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Polyolefin Dispersions, an Aqueous Moisture barrier

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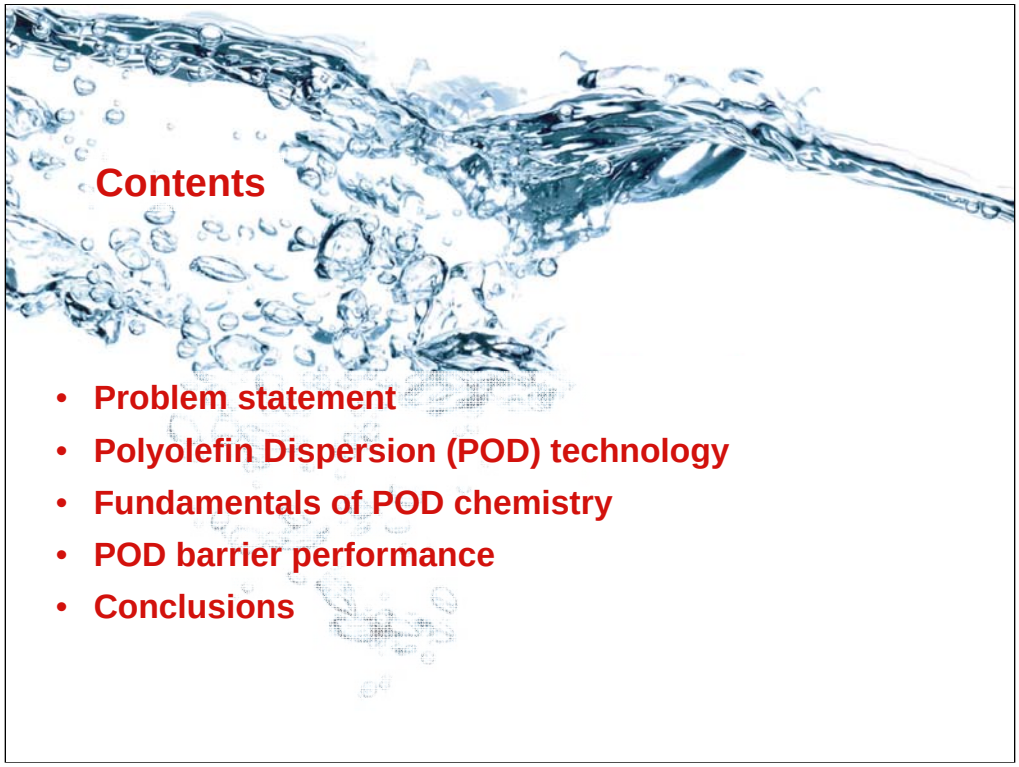
Abstract: Polyolefin Dispersions, an Aqueous Moisture barrier.

Polyolefins are used extensively in many industries due to the attractive combination of attributes they offer. Specifically Polyolefins are used extensively in extrusion coating paper applications for attributes such as moisture barrier. Recently Dow has introduced mechanical dispersions of Polyolefins which allows delivery of these polymers via low viscosity application techniques in an aqueous environment.

This paper will discuss how these polyolefin dispersions can be used to combine moisture vapor barrier with other attributes such as i.e. good heat sealability, low temperature flexibility , adhesion to polar substrates and the ability to accept inorganic fillers. Polyolefin dispersions (PODs) can be applied using traditional low-viscosity application techniques, which include printing operations such as rotogravure. This combination of properties makes these materials ideal for use as a laminating adhesive and as a heat-sealable coating



Contents

- Problem statement
- Polyolefin Dispersion (POD) technology
- Fundamentals of POD chemistry
- POD barrier performance
- Conclusions

Problem Statement:

Why aqueous moisture barriers

Melt application has thickness limitations due to process resulting to:

- Difficult to accomplish significant material reduction
- Limited or more complicated recyclability of end products compared to uncoated papers

Interest in Aqueous dispersions because of:

- Allows for customized solutions
- Safe, installed equipment, experience
- Need Materials with:

  Barrier & Converting Performance

In some cases the processing limitation and polymers set the boundaries for layer thickness that can be achieved in extrusion coating process

In aqueous coatings there is virtually no low limit on the coating thickness and thus the layer thickness can be designed for performance rather than for processing capability.

This gives new opportunities in having poly-olefinic performance and achieving significant material reduction that can also improve recyclability of the end products.

Processing Waterborne Polyolefin Dispersions

Printing/Coating
(Rotogravure)

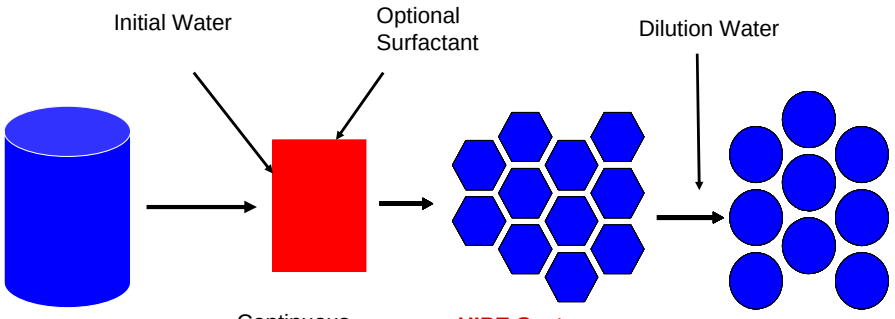
Spray application

Dipping

Frothed Foams

With aqueous polyolefin dispersions the typical aqueous coating equipment can be utilized.

Continuous Mechanical Dispersion Process* & High Internal Phase Emulsions (HIPE)



Liquid or Molten Polymers

- Continuous High Shear Mixer
- Mechanical Energy

- **HIPE System**
- Water Continuous
- 90+% Vol. Fraction
- Rhombohedral
- High Viscosity

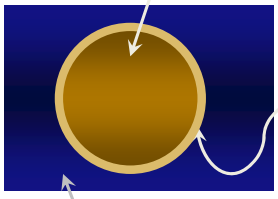
Conventional Emulsion Spherical Particles

* Ref : U.S. Patents: 5,539,021; 5,959,027; 5,688,842; 5,959,027; 6,087,440

An Inside Look at the Chemistry

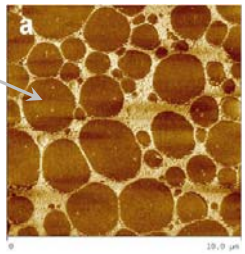
Particle structure

Polyolefin
- Propylene copolymer
- Ethylene copolymer



Stabilizing Agent
- Polymeric
- Surfactant

Aqueous Medium

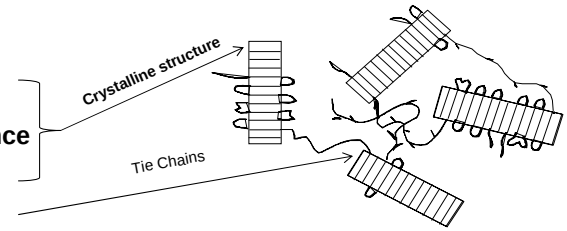


An Inside Look at the Chemistry

Key properties for barrier coatings

Water resistance
Oil & grease resistance
Heat sealability

Elasticity/flexibility



Other important factors for food contact applications:

- Low odor and taste properties
- Food contact compliance
  - 21 CFR 175.105 Adhesives
  - 21 CFR 176.170 Paper and paperboard in contact with aqueous and fatty foods
  - 21 CFR 176.180 Paper and paperboard in contact with dry food

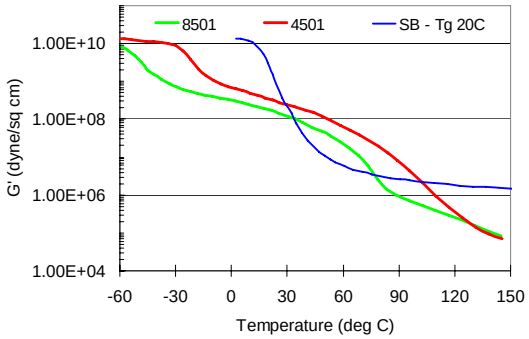
The key elements of POD performance are the crystalline part giving the barrier properties and heat sealing while the tie chains give the flexibility.

These dispersions have low odor and taste and they are approved for direct food contact.

An Inside Look at the Chemistry

Product Designation	Polymer Composition	Carboxyl Content	Polymer Melting Point (deg. C)	Polymer Tg (deg. C)
DPOD 8501	Ethylene Copolymer	Medium	63	-53
DPOD 8502	Ethylene Copolymer	Low	63	-53
DPOD 8510	Ethylene Copolymer	High	63	-53
DPOD 4501	Propylene Copolymer	Medium	85	-26
DPOD 4503	Propylene Copolymer	Low	65	-32
EXP 9501.01	Olefin Block Copolymer	Low	122	-63

Unique Balance of Properties



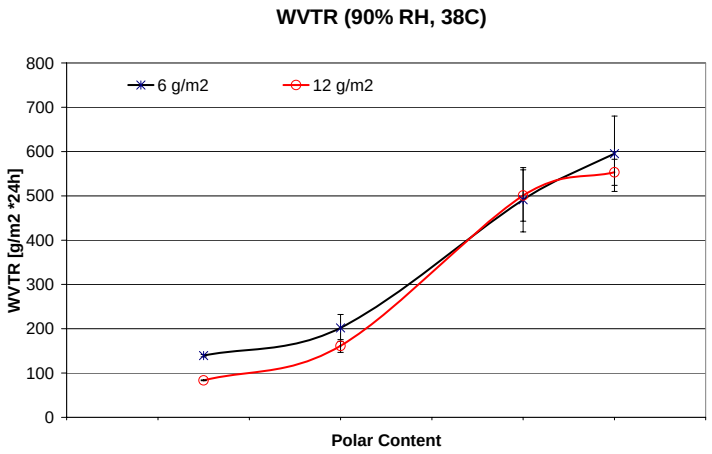
[1]SB = Styrene - Butadiene latex

- low temperature flexibility & low blocking
- good room temperature hand feel & low temperature flexibility
- low in blocking & heat sealing

POD gives viscoelastic behavior typical for polyolefins. We get low temperature flexibility until the Tg of the polymer. At room temperature the polymers are improving in flexibility and after the melting point the polymer flow begins.

This give an unique balance of properties that are more challenging to obtain with other dispersions.

Possibility to modify barrier performance



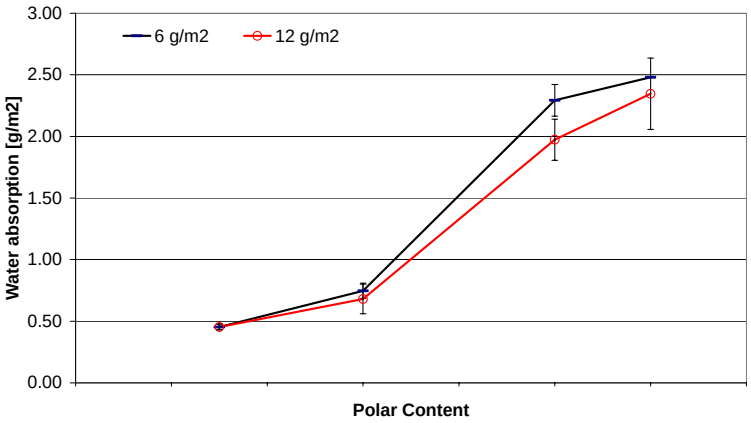
Adjustment of polar content allow significant improvement (or decrease) in water vapor performance

Example of Polyethylene based dispersion

To take the polyolefin into water we need some polar components. As we decrease the amount we see significant improvement on water vapor and liquid water resistance.

Water based systems allow easy possibilities to formulate the systems for specific end use and increase / decrease water uptake if needed.

Possibility to modify barrier performance



Example of Polyethylene based dispersion

- Water resistant coating or water absorbing coating
- Low coat weight performs as good as higher coat weight

To take the polyolefin into water we need some polar components. As we decrease the amount we see significant improvement on water vapor and liquid water resistance.

Water based systems allow easy possibilities to formulate the systems for specific end use and increase / decrease water uptake if needed.

Comparison to extruded LDPE

Moisture, water and oil resistance of 10 gsm coatings with bench coater

Description	WVTR 50%RH, 23C [g/m2/24h]	Cobb 2 min [g/m²]	3M KIT - folded
Ethylene based A	47	2.4	12
Ethylene based B	16	0.5	12
Ref LDPE[1]	12	-	-

[1]Calculated from literature values to 10 µm extrusion coating

POD coatings enable

- Lower coat weights than possible with extruded polyolefins
- Potential for material reduction and improved recycling

POD allow achieving both oil and water resistance. The coatings were made in laboratory bench coater and dried in air oven and thus not fully comparable to industrial coating.

Reference samples, extruded LDPE, show slightly better barrier for water vapor.

Coat weight reduction potential

Water vapor barrier of 6 gsm coating applied with bench coater

Description	WVTR 90%RH, 38C [g/m2/24h]	WVTR 50%RH, 23C [g/m2/24h]
Ref LDPE 10 gsm[1]	48	12
Ethylene based B 10 gsm	71	14
Ethylene based C 6 gsm	100	20

[1]Calculated from literature for comparison

- Developed products show potential to reach or even exceed LDPE WVTR performance

This example compares another experimental POD sample to extruded LDPE.

The result indicate that on equal weight basis POD would have fairly similar performance.

With 6 gsm of POD has roughly 2x higher water vapor transmission and thus the shelf life could be 2x shorter. May be that is already enough for some products that have currently been serviced with extrusion coated paper.

What HYPOD™ polyolefin dispersion barrier coatings can do?

1. POD coatings offer:
   - Polyolefinic performance in aqueous system
   - Lower environmental impact by reducing production steps, allowing material reduction and improved recycling

2. Potential applications:
   - Substitute extrusion coated PE in areas where current systems are over engineered and material reduction brings benefits
   - Opportunity for new structures and concepts…

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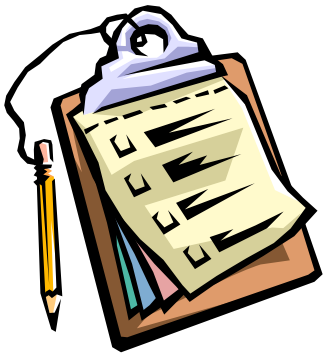

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