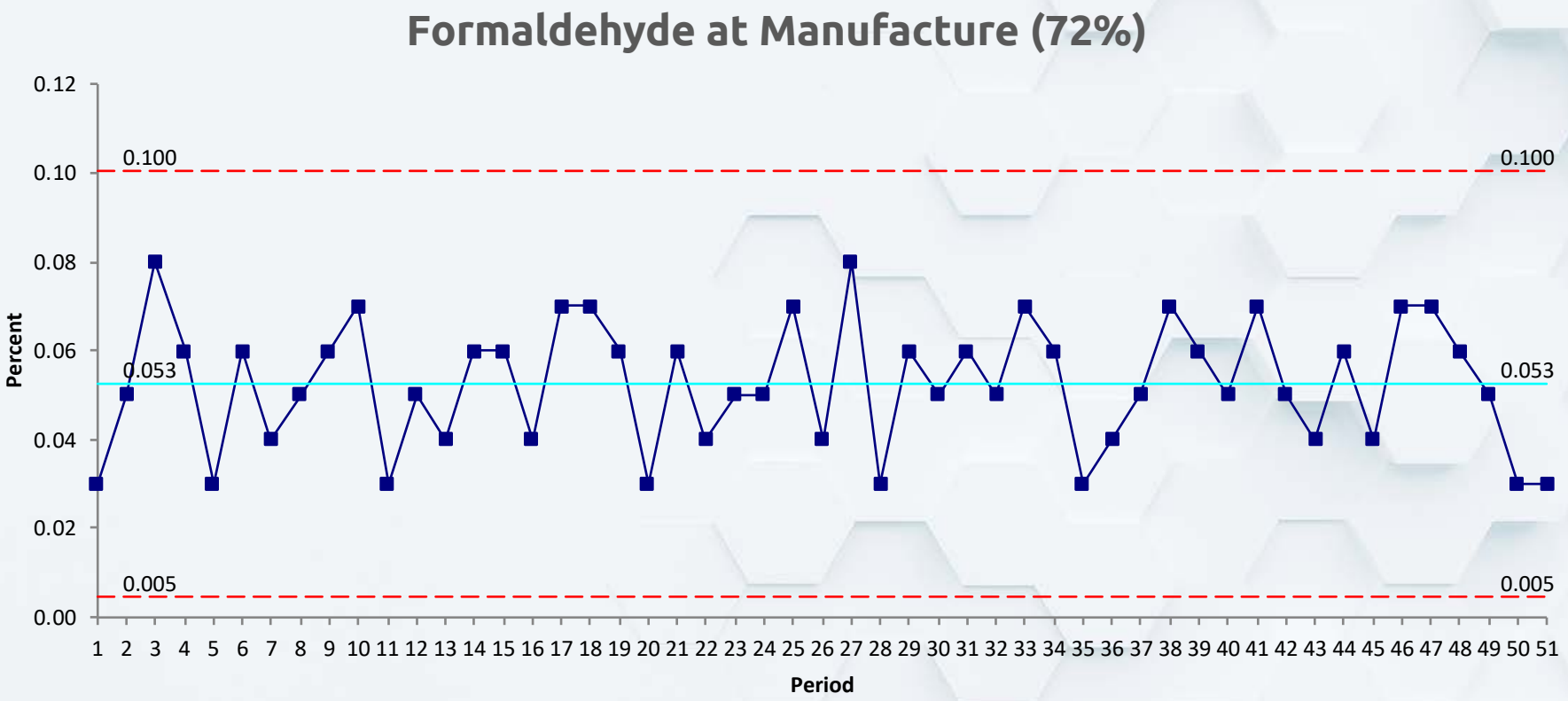
MaxxLink® 7200 KF Resin

Formaldehyde Levels



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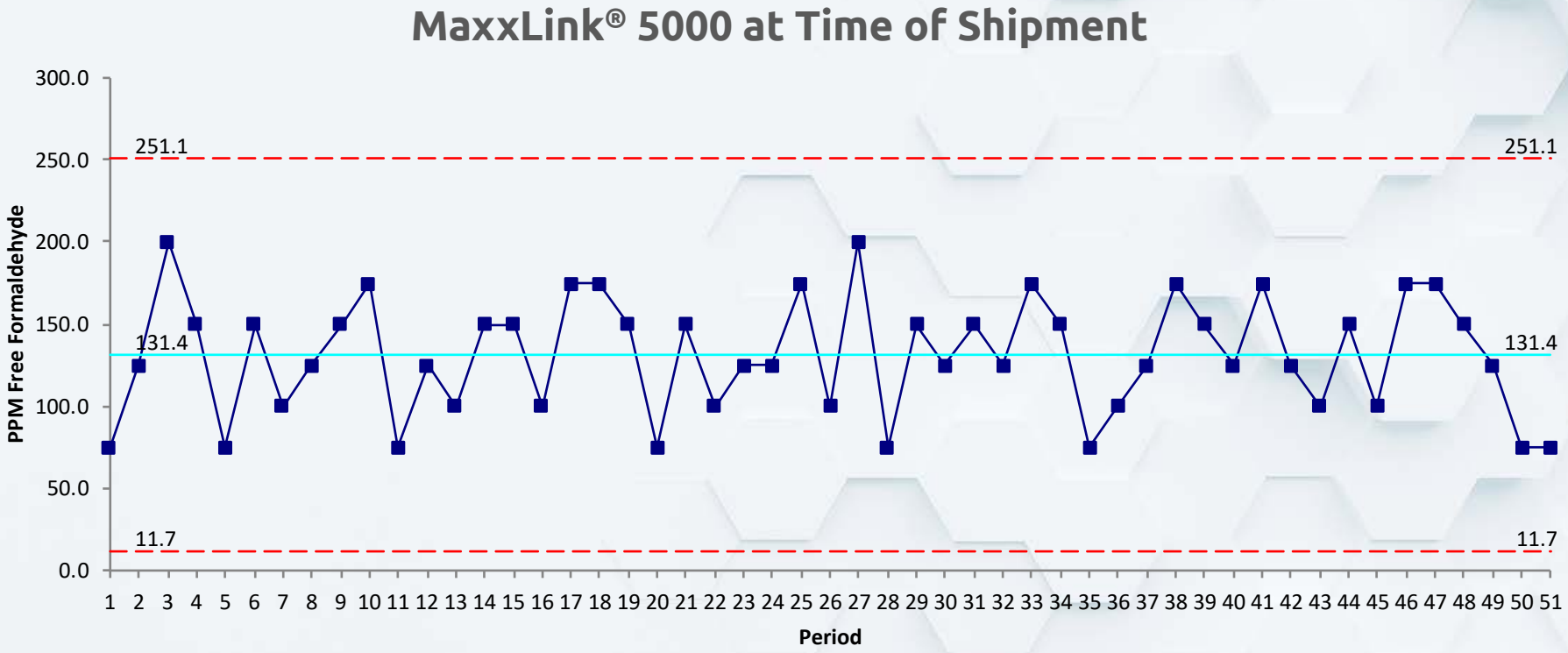
MaxxLink® 5000 KF Resin

Formaldehyde Levels



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MaxxLink® KF Resins

- **MCTRON** is committed to supplying resin where all the solids content comes from active waterproofing chemicals. It will not contain low cost fillers. You will see better wet pin adhesion.
- **MCTRON** is committed to supplying resin with the lowest methanol levels in the industry using our new process technology.
- **MCTRON** is committed to certifying formaldehyde levels as <1000 ppm on all shipments. We invite having our numbers confirmed by outside test labs.

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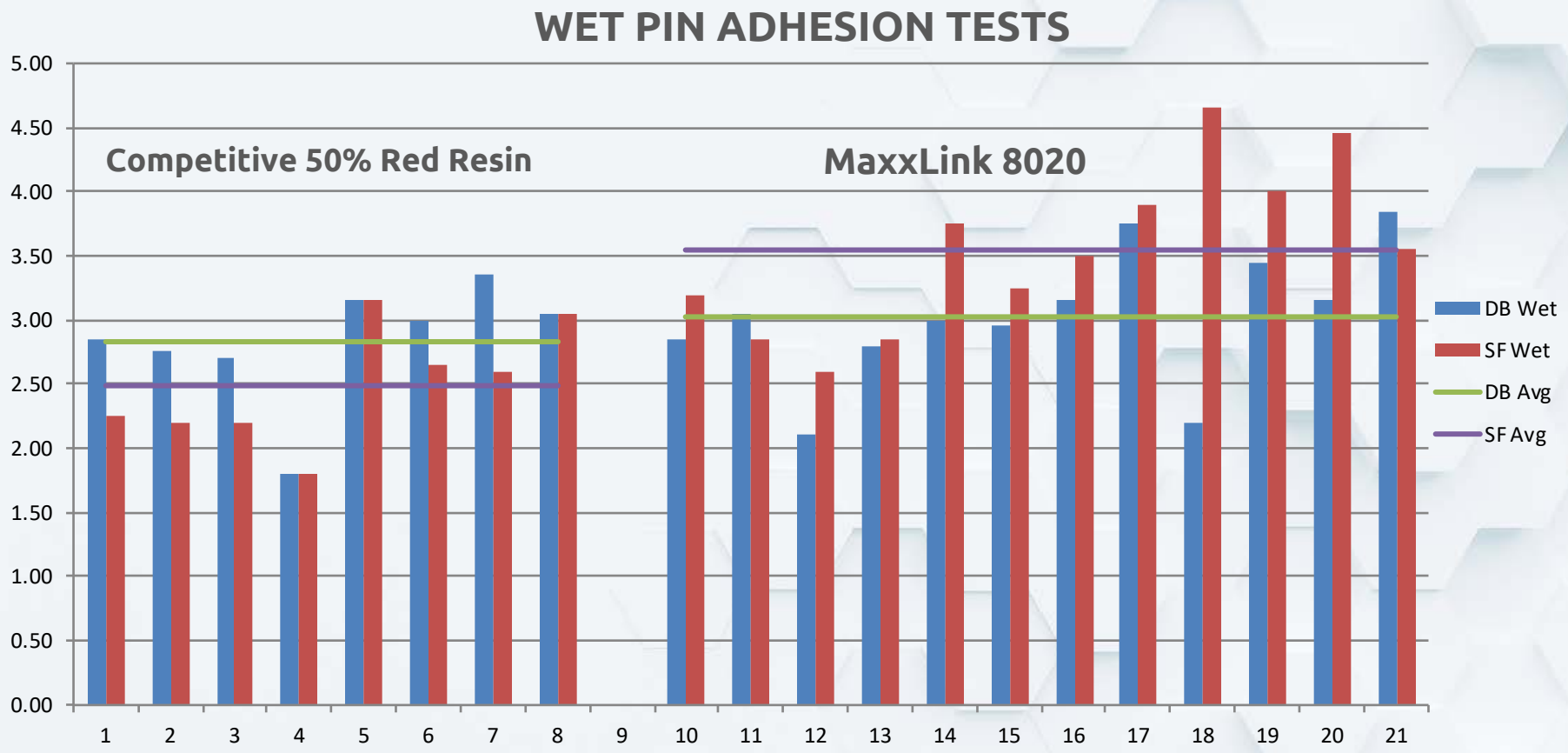
MaxxLink Bond Enhanced Resin

MaxxLink 8020 Wet Pin Data



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MaxxSpeed®

- **MaxxSpeed 15** is a ***green tack*** additive solution designed to improve machine speed.

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MaxxSurf®

- **MaxxSurf P70** is a high solids penetrant used to improve bonding to hard to wet surfaces.

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MaxxCoat®

MaxxCoat WRP Series Coatings Provide

- The ultimate in repulpable/recyclable water resistant coatings
- Low Cobb Values
- Surface Tension for good:
  - Gluing
  - Printing
  - Slide Angle

MaxxBond & Maxxetate Adhesive Products

MaxxBond DLA

- A dextrin laminating adhesive

Maxxetate

- Polyvinyl acetate adhesives

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MCTRON Business Model

- Responsive product development
- Multiple chemistries
- Focused on technology development
- Market oriented
- R&D at most production sites
- On-site QC
- Excellent financial position – Strong raw material position
- Experienced degreed technologists
- Protected Intellectual Property

Quality Management System

- Mutually agreed upon specifications
- Proven QC Test Methods
- C of A as a “Contract” between us and customers
- Management of change protocols
- Quarterly SQC Charts
- Regular Employee Training (records)
- Internal audits of our manufacturing sites

Safety & Environment

- MCTRON is focused on “Green” chemistries development
- New Thermosets Resin Technology
- Low VOC alternatives
- Strong Safety Programs

No lost time incidents ever!

Why Choose MCTRON?

- We offer **customized solutions** to our customers.
- We are committed to creating **sustainable value**.
- We strive to **exceed customer expectations**.
- We provide solutions and service that offers **competitive advantage** for our customers.
- Our people offer **market knowledge** and understand customer needs.
- We are **open, flexible and collaborative** and provide the best products and service possible.