Chemistry is critical to building effective barrier coatings and paper structures

Rob Beyersdorf, Vice President, 22 October 2024

Water-based chemistry options

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- Emulsion polymers are a broad range of high molecular weight polymers, all of which have various degrees of hydrophobicity.
  - Polymer family are thermoplastic (‘amorphous’), while manufacturers like MCP are working to build thermal dimensional stability (and recyclability) and crystallinity (Oxygen barrier?)
- Styrene Butadiene polymers have been utilized for over 40 years within paints, coatings, building/construction products, and traditional graphic paper coatings. These polymers provide superior MVTR and water resistance.
- Styrene-acrylic emulsion polymers have been used in graphic arts for decades (inks and coatings). In barrier coatings, this polymer family provides balance between water resistance and oil and grease resistance while having excellent runnability on flexographic and size presses.
- Pure acrylics have excellent OGR performance, but carry the highest cost of the emulsion polymer family of products.
- Vinyl Acetate homopolymers and copolymers provide heat sealability, reasonable cost, and good runnability.
- Note: Other water-based polymers are also important to barrier properties. These include EAA dispersions, wax dispersions, starches and other natural binders.

Technologies available: impact

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- Styrene Butadiene (XSBR)
  - Carboxylated and non-carboxylated (pre-crosslinked)
  - Tg -70 to +80
- Styrene Acrylic (SA)
  - Self crosslinking, crosslinkable
  - Tg -45 to +100
- All acrylic (PA)
  - Self crosslinking, crosslinkable
  - Tg -25 to +90
- Resin Supported Emulsions: Wide Tg range on a supported system
- Vinyl Acetate Ethylene (VAE) latex: Tg -15 to +30
- Natural binders (not thermoplastic, generally)

Properties to explore for paper

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- Water resistance
- Moisture vapour transmission rate (MVTR)
- Oil and grease resistance (OGR)
- Oxygen barrier
- Application runnability (flexography, size press, on machine coating, off machine coating, curtain coating, etc.)
- Food contact compliance
- Recyclability
- Compost ability
- Heat seal
- Others?

Properties to explore: XSBR

- Water resistance: Hyrdrophobic monomers—styrene, butadiene, ethylene. Styrene-butadiene copolymers are best.
- Moisture vapour transmission rate (MVTR): Hydrophobic monomers, low surfactant concentration, high styrene for orientation, excellent film formation: Styrene-butadiene copolymers with film formation best.
- Oxygen barrier: film formation critical, torturous path for O2 can be developed, crystallinity (PVdC is best, but unacceptable)

Note: Excellent water resistance and film formation can create challenges for machine runnability and recyclability.

Properties to explore: Acrylics

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- Best for Oil and grease resistance (OGR): High acid is best, but can create food contact compliance challenges. Acrylate esters create excellent OGR performance. This must be measured with actual oil, not KIT.
- Application runnability (flexography, size press, on machine coating, off machine coating, curtain coating, etc.) can be built in.
- Recyclability can be built, sometimes using the correct base.
- Heat seal properties can be controlled somewhat by controlling to overall molecular weight.

Properties to explore: VAE

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- OGR properties are generally positive.
- Application runnability (flexography, size press, on machine coating, off machine coating, curtain coating, etc.)
- Recyclability: Historically, vinyl acetate polymers can create challenges in paper mill broke systems.
- Compostability: Vinyl acetate is susceptible to pH degradation and has poor water resistance.
- Heat Seal properties are positive, while all chemistries heat seal properties are based on temperature and dwell time.

Formulations, coating layers, etc.

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- The polymer chemistry is only part of the story.
- The stabilization system used for the emulsion polymer will be critical to the overall performance.
- Formulation know how and problem solving is critical to support application methodology, film formation, recyclability, etc.
- Inorganic content can be critical, and the polymer's ability to 'interact' with the inorganic material will determine final performance.
- Providing some renewable carbons will always be a benefit.
- Consideration for every coating layer is key to making paper work.

Sheet structure is a key approach

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- The paper stock is the place to begin: smoothness, porosity, water resistance, thickness, basis weight, etc.
- Size press coatings can create the best substrate to assure fold crack resistance and coating hold-out. (polymer + starch)
- Inner layers can focus on MVTR and Oxygen barrier, therefore the optimized binders can be selected (XSBR, platy pigments)
- Outer layer can be built for heat seal and anti-blocking in the roll. This can include acrylics, EAA dispersions, VAE latex
- Note: The entire structure has to enable recyclability.

Make Paper work: Tykote Latex example

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- **Tykote 1004**: S/B with excellent water resistance and moisture vapor barrier.
- Typical range of values (neat latex; base stock dependent):
  - *30-minute Cobb Size:* <5 gsm
  - *Jungle MVTR (38° C/90% RH):* 125-225 gsm

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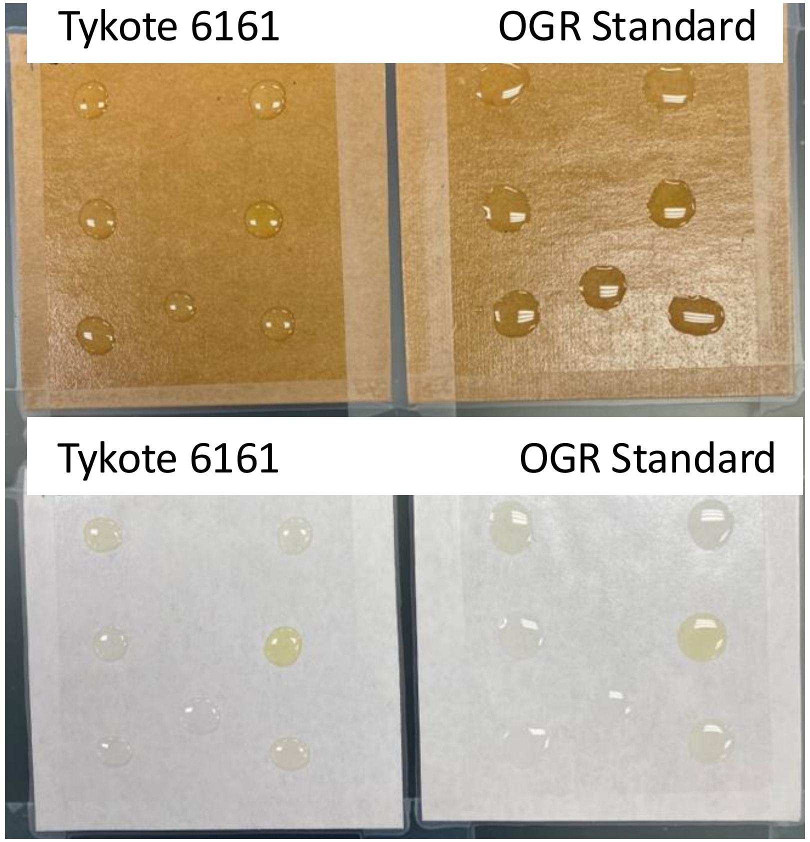
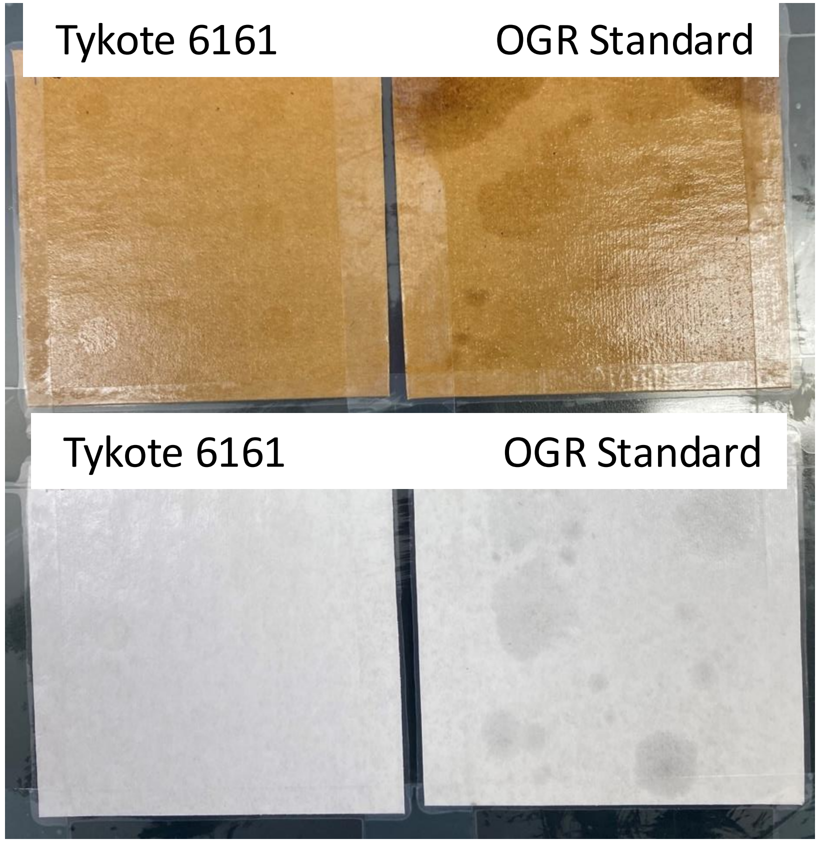
Make Paper Work: Tykote Latex #2

- **Tykote 6161**: great OGR with excellent fold crack resistance
- **Mallard Creek Polymers:** strong partners in product development.





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In Summary…

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- Significant research and great researchers are required to meet the complex demands of barrier papers.
- Multiple polymer chemistries will enable the development of excellent barrier coatings for paper.
- Coating formulation development is critical in addition to understand the right polymers.
- Multiple coatings will support the development of high quality barrier papers.

Thank you for your time!

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