Effective Packaging Solutions For HPP

2017 HPP SUMMIT
Hosted by Universal Pure

TEINNOVATIONS

Prem Singh, President & Chief Technology Officer, Teinnovations

Effective Packaging Solutions for HPP

Prem Singh
President & Chief Technology Officer
Teinnovations LLC
Warrenville , IL, USA

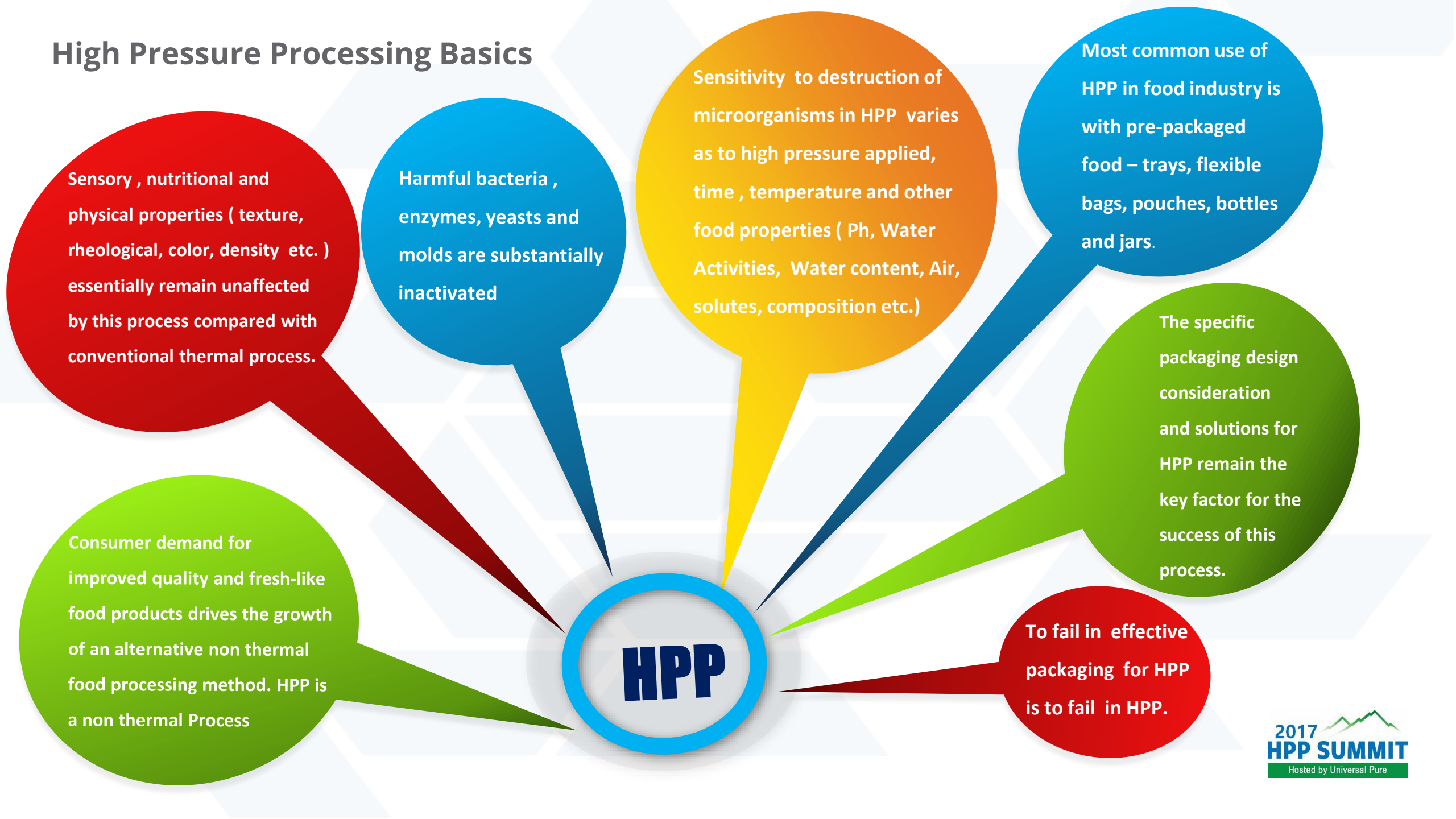
TEINNOVATIONS

Provides:

- *Product development for HPP*
- *Shelf-Life evaluation*
- *Films, Containers*
- *Filling/sealing machines*
- *Problem Solving and consulting survives for HPP processing*

2017 HPP SUMMIT
Hosted by Universal Pure

High Pressure Processing Basics



2017 HPP SUMMIT
Hosted by Universal Pure

HPP Packaging Flow Sheet

HPP Compatible labels

HPP Compatible Films

HPP Compatible caps

Sealing /Capping/Bagging Process

Material Handling

MAP/Vacuum/Gas Flushing Process

- Remove Air (Deaerate)
- Water Activity
- Ph
- Water Content
- Micro Load Reduction
- Food Composition

- Do not <u>contaminate</u> the sealing surface

Fill with Product

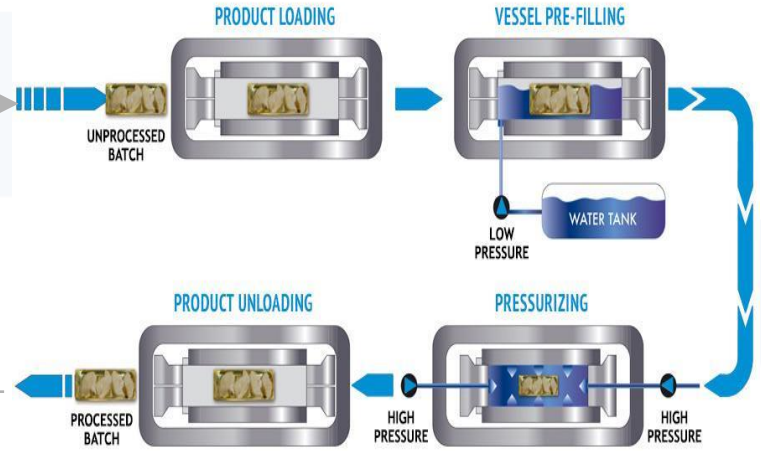
Jars

Bottles

Pouches

Bags

Container



Label/Lidding

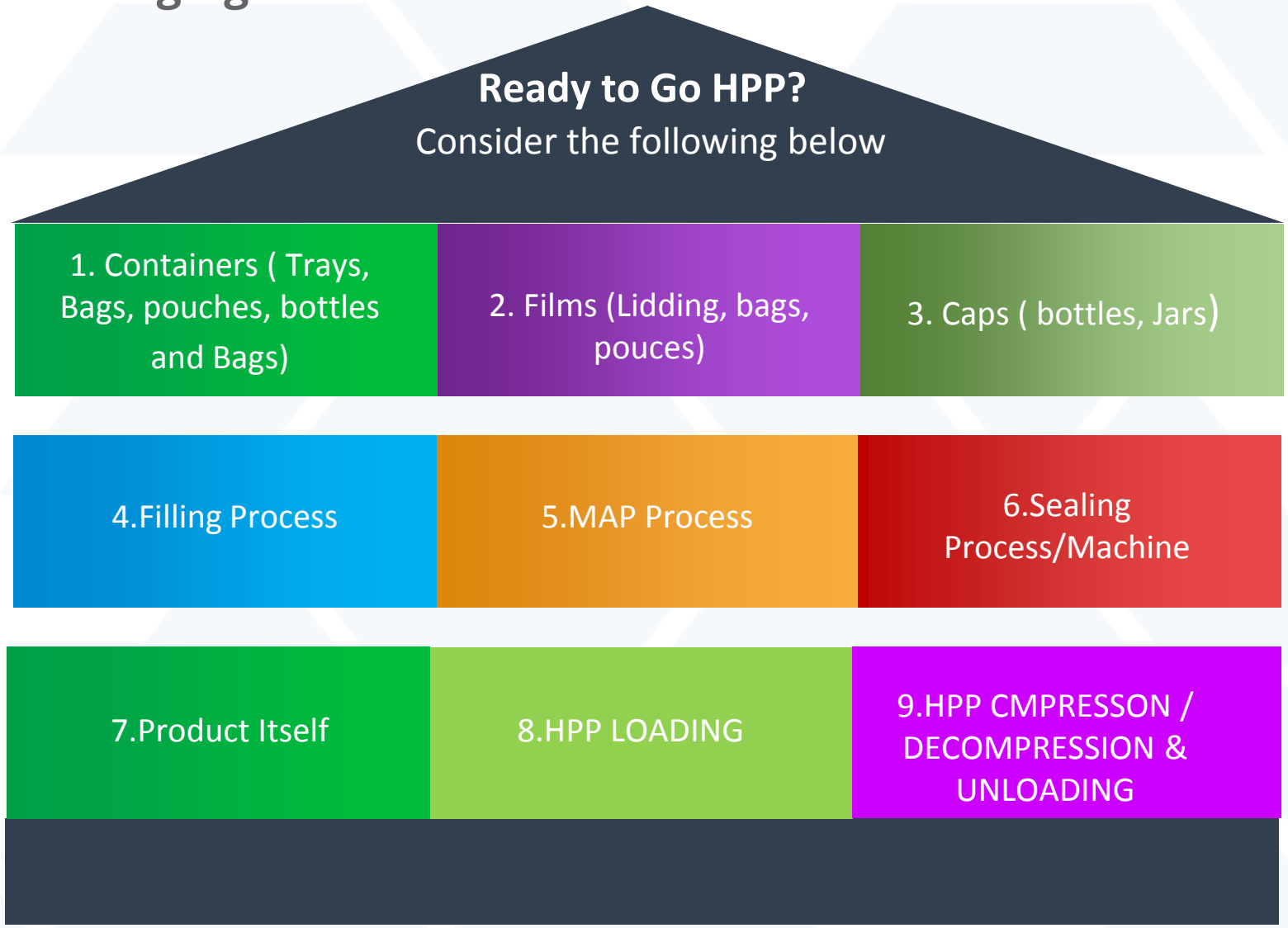
Material Handling

Storage & Shipping.

2017 HPP SUMMIT
Hosted by Universal Pure

2017 HPP SUMMIT
Hosted by Universal Pure

Elements of HPP Packaging

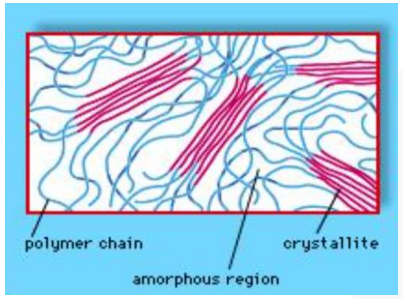


2017 HPP SUMMIT
Hosted by Universal Pure

Fundamental Understanding

Packaging Material will compress

The packaging films and containers do compress more than water under HPP reducing volume of film



Generally barrier properties of film are not affected in HPP

Studies show that generally the OTR and WVTR has even improved in HPP processing . This is because under high pressure , the volume reduction may cause increase in the ordering of molecules , specially amorphous region of the polymer

OTR of films will vary as thickness and the molecular compositional makeup

See The OTR chart in this presentation . All EVOH are not the same

HPP pressure is uniform and instant

- HPP acts instantaneously and the pressure is uniformly distributed through a mass of food regardless of size, shape and food composition
- However, the compressibility is different for the different component of food

Food will Compress and the film will too

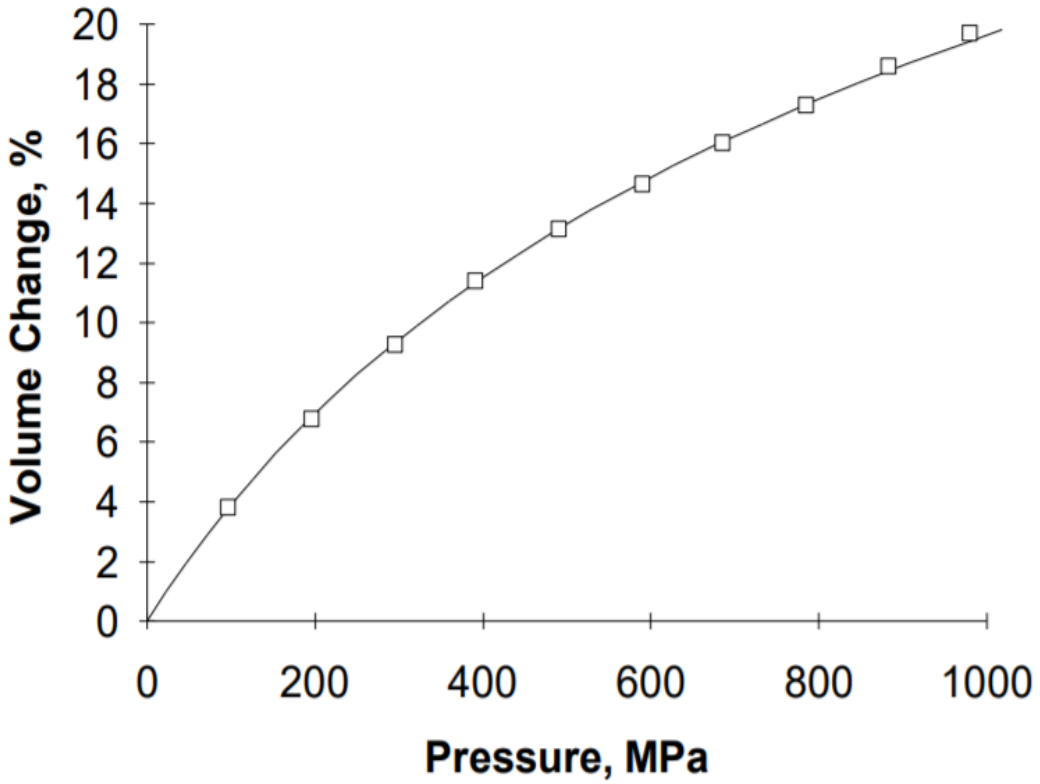
Water or food will be compressed dependent upon the pressure - at 600Mpa , water will compress by 15 % by volume , so the packaging will need to flex reversibly at least that amount plus the compression of head space gases and the film

Minimum Air in product and in head space is necessarily desired.

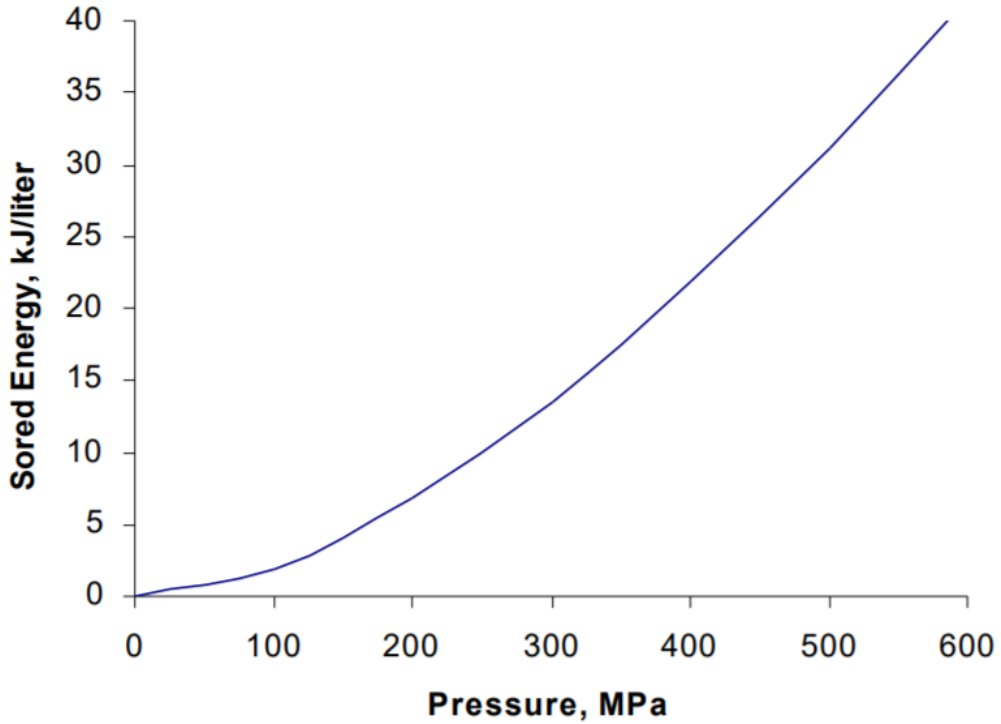
2017 HPP SUMMIT
Hosted by Universal Pure

Food is Compressed Under HPP

Compression of Water

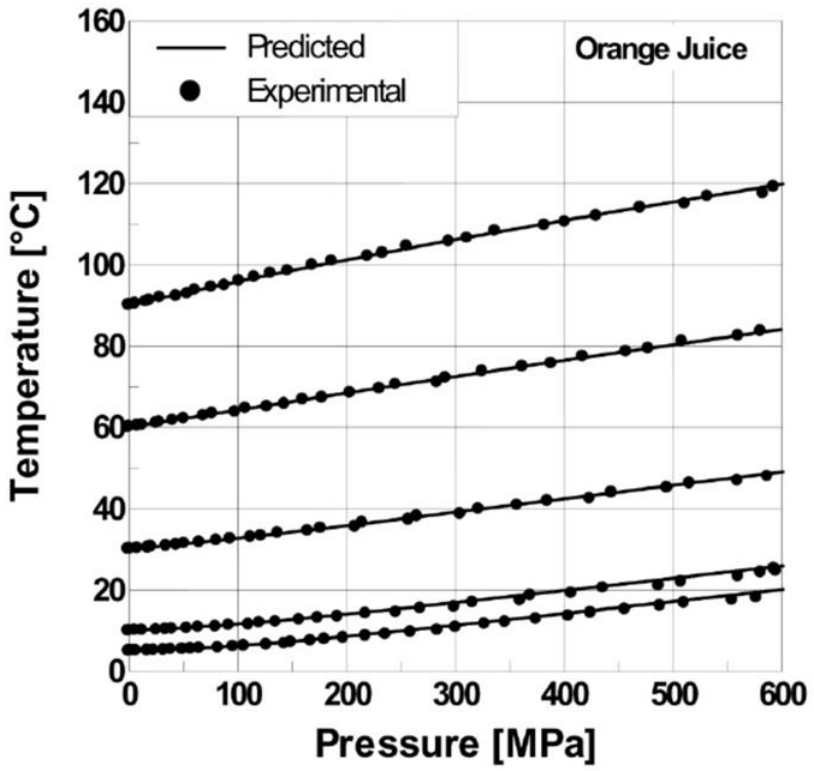


Stored energy in a 1-liter water-filled pressure vessel

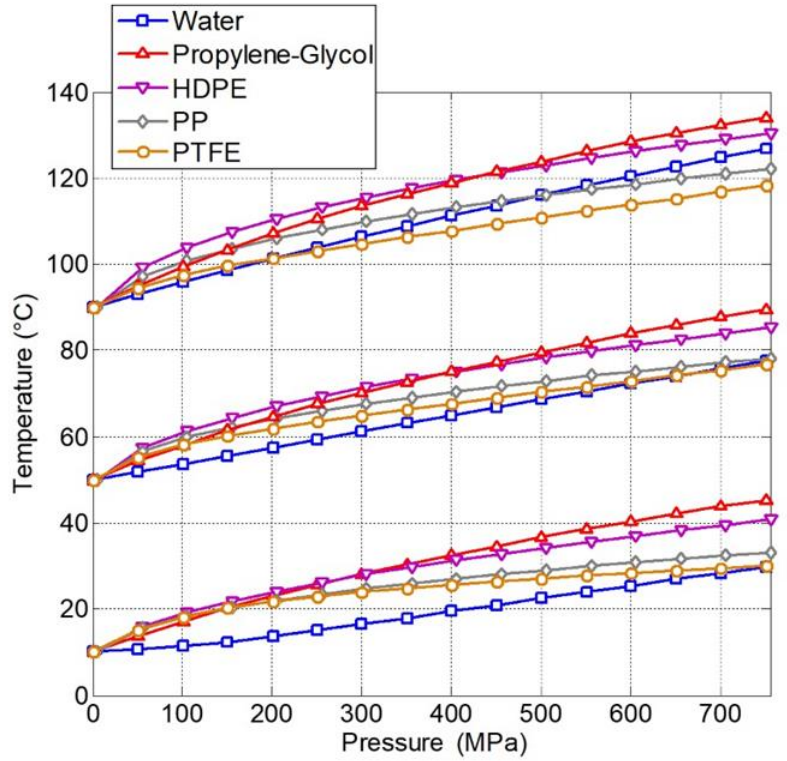


Pascal's law (also **Pascal's principle**[I] or the **principle of transmission of fluid-pressure**) is a principle in fluid mechanics that states that a pressure change occurring anywhere in a confined incompressible fluid is transmitted throughout the fluid such that the same change occurs everywhere. The law was established by French mathematician Blaise Pascal in 1647–48.

Temperature elevation due to pressurization



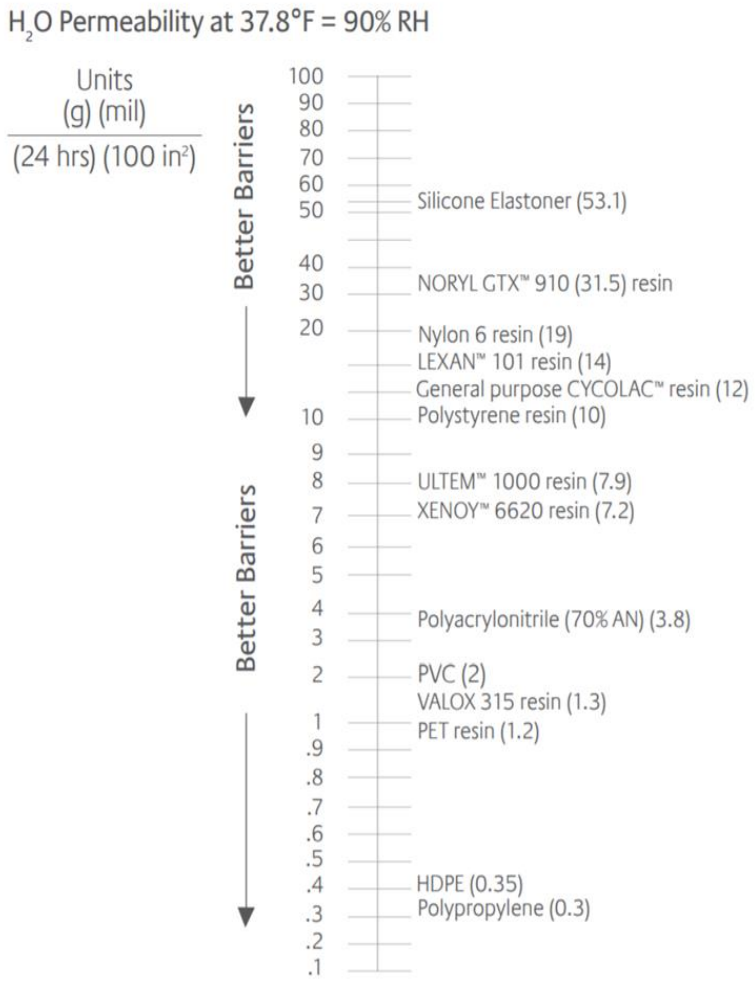
Ardia et al., 2004

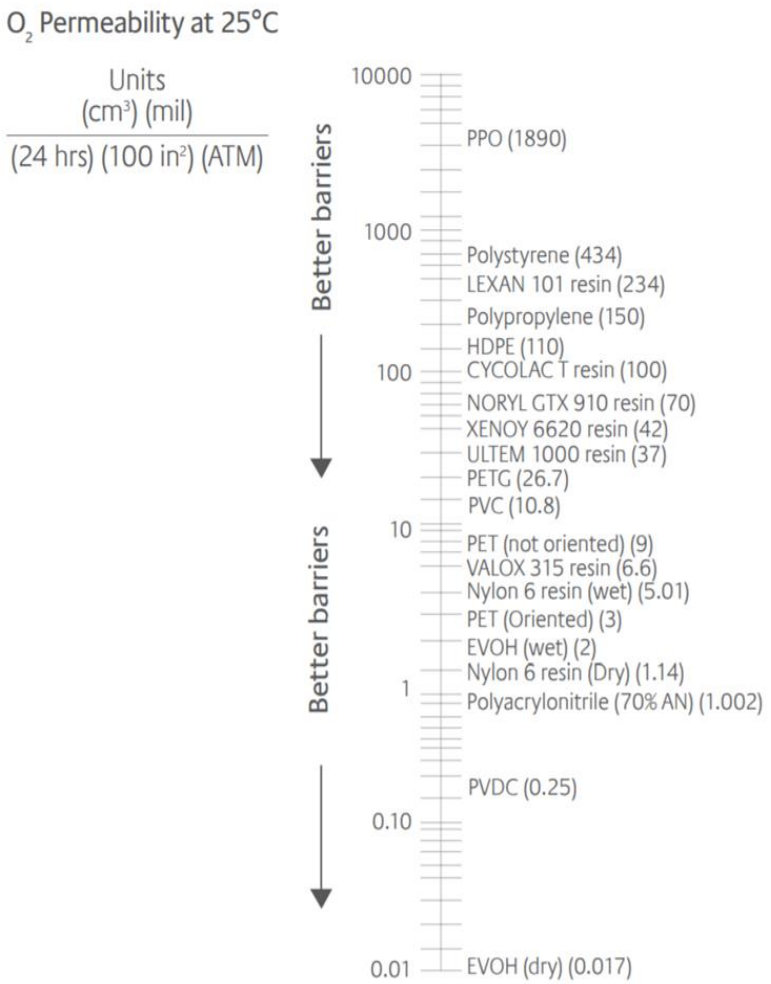


Knoerzer and Versteeg, 2009

$\ln (V/V_0) = \ln[1 - C \ln(1 + p/CB_0)]$

– *where V_o and B_o are the polymer volume and the bulk modulus at atmospheric pressure for each polymer, respectively, p is pressure and C is a polymer dependent*

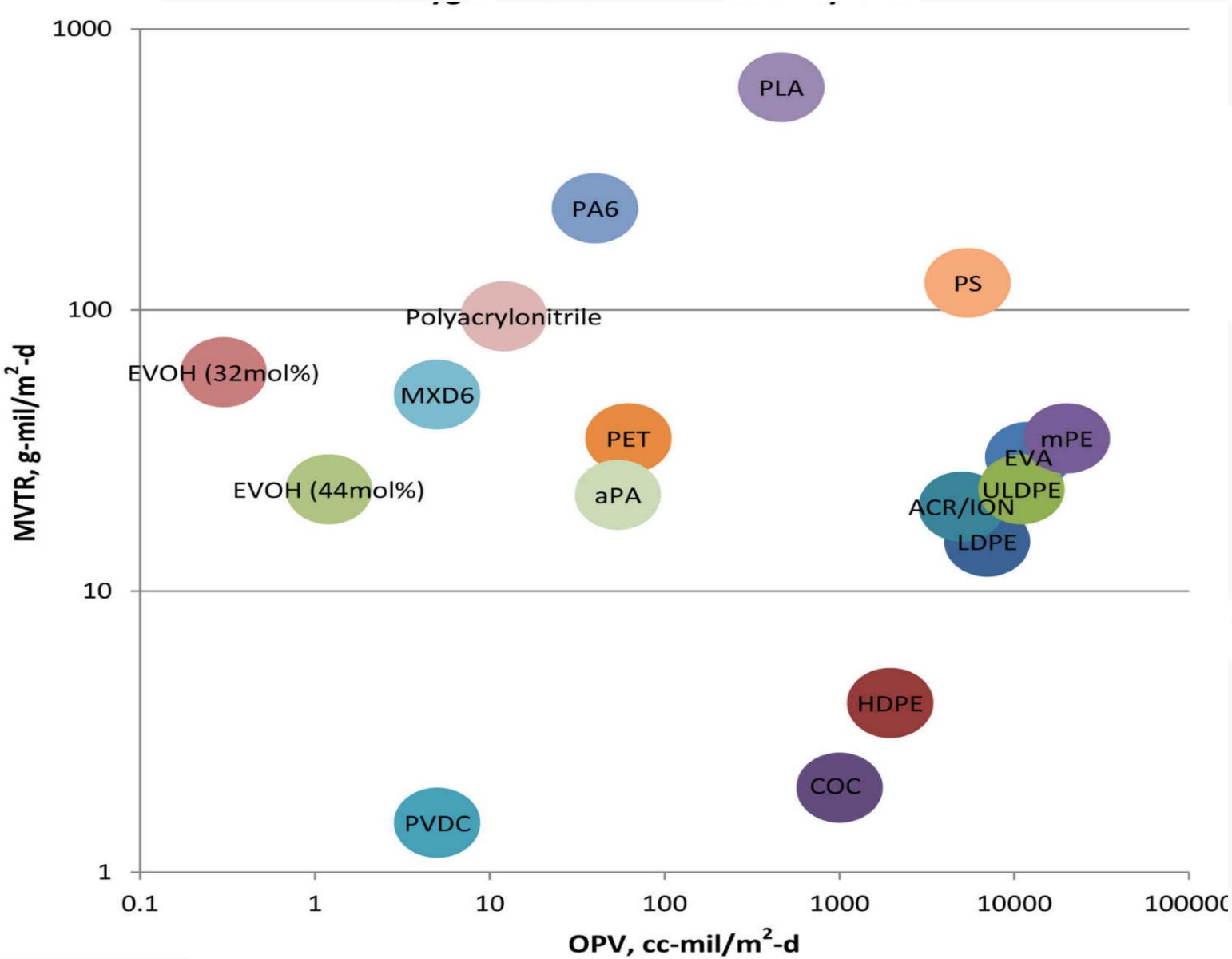


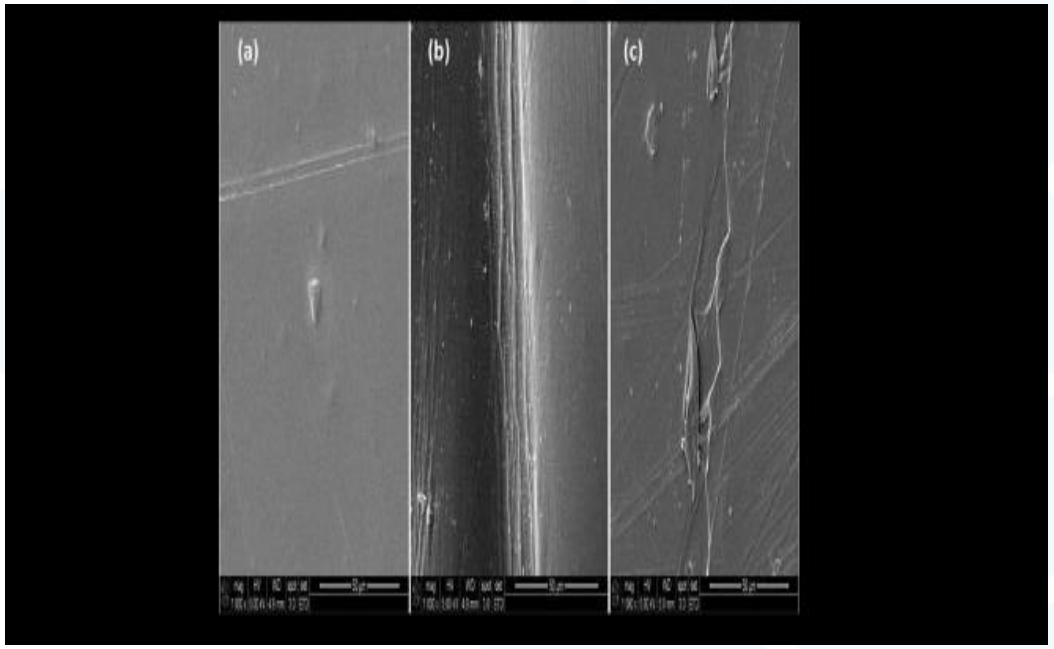


- Important Note: In order to reach the full OTR protection , the packages must be hermitically sealed otherwise the high barrier properties are lost through channel leaks or compromised seal.
- CO2 TR = 3 to 5 times the OTR value at 73ºF (23ºC), 0% RH

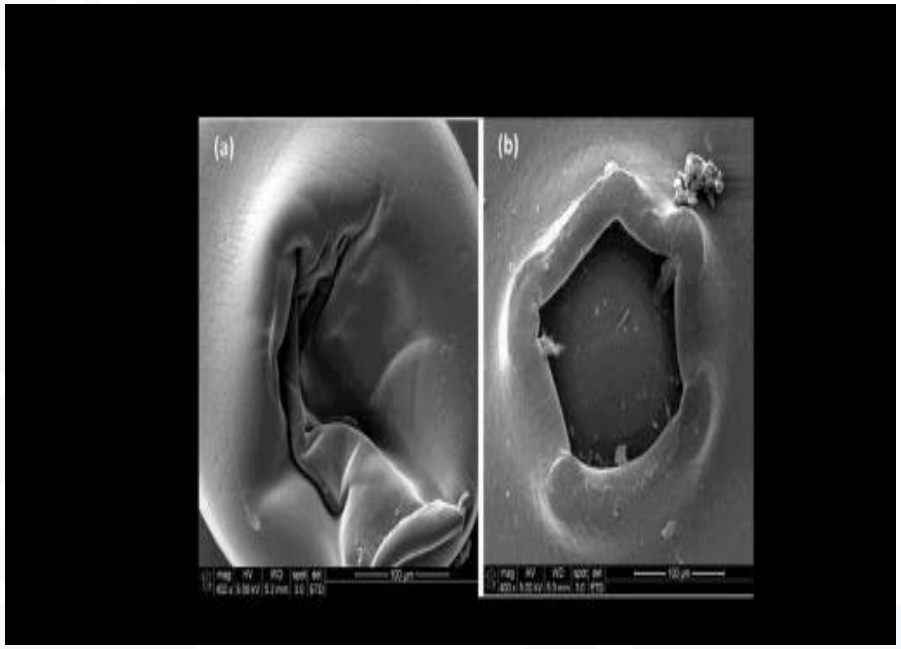
Data from Sabic
productinquiries@sabic-ip.com

Oxygen- Moisture Permeability Grid





Scanning Electron Micrograph of Met –PET/PE showing the damage caused by PATP treatment . (a) Control , b and c PATP treated . (Ayaz et al 2012), 1000 magnification magnification , 600Mpa, 110^{0}C, 10 minutes



Scanning Electron Micrograph of Nylon /EVOH pouch showing the pinholes . (a) PATP treated with no storage . (b) PATP treated and stored @ 25^{0}C(Ayaz et al 2012), 400 magnification magnification , 600Mpa, 110^{0}C, 10 minutes

Packaging Containers for HPP

- C-PET Containers and Trays (Crystallized Polyethylene Terephthalate)
  - Need to be flexible for HPP – 15-20% flexible .
  - Used for frozen and chilled prepared meals, case-ready meat trays, bakery products and the food service industry
  - From Freezer to MW or Oven -40 to 400 degrees F,
  - Custom design shape and features available
  - RePET trays with up to 40% PCR (Post Consumer Recycled)
  - Multiple colors and compartment options are available
  - VSP (Vacuum Skin Packaging) works well in HPP

2017 HPP SUMMIT
Hosted by Universal Pure

Packaging Containers For HPP

Cous cous

Tzat ziki

Tabaouli

- A-PET Containers and Trays (Amorphous Polyethylene Terephthalate)
  - Good for HPP- Need to be flexible and Sturdy
  - Very Popular for HPP foods
  - Wider Flange very important
  - Minimize silicon on the sealing surface to seal effectively
  - Temperature: -40°F to +149°F (-40°C to +65°C)
  - High Barrier with EVOH available
  - Color: clear
  - Many attractive shapes and cool designs are available

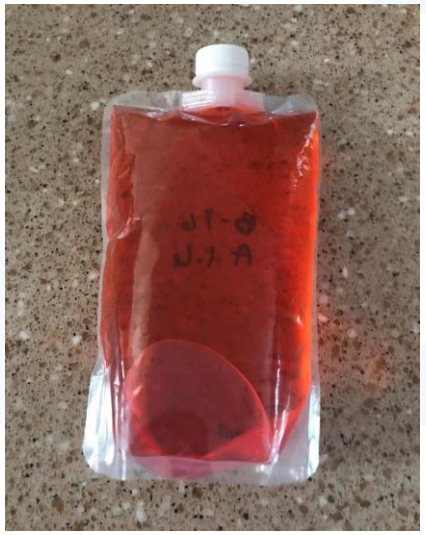
PP Containers (Poly Propylene)

- Freezer and microwave safe
- Wider Flange very important
- Temp ranges of PP: 32°F to +257°F (0°C to +125°C)
- PPDF with copolymer soften plastic for deep freeze applications without cracking: -40°F to +257°F (-40°C to +125°C)
- Available in High Barrier (EVOH/PP)
- Colors: colorless (milky clear), black and white or customized print

2017 HPP SUMMIT
Hosted by Universal Pure

Packaging Containers for HPP

Bags and Pouches



BIBs(bags-in-box

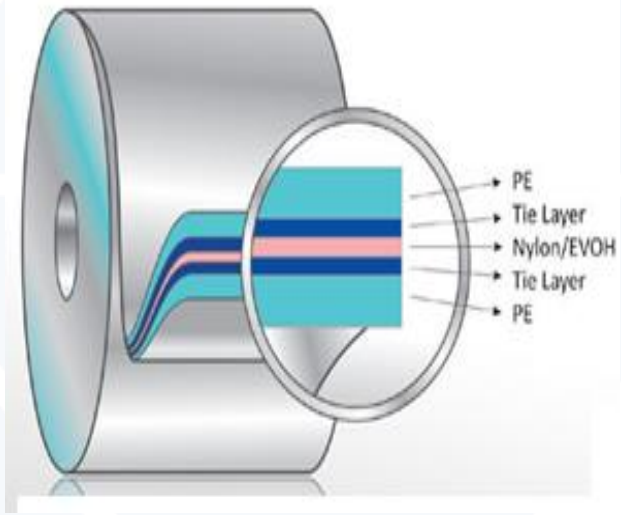
Bottles

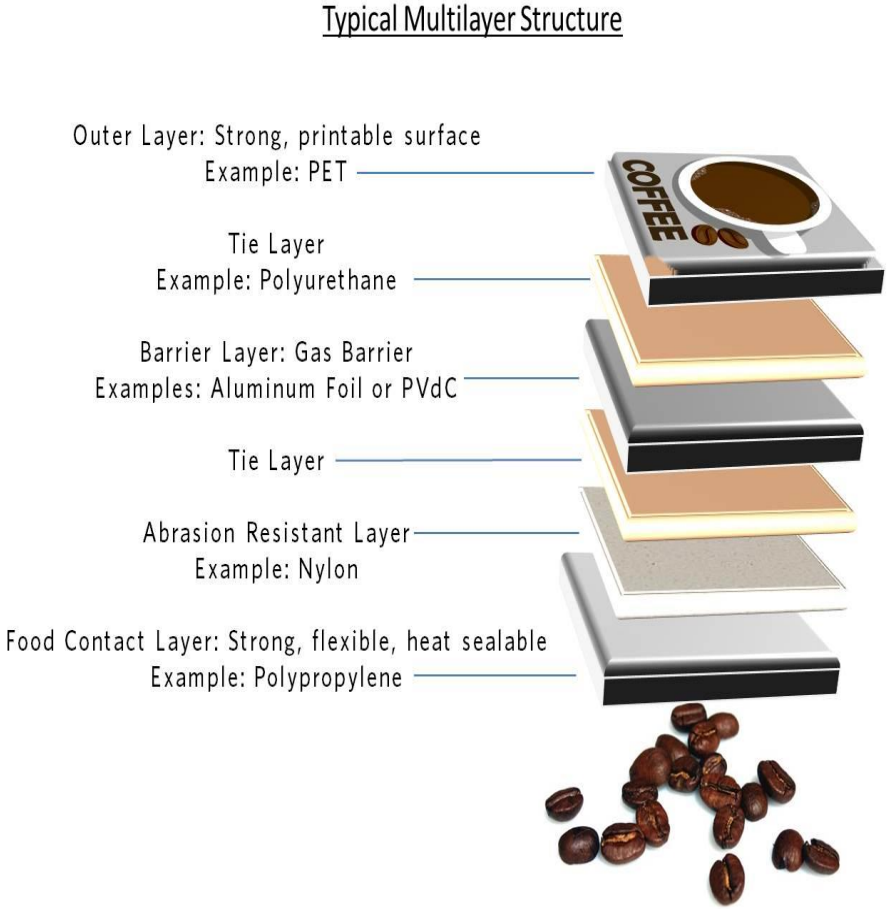
2017 HPP SUMMIT
Hosted by Universal Pure

Films for HPP

Selecting the film:

- Substrate to which the film is to be sealed (substrate- CPET, PET, PP, PE or to self)
- Easy Peel or lock seal
- Seal Strength required
- Seal time and temperature limitations
- Barrier properties both oxygen and moisture (EVOH, PVDC, AlOx , PVOH)
- How the package is further subjected to (HPP, retort, hot filled, MW, Oven etc.)
- Mechanical properties (puncture resistance, drop test)
- Optical Properties (Clarity)
- Thickness
- Contaminant present on the sealing surface
- Regulatory compliance – extraction certificate
- Recyclability required.
- Generally, the single component or multilayer of PET, PE, PP, EVOH , PA
- For containers, most used sealant layer is EVA





2017 HPP SUMMIT
Hosted by Universal Pure

Some Consideration for Films for HPP

Some helpful general knowledge of films for HPP

- Seals:
  - For Successful seal strength in HPP , a burst strength of 17 ” Hg in vacuum chamber with water is found to be a guiding factor- but yet need to be peelable in most cases.
  - A peel test is helpful to make sure the seal is strong enough

- Flexibility :
  - The film must be flexible (15-20%) to endure compression/decompression forces in HPP. The film goes through volume changes and must return to its original dimension and geometry.

- Robustness: The film must be robust not to tear during the thermomechanical stress in HPP .

- Barrier Properties :
  - EVOH seems to be the choice – must be laminated between two layers to protect from water.
  - Metalized films specially with SIOX2 does not seem to be a good choice .

  - In HPP process the barrier properties does not decrease.

HPP Packaging – Lidding Film

Lidding Films

- Type
  - PET (Poly Ethylene Terephthalate)
  - PP
  - PET/PE – Co-ex
  - PE
  - PP
- Composition
- OTR
- Barrier Properties
- Clarity
- Thickness
- Color
- Peelabilty (Easy Peel , Lock Seal)
- VSP
- Resistant to food ingredients , Chemicals
- Food Compatibility
- Sustainability

Lidding Films –Operating Parameters For HPP

- Seal Temperature
- Seal Pressure
- Seal Time
- Seal Strength suitable for HPP
- Sealing Heater heat capacity Clarity
- Seal temperature uniformity and calibration
- Cleanliness of Heater Surface
- Cutting Knives sharpness and Cleanliness
- Mold holder and seal integrity
- Peelabilty (Easy Peel , Lock Seal)

Filling and Sealing Machines Used for HPP

- Orics
- Zitropack
- World Cup
- Modern
- VC999
- Multivac
- SealMax
- Ross
- Mondini
- ATS Engineering
- Harpak-ULMA
- Pack Line

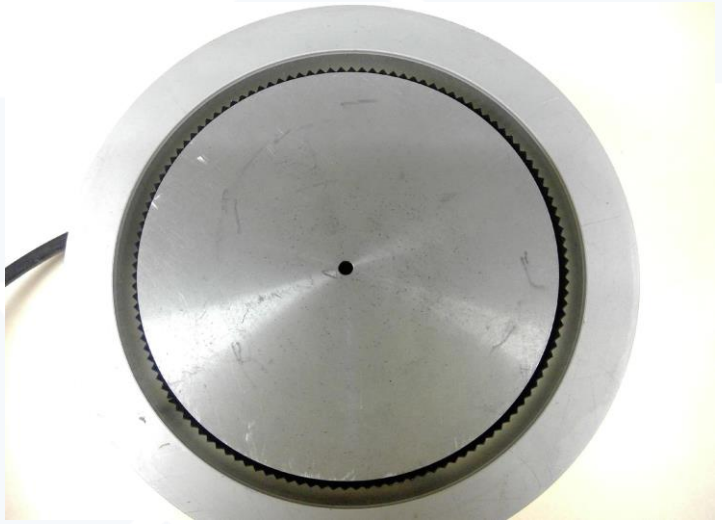
- Autoprod / Holmatic
- KartridgPak (chubs)
- Tex- Wrap (Wrapping after HPP)

2017 HPP SUMMIT
Hosted by Universal Pure

Tray Sealing for HPP Understanding

Packaging Sealing:

- *Sealing Head /Heater/Temperature*
  - Sealing head surfaces must be clear of any scratches, roughness, contamination deposit
  - Check seal head every 2 weeks
  - Calibrate Seal head temperature uniformity
  - *Adjust temperature to make good seal*
- *Sealing Pressure*:
  - Appropriate pressure is essential in combination with temperature (typical 70 -75 lbs. /PSI)
- Sealing Time
  - *Adjust seal time to get good seal*
  - *Affects the production rate*
- *MAP (Gas Flushing)*
  - *Need time to evacuate and gas flow*
  - *Need good gas flow and pressure system with properly designed vent –*
  - *Minimum gas possible*



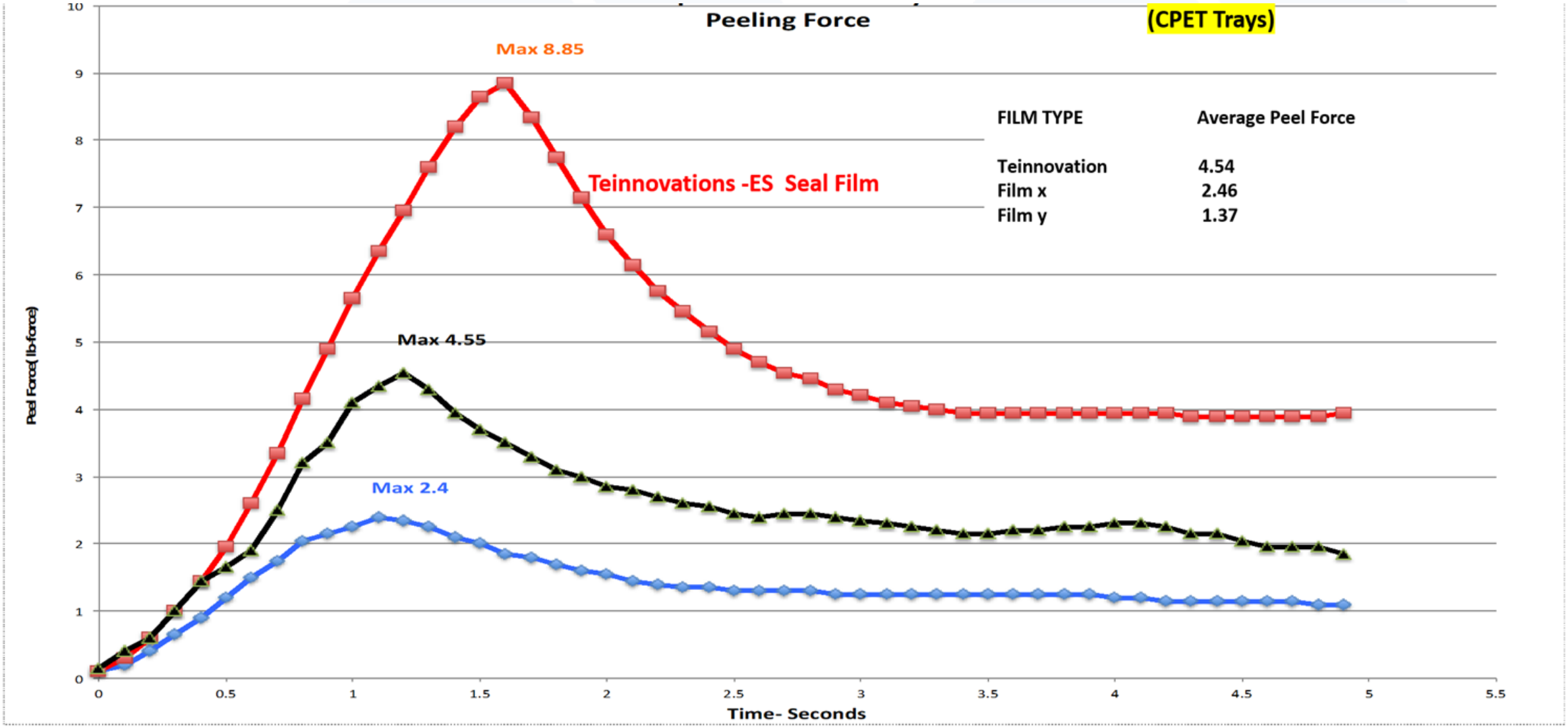
Clean/Smooth Heater

Not so Clean/Smooth Heater

2017 HPP SUMMIT
Hosted by Universal Pure

Seal Strength for HPP Success

Lb –force- 45degrees angle



2017 HPP SUMMIT
Hosted by Universal Pure

Burst Strength for HPP Success

FILMS ANALYSIS SUMMARY

Teinnovation Film is sigficantly better in seal force and Burst Tests (useful for HPP Pasteurization)

TEST CONDITIONS

Date 6/10/15 and 6/16/15

45 degree peel test
speed of peel = 26"/min
PET wide rim deli container - easypak DR8W-GF
SealMAX 528XL, 155C, 1.5 second dwell

	ES (Teinnovation)					
	Peak peel force	*avg peel force*	*Peak peel lbs*	*avg peel force*	*Peak Peel force*	*avg peel force*
sample A	5.7	2.77	2.55	1.23	1.8	0.96
sample B	6.05	2.71	2.5	1.07	1.7	0.83
sample C	5.55	2.71	1.95	0.92	1.75	0.87
Peel Force(lbf)	**5.77**	**2.73**	**2.33**	**1.07**	**1.75**	**0.89**

Vaccuum Burst Force (inches Hg)	**17.5**	**11**	**11**

CPET Sonoco 7589 tray
SealMAX 168L, 165C, 1.2 second dwell

	ES (Teinnovation)					
	Peak peel force	*avg peel force*	*Peak peel lbs*	*avg peel force*	*Peak Peel force*	*avg peel force*
sample A	7.65	4.1	3.95	2.17	2.4	1.38
sample B	8.85	4.5	3.6	2.1	2.15	1.22
sample C	8.1	4.47	4.55	2.46	2.2	1.45
average	**8.20**	**4.36**	**4.03**	**2.24**	**2.25**	**1.35**

Vaccuum Burst Force (inches Hg)	**21.5**	**12.5**	**12.5**

A Specially Designed HPP Film

Near zero leaker rate – sealing to various substrates

6000 bars , 3 minutes, 15^0 C water
NO LEAKERS WERE FOUND

ES Standard Teinnovation Film
High Barrier PP containers with Apple Sauce

To demonstrate the integrity of our film, empty containers were processed through HPP @ 6000 bars for 3 minutes. Seal integrity remained intact even when the container collapsed.

2017 HPP SUMMIT
Hosted by Universal Pure

SealMAX SC-1350

2017 HPP SUMMIT
Hosted by Universal Pure

Some Typical Defects We See

Impression Paper- a tool to check seal uniformity

The following check list for trouble shooting the leaker in HPP

- What was the seal strength before HPP (burst test and peel tests)
- Does the seal look smooth without any channel, bubble or missing seal areas
- Excessive contaminant on seal surface
- Check if there was no abnormal head space air
- Check if temperature , time and pressure are optimized in the sealing process and calibrated
- Check that the correct sealing surface of the film is used (It happens)
- Check the heater surface if it is not damaged and dirty
- Check the loading and handling in HPP chamber – it should be uniformly loaded not just dumped
- Check the unloading process

TEINNOVATIONS

Effective Packaging Solutions For HPP

2017 HPP SUMMIT
Hosted by Universal Pure

thank you!