

**PLACE** 2016

EXPLORING  
NEW FRONTIERS

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# Improvements in Productivity and Efficiency of Modern Solventless Adhesives

**Larry Jopko**

**TS&D**

**The Dow Chemical Company**

**Dow Adhesives for Packaging, Textiles & Hygiene**

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## What Is the Issue?

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Current solventless machines can run faster than ever before. While many adhesives can also be applied at these high line speeds, there are limitations in the adhesive application and appearance in the lamination. These limitations limit the effective line speed of the laminator.

**Requirement:** solventless adhesives that can be applied at higher line speeds while maintaining current performance and food law compliance and improving appearance.



## Agenda

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- Rise of Solventless Adhesives
- Older products
- Current and new products
- Economics
- Market size
- Efficiency
- Performance
- Outcomes



## **Beginning of Solventless Adhesive Lamination**

### **Oil Embargo – 1980's**

- OPEC reduced supply of oil.
- Resulting in high energy prices.
- Shortage of petroleum derived raw materials.

### **Response**

- Develop adhesives with no need to dry.
- Use less raw materials – 100 % solids.
- Machine manufacturers created first laminators for food packaging.

## Older Products

First adhesive systems were one part, moisture reactive:

- High viscosity.
- Needed to be heated to 70 – 90° C.
- Long time to cure – 7 to 21 days.
- Slow line speeds.

Two part systems developed:

- Needed to preheat to 50 – 70° C, some higher.
- Needed metering and mixing pump.
- Reduced cure time - 7 to 14 days.
- Better bonding performance on diverse substrates.

## Current Products

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Predominately two part systems

- Much lower viscosity.
- Needed to be heated to 35 – 60° C (some still higher).
- Shorter cure times – 2 to 7 days.
- Higher line speeds – up to 400 MPM (1300 FPM).
- Improved bonding performance on diverse substrates.
- Increased compliance to food laws.





# Economics

## Adhesive Material – a comparison

- Solventless lowest cost per unit weight applied.
- Water based slightly higher cost, but added drying expense.
- Solvent based most expensive, and added drying cost.

## Cure time / Work in Process

- Solventless getting faster to fit for use, shorter time before next process.
- Water based remaining more or less the same speed.
- Solvent based also getting faster cure.

## Bottom Line

- Adhesive prices not likely to lower, and economies need to be found elsewhere.



# Economics

## Machinery

- Getting faster mechanically, now possible to run 600 + MPM (1900 + FPM).
- Is it practical? Materials, man power, material handling.

## Rate limiting properties are the adhesive

- (Outside of substrates and manpower).
- Misting at higher speeds.
- Appearance on clear laminations – no orange peel effect.
- Interference with the inks in sandwich lamination.
- Appearance on reverse print laminated to metallized film or metal foil.

## Solution

- **Improve runnability and performance of adhesive!**



# Lamination Life Cycle Inventory<sup>1</sup>

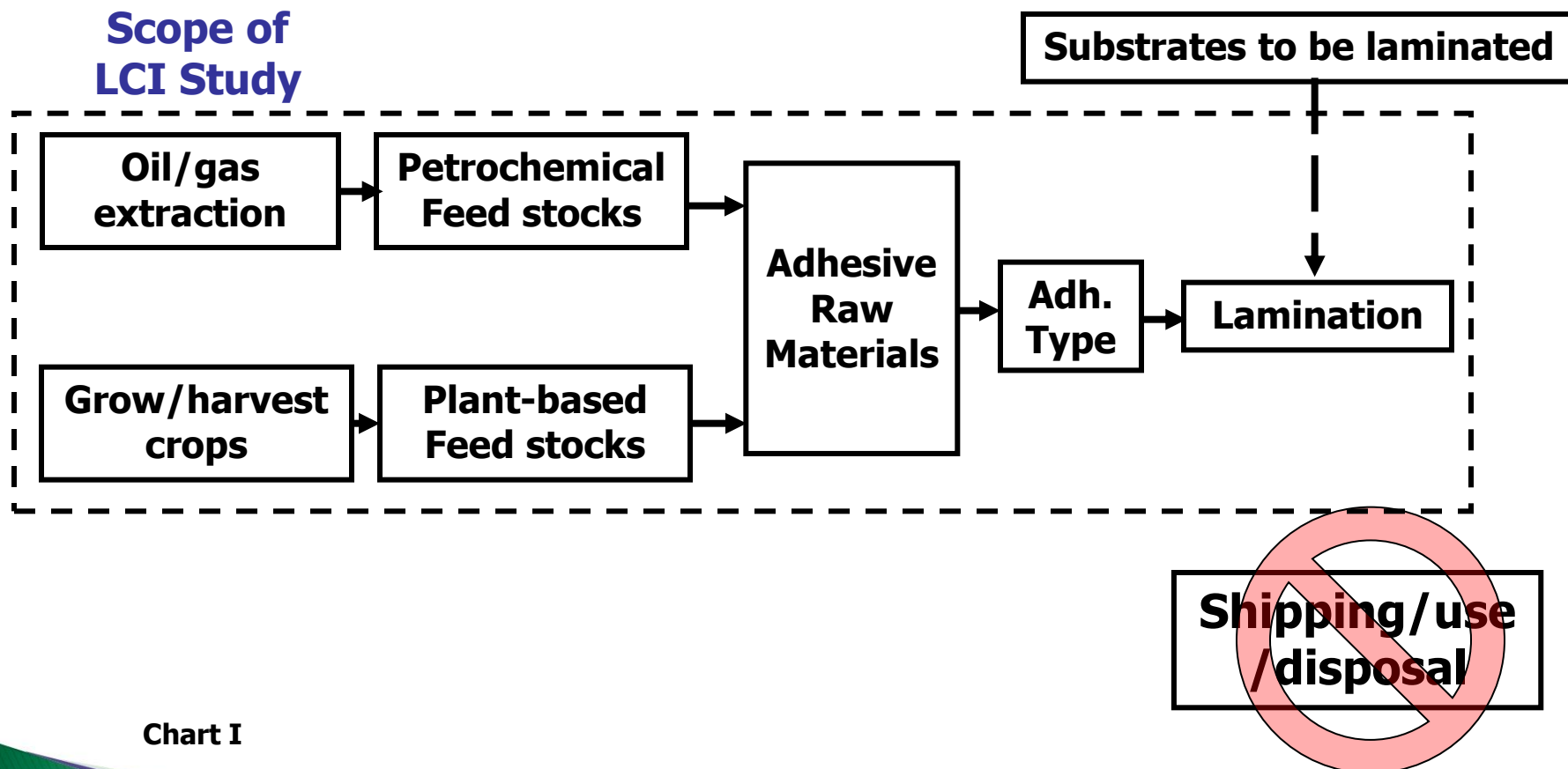


Chart I

<sup>1</sup>“Life Cycle Inventory: Comparison Between Extrusion and Adhesive Lamination” - 2010 Place Conference.



## Flexible Packaging Adhesive/Coreactant for LCI Comparison<sup>1</sup>

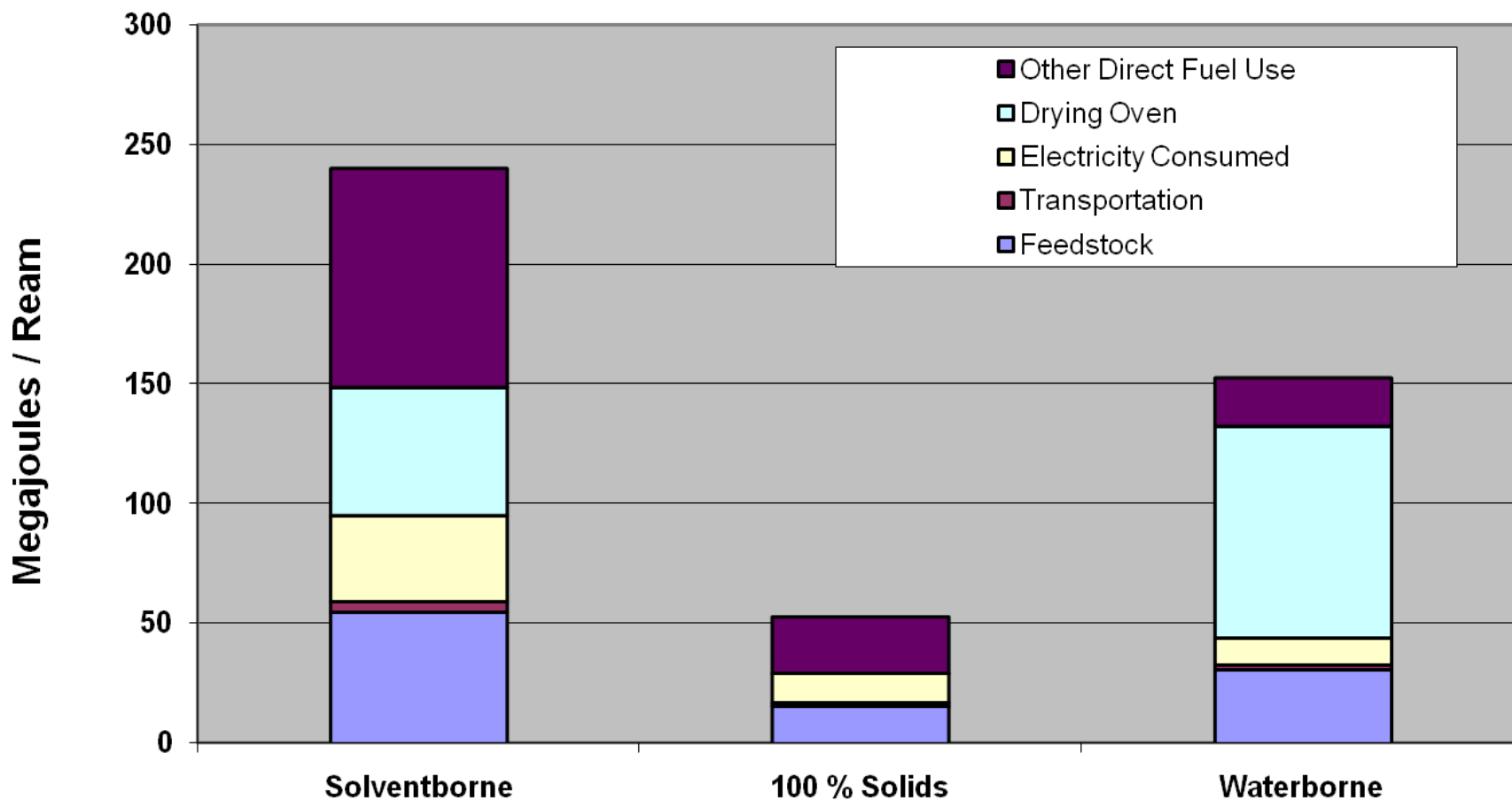
**LCI Functional Unit: Lamination of 1 ream (3000 ft<sup>2</sup> / 278.7m<sup>2</sup>)**

	Application Rate		Total Organics	
	Lbs. Solids Per Ream	Grams Solids Per Meter <sup>2</sup>	Lbs. Organics Per Ream	Grams Organics Per Meter <sup>2</sup>
Adhesive				
<b>Solvent borne</b>	<b>1.75</b>	<b>2.85</b>	<b>2.9</b>	<b>4.72</b>
<b>100% Solid</b>	<b>1.00</b>	<b>1.63</b>	<b>1.00</b>	<b>1.63</b>
<b>Water borne</b>	<b>1.50</b>	<b>2.44</b>	<b>1.50</b>	<b>2.44</b>

<sup>1</sup>."Life Cycle Inventory: Comparison Between Extrusion and Adhesive Lamination" - 2010 Place Conference.

## Total Energy LCI of Liquid Adhesives<sup>1</sup>

### Megajoules per 1 ream (3000 ft<sup>2</sup> / 278.7m<sup>2</sup>)



<sup>1</sup>“Life Cycle Inventory: Comparison Between Extrusion and Adhesive Lamination” - 2010 Place Conference.

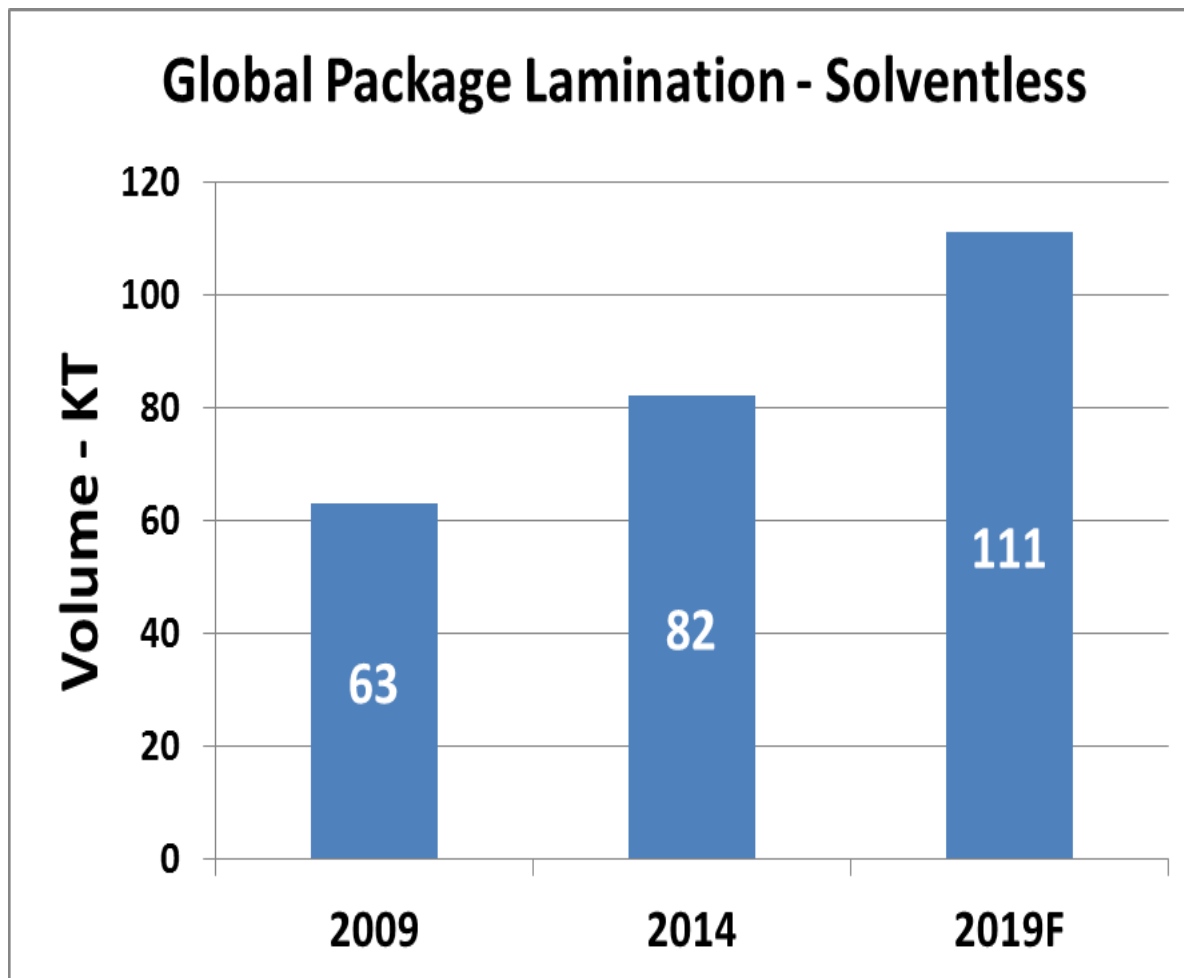
Chart II



# Solventless Market Size<sup>1</sup>

**Solventless usage expected to grow by 76 % from 2009 to 2019.**

**Solventless will contribute about 26 % of overall food packaging adhesive market.**



<sup>1</sup> Source: The Global Adhesives Industry, 2014 – 2019, Kusumgar, Nerlfi, Growney

Chart III



## Road to Improved economy

### Requirement for Solventless Adhesive:

- Increase line speed with no misting.
- Improve appearance on metallized film structures.
- Maintain bonding to diverse substrates.
- Maintain or improve rate of cure.
- Maintain or improve heat and chemical resistance.
- Meet all food law requirements for the intended package use.
- Maintain or improve incompatibility to common lamination grade inks.
- Maintain or improve clean up characteristics.



# Road to Improved economy

## Production

### ■ Improved Machine Efficiency.

1. Moving from 210 MPM to 305 MPM = 45 % gain.
2. Moving from 210 MPM to 425 MPM = 100 + % gain.

**Result:** Can delay capital investment for 2 years or more.

(But need increased roll handling, storage and slitting)

3. For example, if the Machine rate is estimated at USD 500 per hour, then can **gain USD 225 to 500 per hour.**

**Result: improved bottom line.**



## High-Efficiency Solventless Adhesives

### High running speed

- 400 + MPM, without misting: Increased productivity.
- Excellent appearance in white / metalized film lamination.
- Easy cleaning, less machine down-time.

### High performance

- Good adhesion & chemical resistance on a range of structures including foil.
- "All-in-one" usage (GP to HP, except retort). Reduced operator error (no switching adhesives).
- Fast curing: slit in 3-4 hrs, pouch next day, food contact in 2 days.
- COF neutral, reduced antiseal.

### High food safety compliance

- 2 day cure on 1mil PE sealant layer, FDA 177.1395 B thru J.
- No need to switch adhesive to meet FDA.
- EU 10/2011 compliance.
- Fast PAA decay in 2 days.





# Adhesive Definitions

Property	Conventional GP – HP	Fast Cure GP - MP	HE GP - HP
Adhesion to films and foils	5	4	4
Fit for use <sup>A</sup>	7 to 10 days	3 days	2 days
Chemical	5	4	4
Heat	5	4	4
FDA: 175.105	Yes	Yes	Yes
177.1395 "C"	No	Yes (3 day)	Yes
Through "H"	No	Yes (5 day)	Yes
177.1395 "B" through "J" (25 µ PE)	No No	Not tested Not tested	Yes Yes
EU Status	No	possible	Yes
Misting	2	4	5
Clean Up	3	4	4

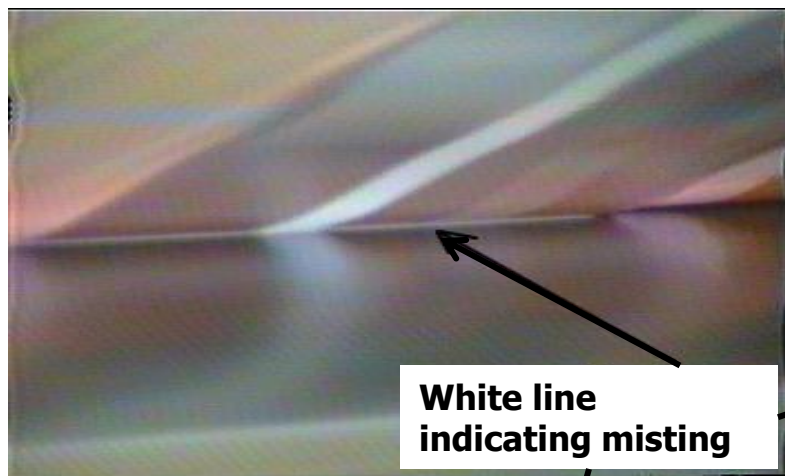
1 = poor  
5 = excellent

A = Room Temperature Cure

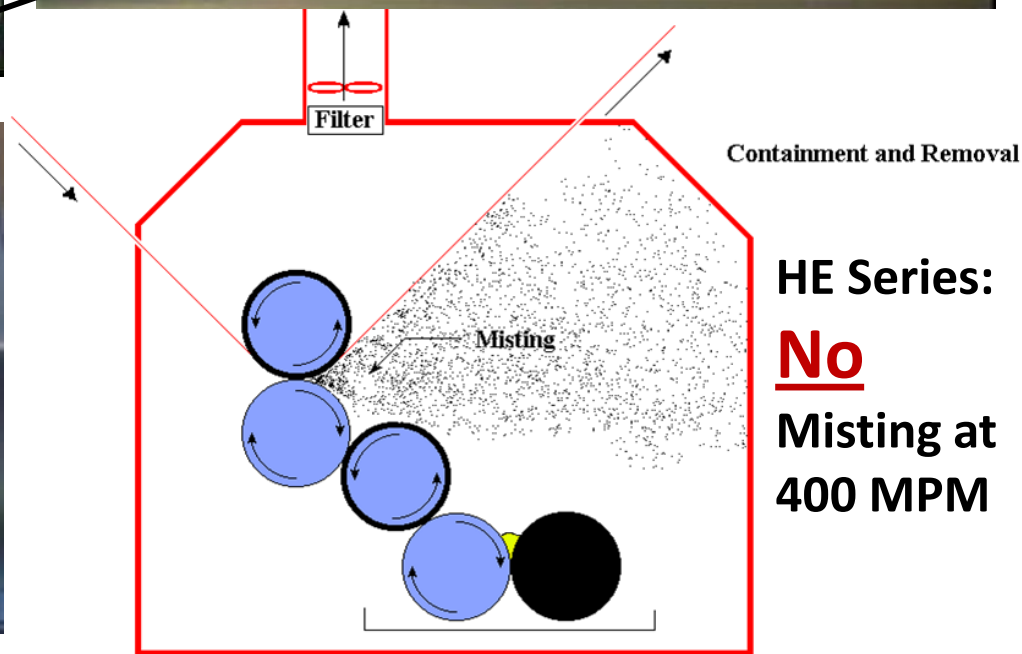
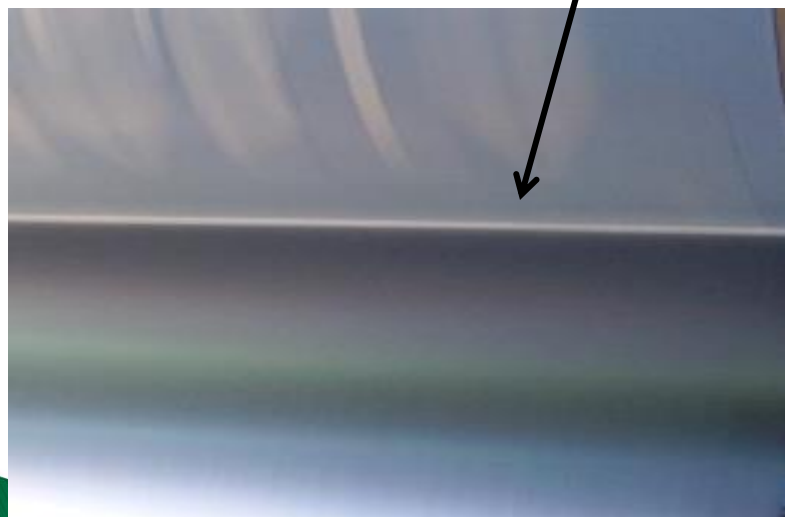
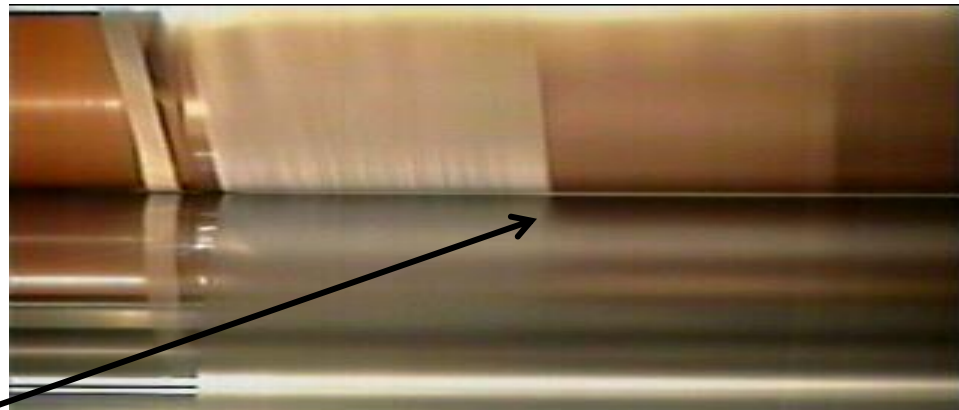
Table II



## Misting



White line  
indicating misting



HE Series:  
**No**  
Misting at  
400 MPM





## Appearance - Reverse Printed PET White to Metallized PET



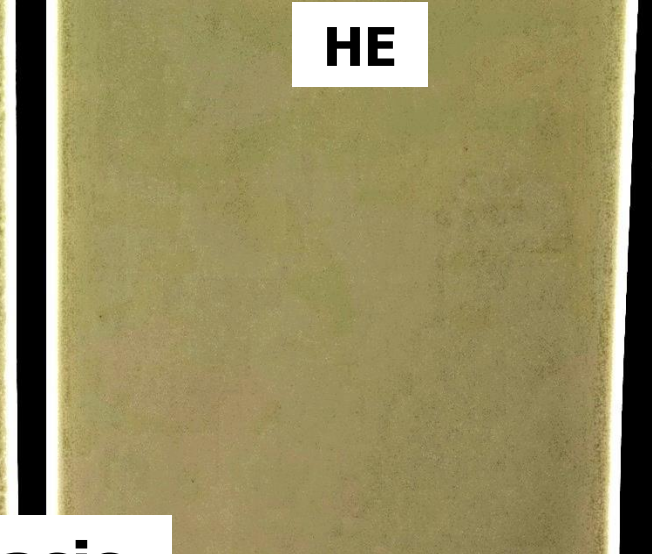
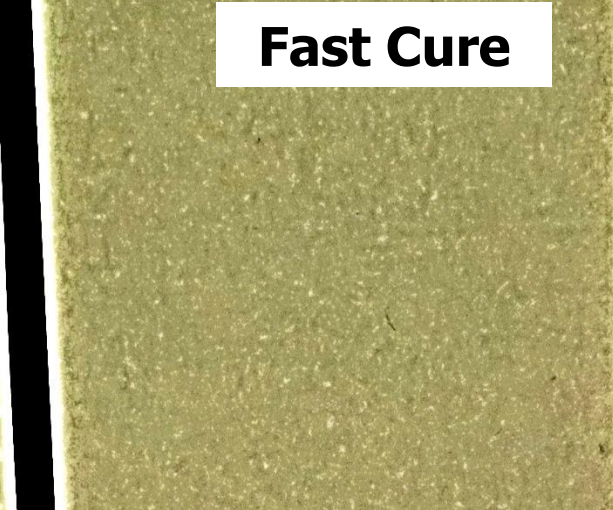
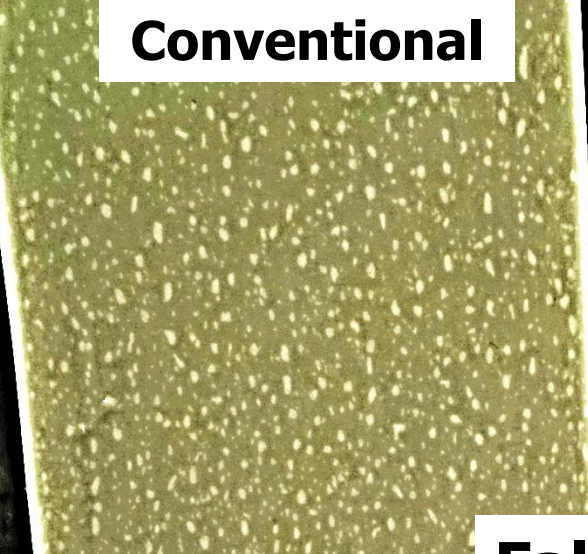
**Conventional**



**Fast Cure**



**HE**

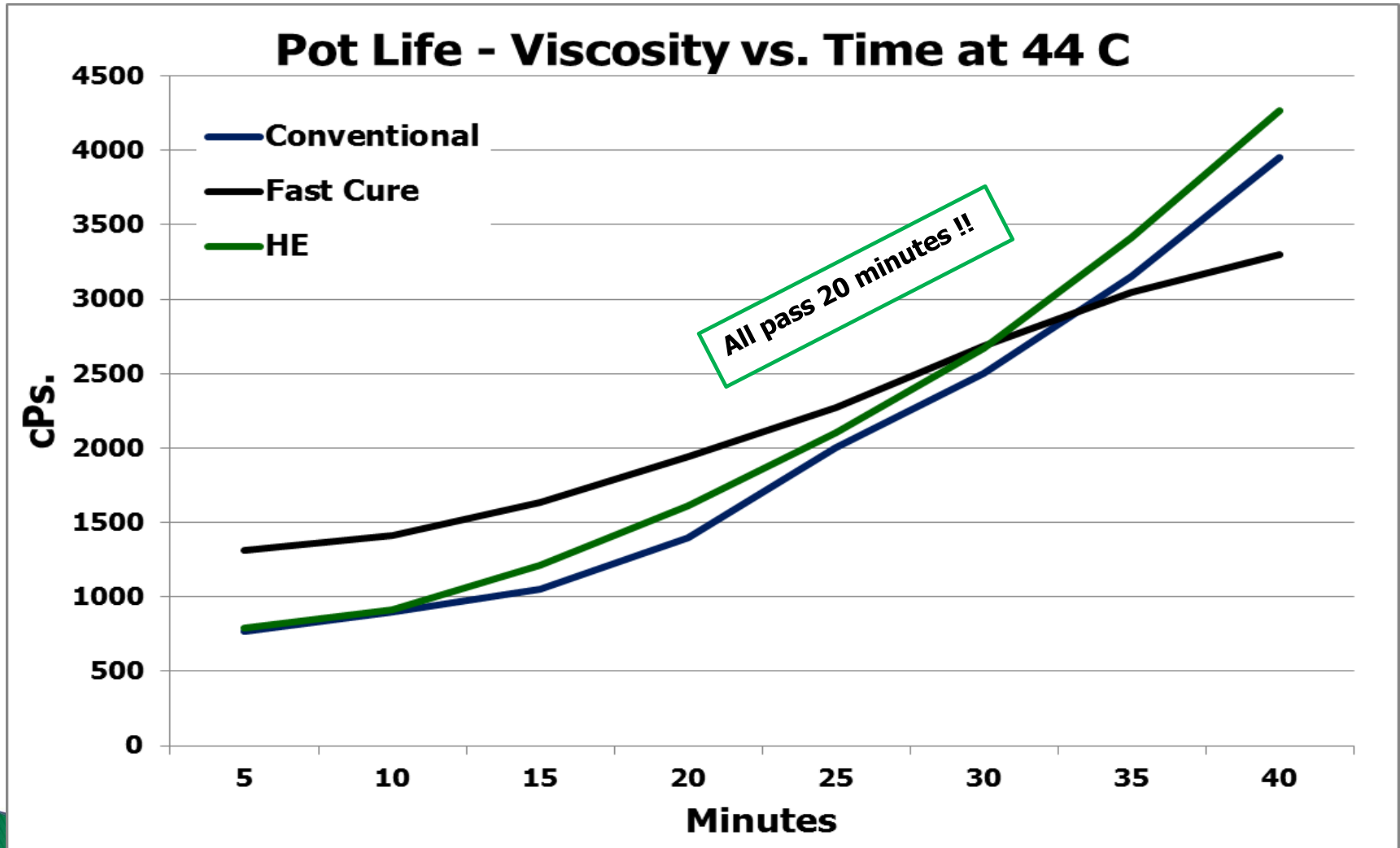


**False Colour for Emphasis**

**Picture II**



# Useful Pot Life



Dow generated data

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Chart IV

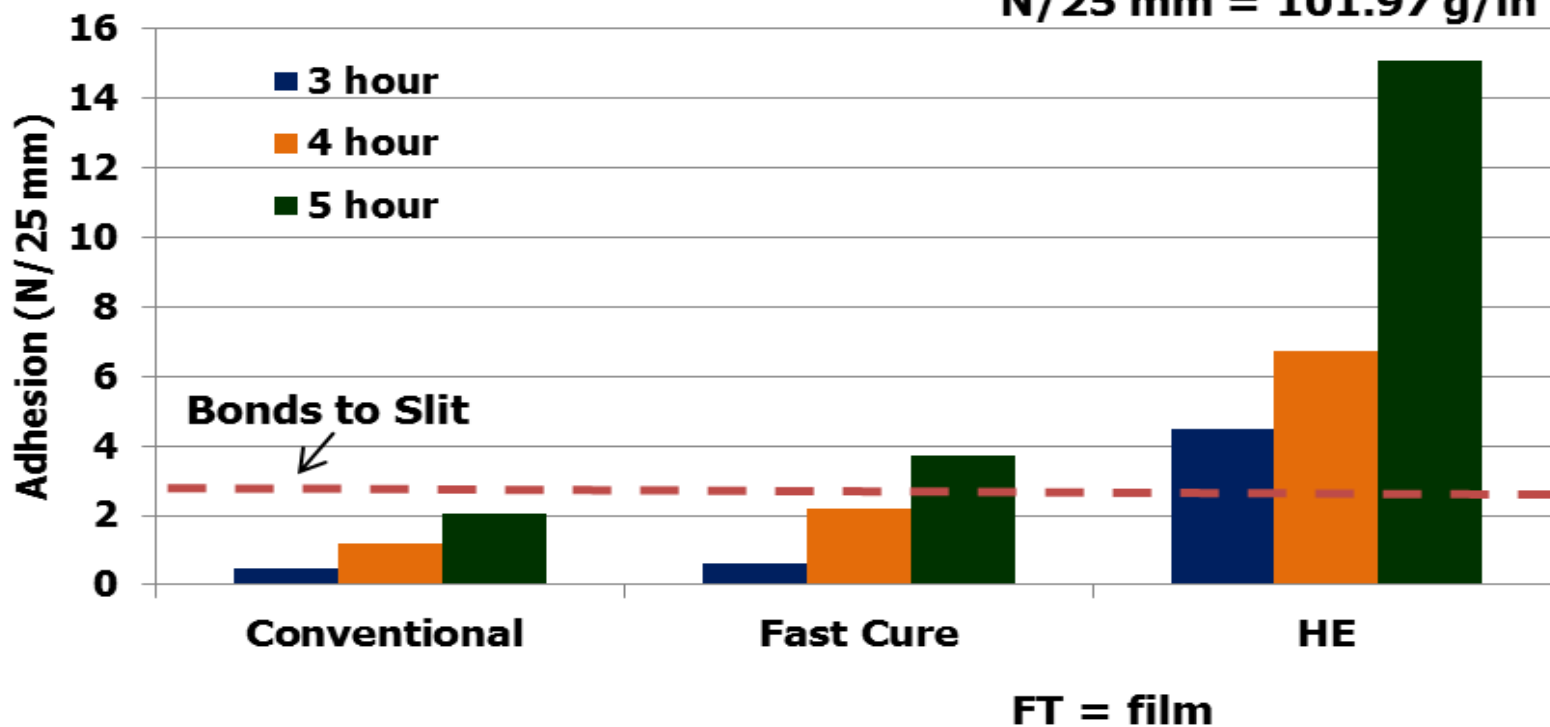


# Fast Cure – Time to Next Process Step

## Fast Curing for Slitting

23  $\mu$  PET/38  $\mu$  LDPE

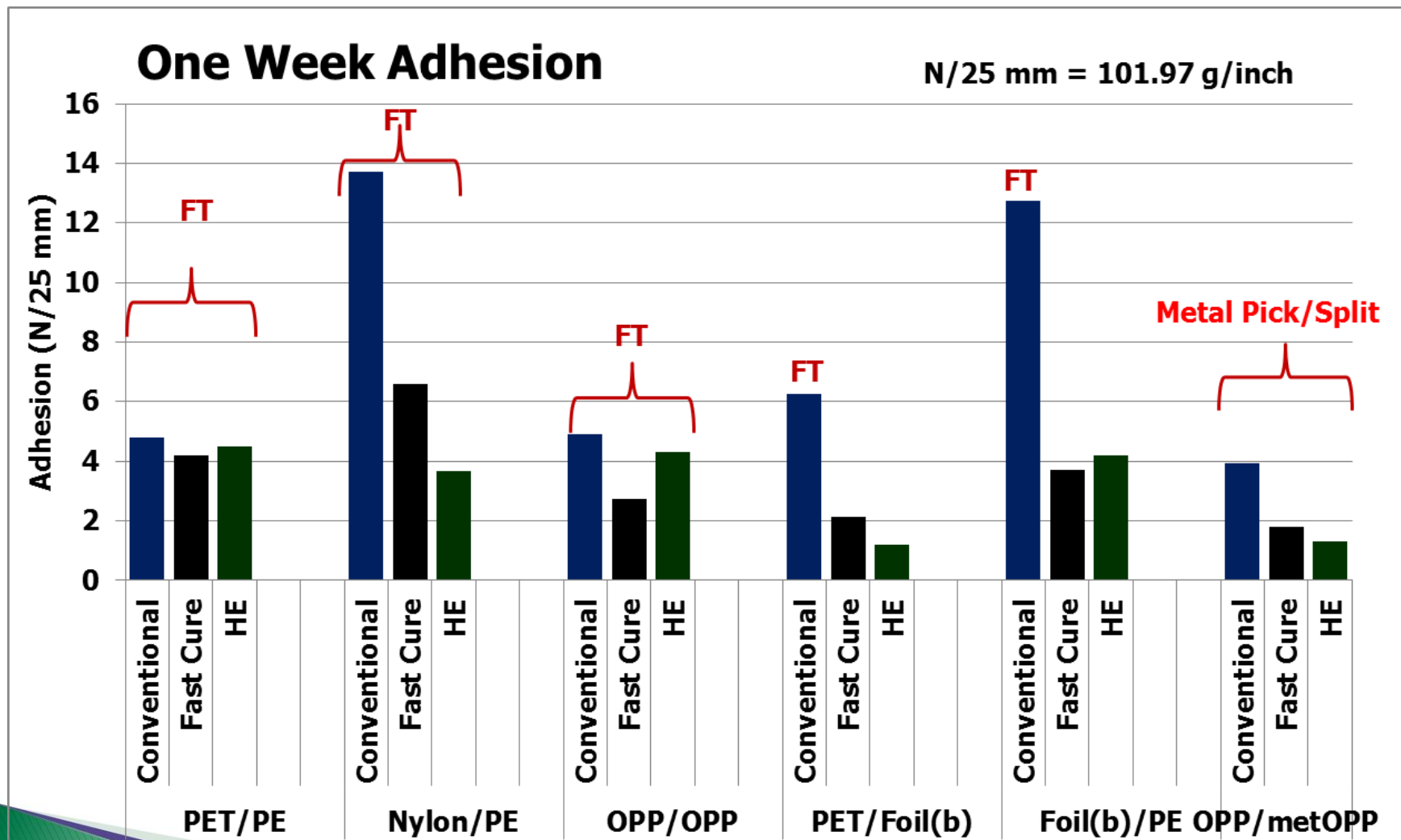
N/25 mm = 101.97 g/in







# Full Cure – Various Substrates



Dow generated data

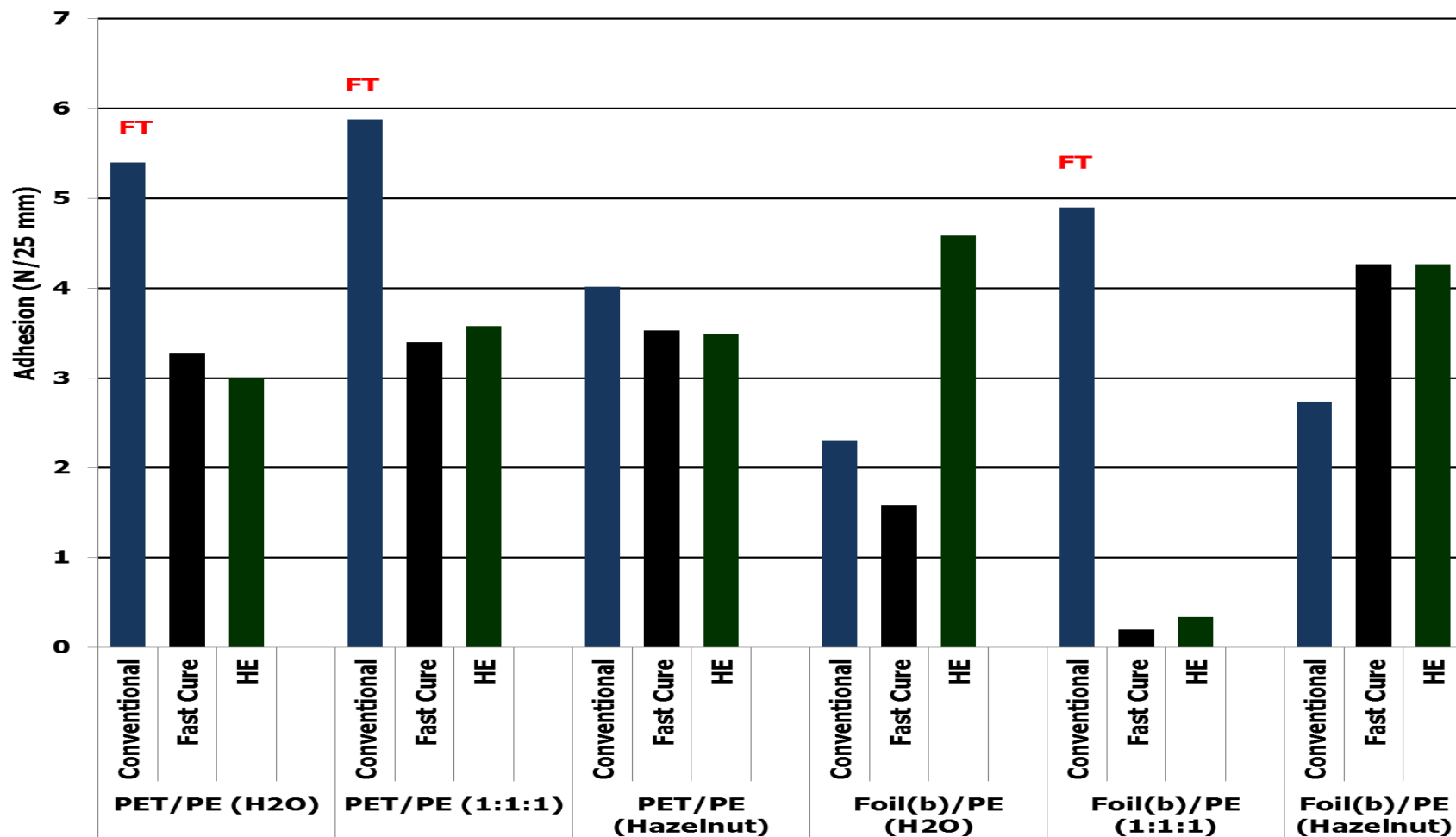
FT = film tear

Chart VI



# Chemical Resistance

## "Boil-in-bag" (60 minutes) Test Results







## Outcomes

- ✓ Fast line speed with excellent appearance.
- ✓ Faster cure for reduced wait time.
- ✓ Fit-for-use in 2 day at RT cure using 25μ PE.
- ✓ Compliant with FDA and EU food laws including elevated temperature use.
- ✓ Maintain acceptable performance on various substrates.
- ✓ Maintains same pot life and ease to clean-up.

**Bottom line: New line of MOR-FREE™ Solventless Adhesives promote improved efficiencies and economics.**



# Thank you

**Larry Jopko**

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**LJOPKO@DOW.COM**



## References

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1. Jopko, L., "Life Cycle Inventory: Comparison Between Extrusion and Adhesive Lamination" - 2010 Place Conference.
2. Kusumgar, Nerlfi, Growney, "The Global Adhesives Industry, 2014 – 2019".
3. The Dow Chemical Company – internal and customer generated data.