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Heat Sealing

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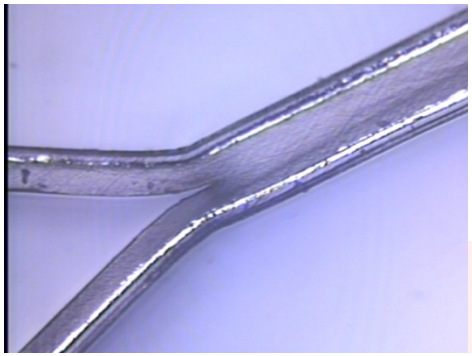

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Common Method to Close / Shape Flexible Packages

- Supply thermal energy on outside of package
- Soften / “melt” sealant

- Also used in closure of semi-rigid and rigid packages
  - Especially combinations with flexible, e.g. cups & lids, etc.



What Is Needed to Make a Seal

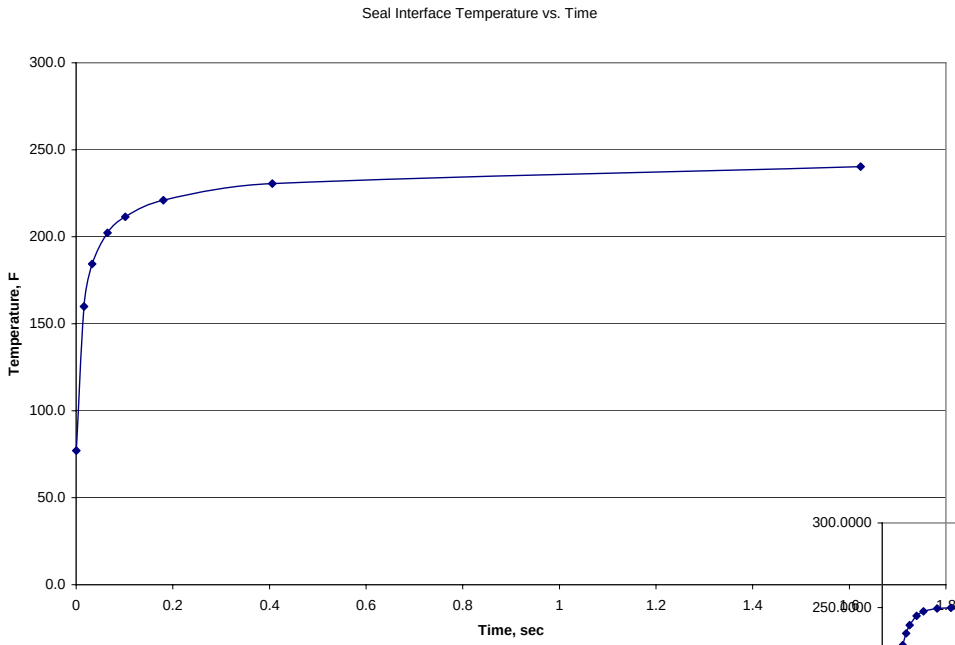
- Two surfaces- thermoplastic “seal partners”
- Time, Temperature and Pressure??

- Actually time, energy and pressure
  - Different seal methods supply energy in different ways

Heat Conduction

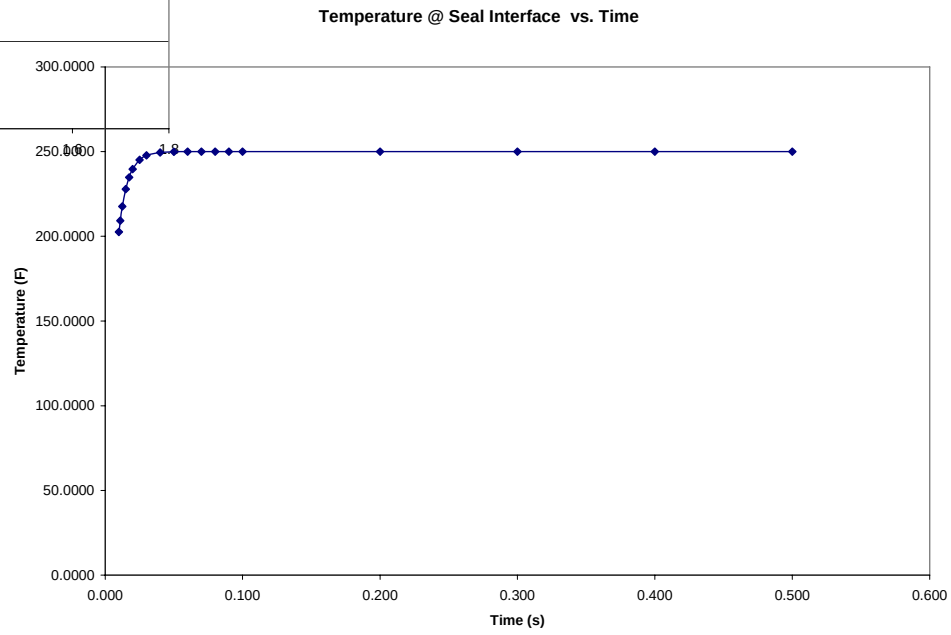
- Most common type of sealing is heated tooling
  - Often called hot bar, bar, constant temperature, heat sealing, etc.
- Depending on conduction through the materials
- Generally need higher melt point on outside than on inside

Model of Conductive Heat Sealing

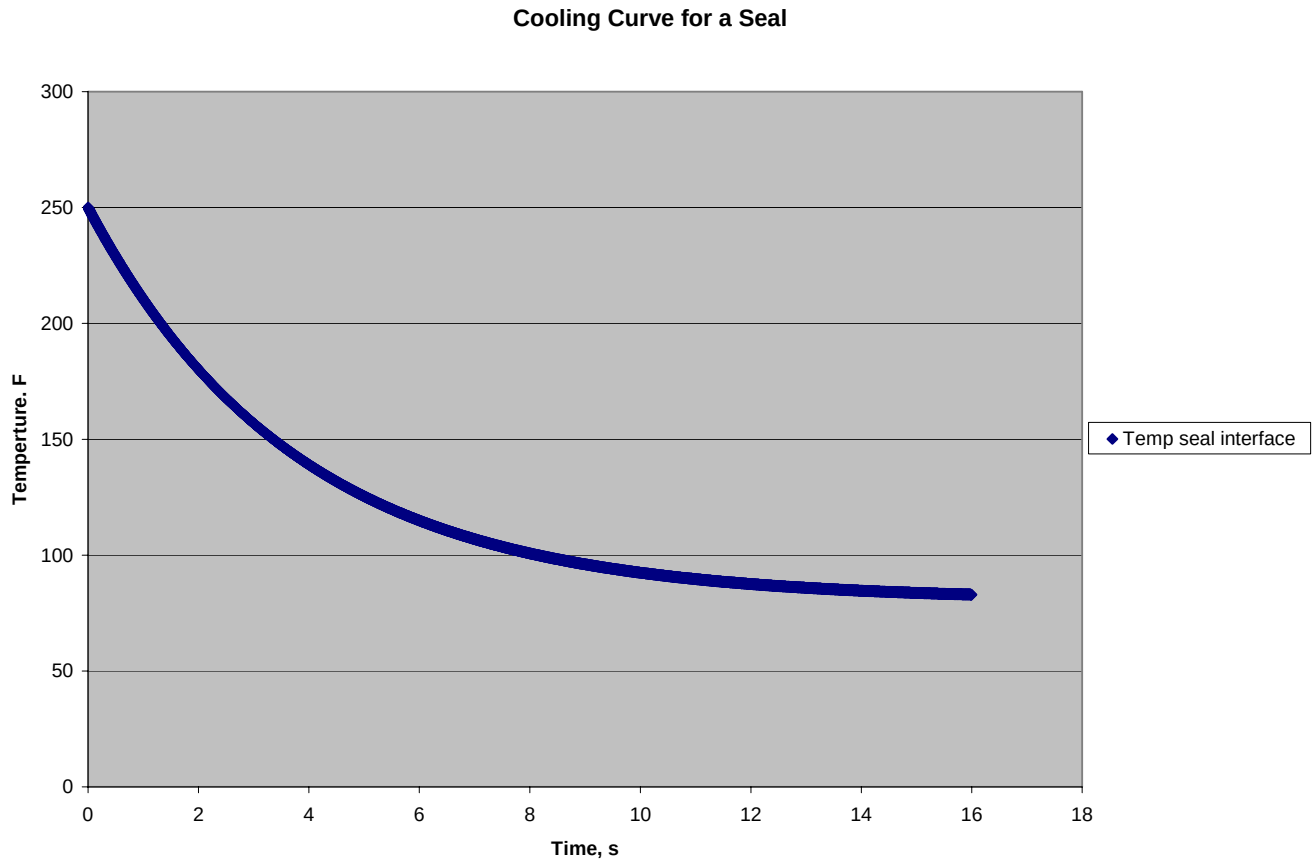


2 mil LLDPE sealed two sides at 250 F

2 mil LLDPE sealed one side at 250 F



Model of Cooling of Heat Seal



2 mil LLDPE initially at 250 F

To Understand Seal Mechanisms

- Separate:
  - The mechanism of creating the seal
  - The mechanism of opening the seal

3 Mechanisms of Making a Seal

- Chain entanglement across seal interface
  - Aka molecular intermingling, autohesion
  - Molecular chains cross interface & entangle together
- Intermolecular bonding
  - Functional groups on one seal partner attracted to those on other seal partner
- Mechanical Seal
  - No real chemical compatibility involved
  - Plastic flows into pores or around fibers of seal partner

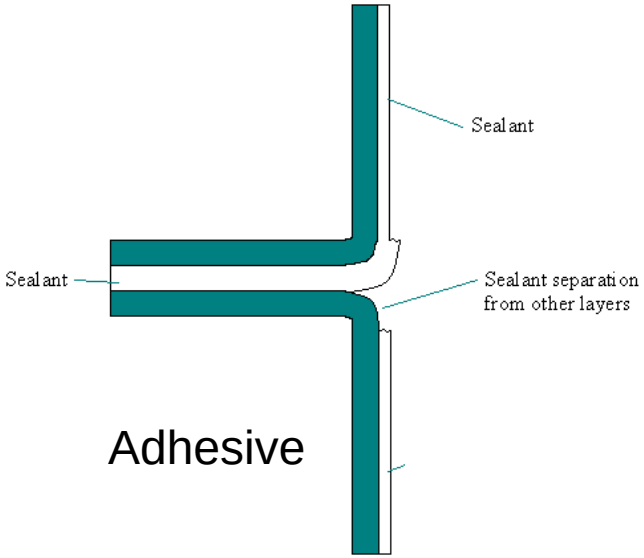
4 Opening Mechanisms

- Destruct / Fusion - Seal is stronger than something else, so something else breaks
- Adhesive (peelable)- When opening, sealant comes away from seal partner
- Cohesive (peelable)- Sealant on one of the seal partners breaks within itself
- Interfacial / delamination (peelable)- Seal strong, but delamination built into structure allows for easier opening

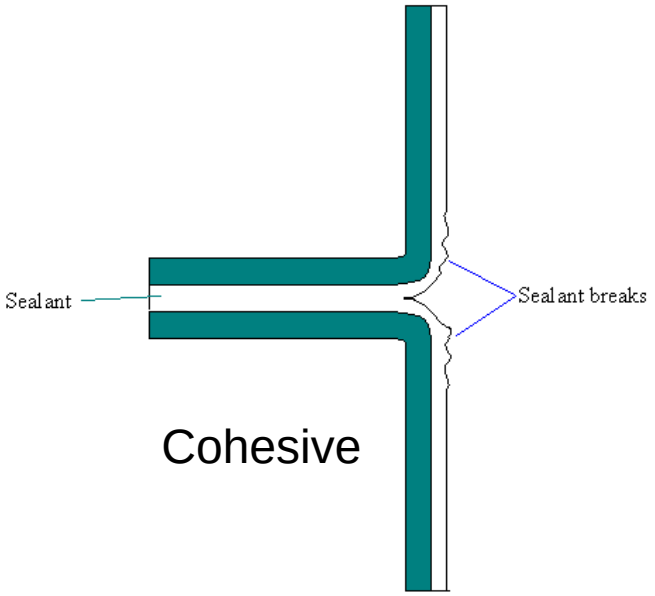
Relating Seal Mechanisms to Opening Mechanisms

- Chain entanglement
  - Typically destruct, cohesive, interfacial peel
  - Blended sealants can result in cohesive or adhesive bonds
- Intermolecular bonding
  - Typically adhesive
- Mechanical
  - Typically destruct, cohesive

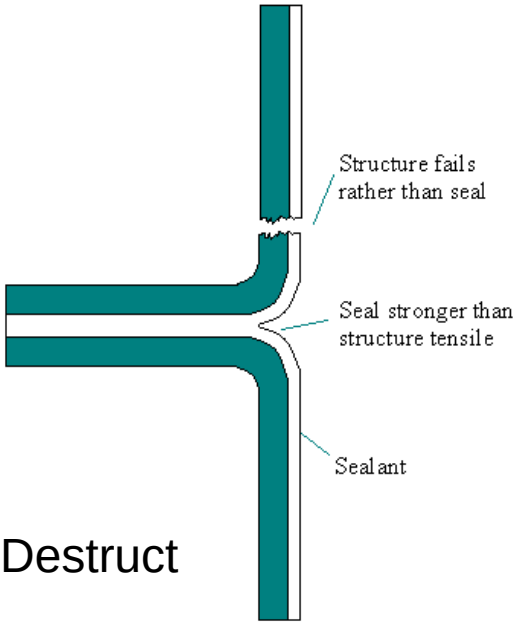
Opening Mechanisms



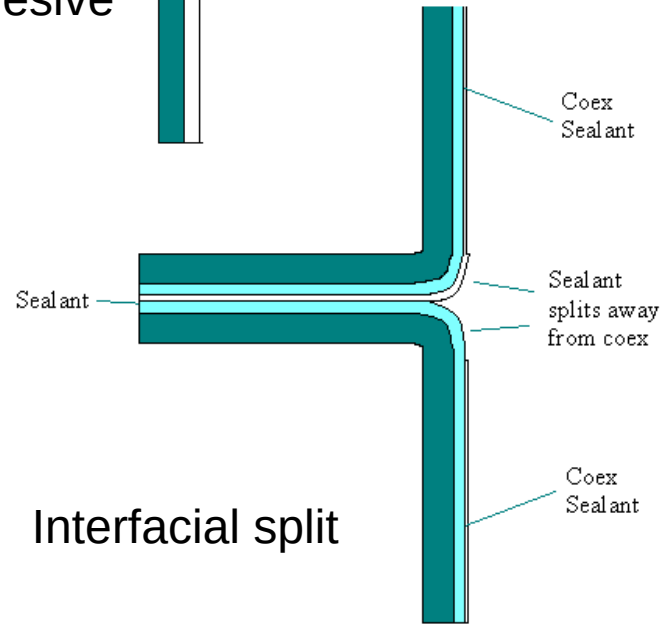
Adhesive



Cohesive



Destruct



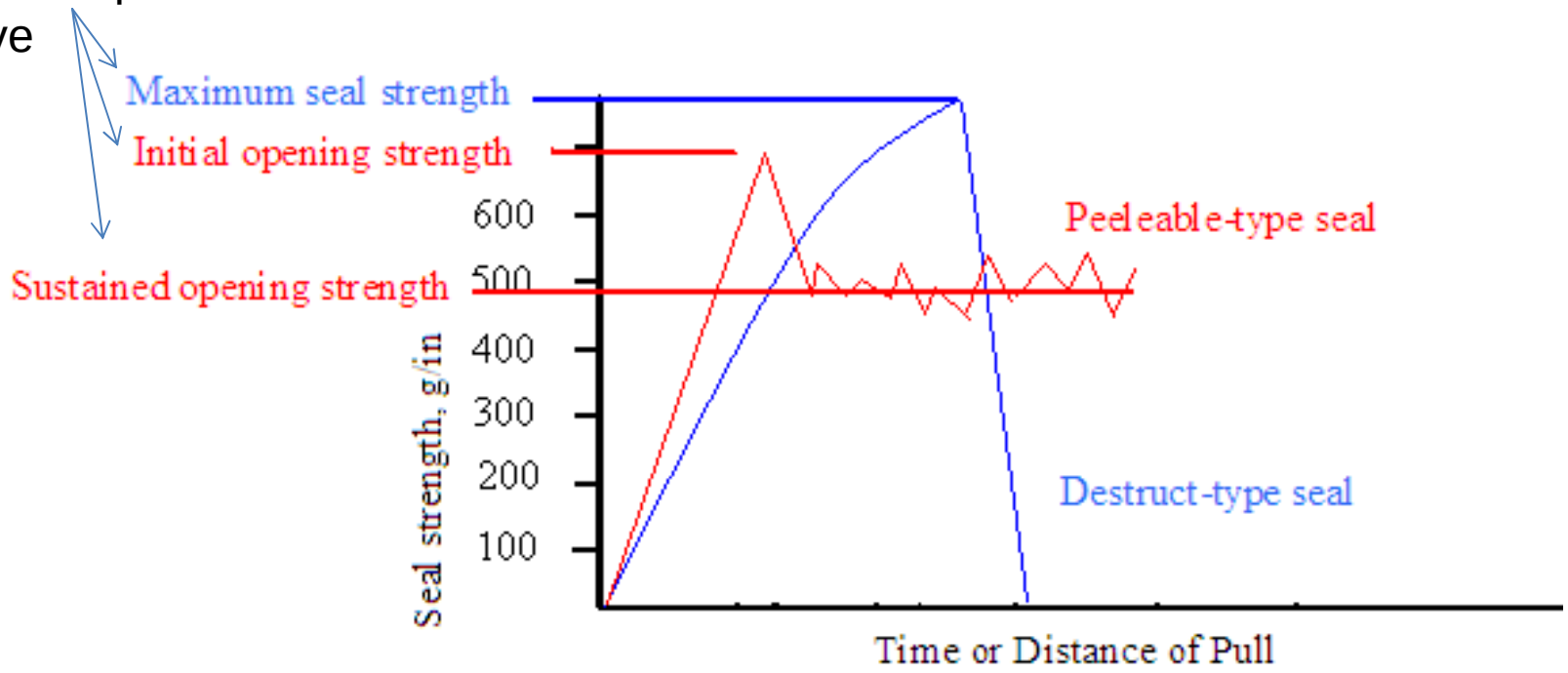
Interfacial split

Seal Curves

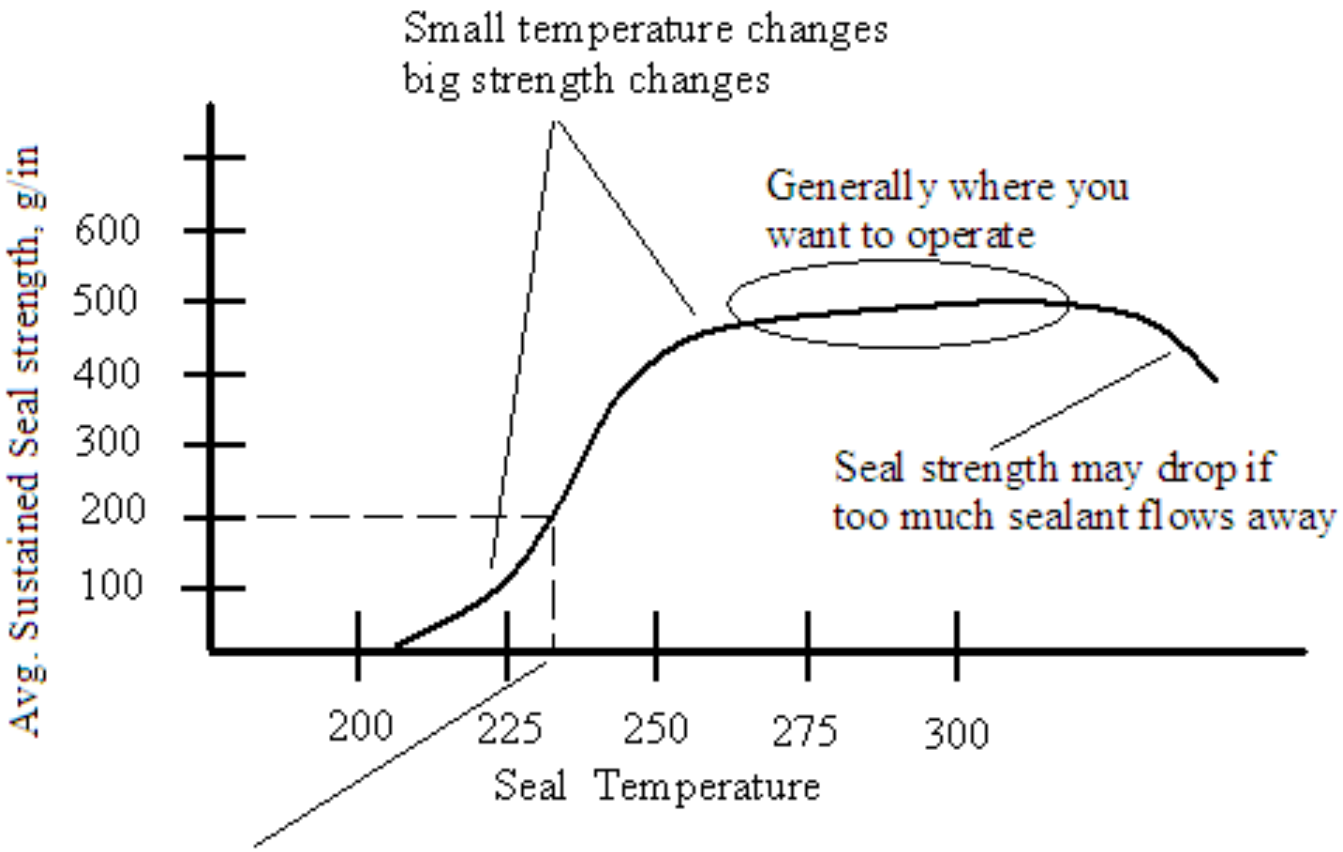
- Help to characterize / predict seal behavior of material
- Derived from seal test
- Y-axis: Seal strength
- X-axis: Energy (usually temperature)
  - Pressure, time could also be used

Seal Test- What To Expect

Typically, one of these will end up in the seal curve



Example Seal Curve



Risks of Using MST / SIT

- Can be arbitrary- different film companies use different “minimums”
  - ASTM specifies a number
- Different polymers / processing may give different shapes
- Best practice is to have entire curve

Seal Curves with MST's

Hot Tack

- Seal curves measured when seal has cooled
- For some applications, seal when hot is important
- Seal may encounter impact or pressure when hot trying to push seal open
  - Vertical form fill seal machines
  - Hot fill applications

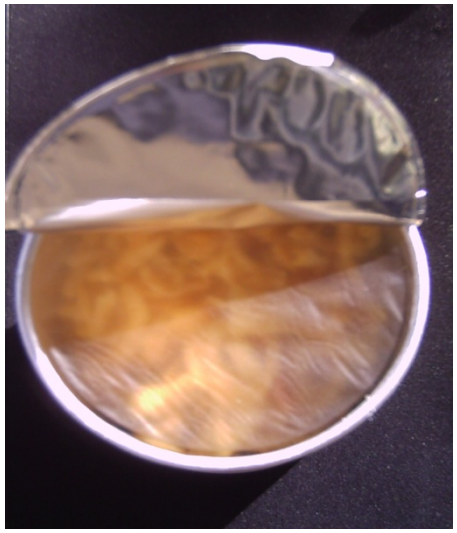
Measuring Hot Tack

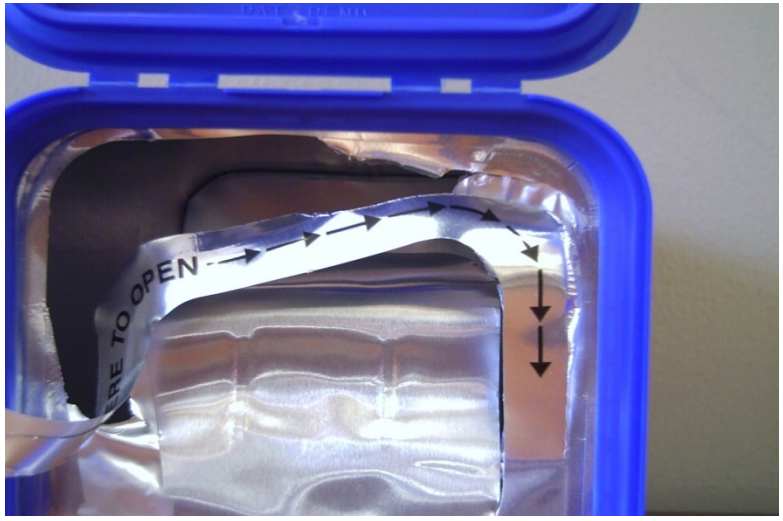
- Make seal on device
- Immediately after seal jaw opens, measure seal strength
- The stronger the opening force when hot, the better the hot tack properties

Heat Seal Defects: Poor Seals

- Insufficient / Excess time, energy, pressure
- Incompatible layers
- Wrinkles in seal area
- Misalignment on packaging line
- Completely missed seal
- Tear / delaminate on opening

General Seal Defects

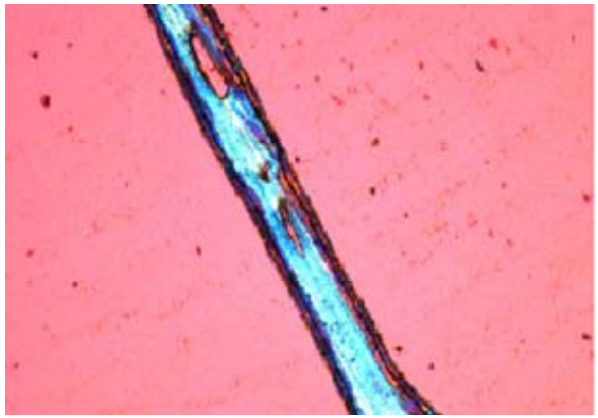


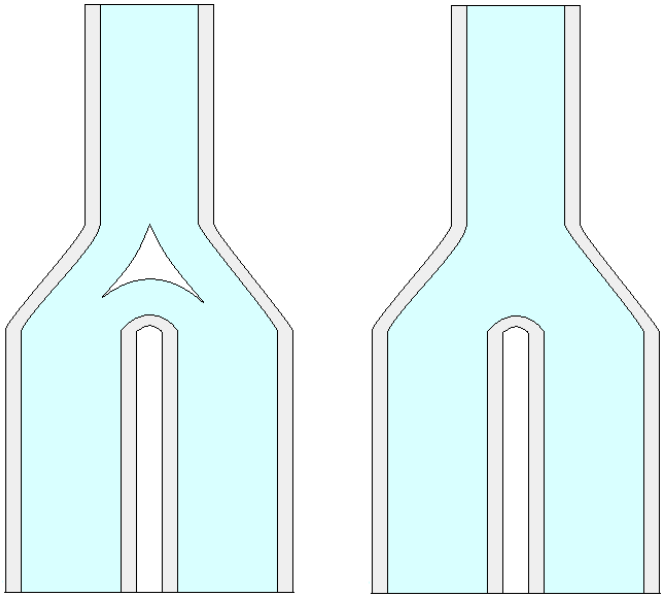


Causes of Leaking Seals

- Product in seal
- Insufficient (or excess) time, energy, pressure
- Gussets, fins, laps that go from one thickness to another
  - Sealant has to flow to prevent open channels
  - “Caulking”

Leaking Seals





Product in Seal: Powders & Particulate

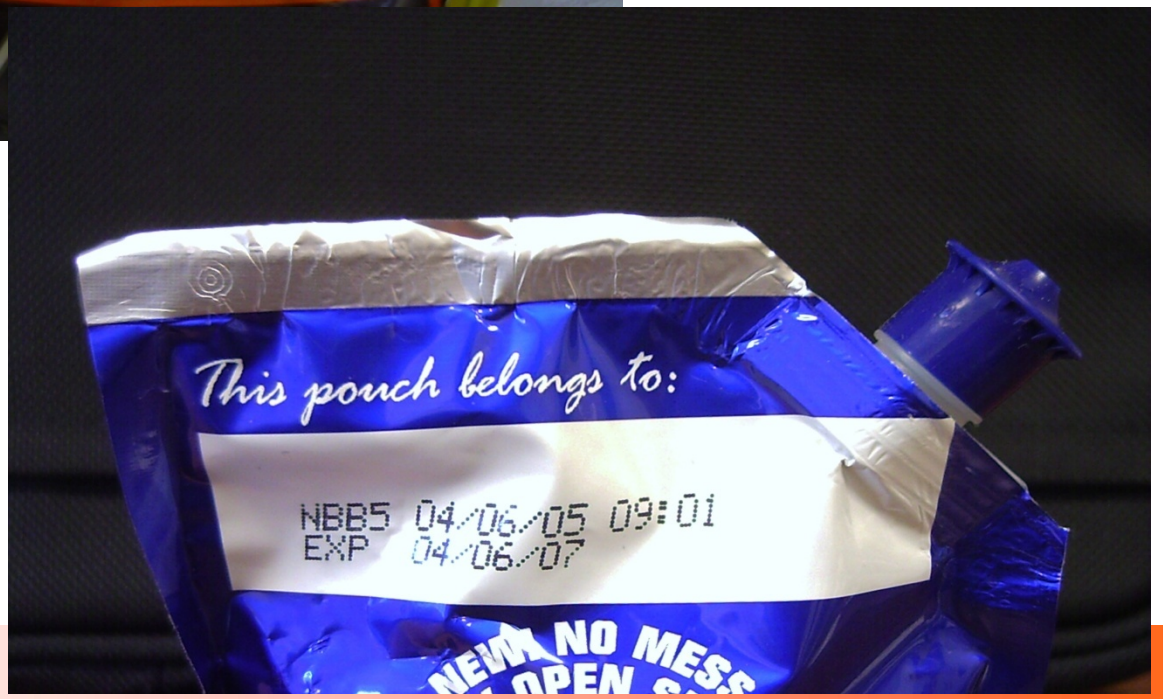
- May not melt at all
- If they do melt, probably not compatible with sealant
- Options
  - Prevent it from happening during fill
  - Flush it out with lots of sealant
  - Get sealant that seals through contamination

Solid in Seals

Product in Seal: Liquids & Grease

- Low vaporization temperatures
  - Vaporize & expand during seal, may break seal back open
- High vaporization temperatures
  - May not blow seal open, probably prevent seal
- Options
  - Prevent it from happening during fill
  - Get sealant that seals through contamination

Liquid in Seals



Packaging Material Components in Seal: Slip Additive

- Added to promote machinability
- Some versions migrate to film surface: “bloom”
- Slick, powdery on surface & prevent good seals
- Options
  - Adjust slip additive to balance machinability and COF
  - Use non-migratory slip additives

Packaging Material Components in Seal: Solvent-free Adhesive

- Solvent-free adhesives start as monomers / oligomers
- Small enough to migrate into and through film
- Interact with slip additive in high slip films to contaminate seal surface
- Options
  - Change slip package / concentration
  - Change adhesive

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Thank You

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