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Testing Solutions for Beverage Applications – Closures and their Test Methods



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Closures - Their Job

- Primary Function
 - To seal the container
 - lined closure
 - linerless closure
- Secondary Function
 - To offer tamper indication
 - shrink band
 - mechanical band
 - shrink wrap



Closure Styles

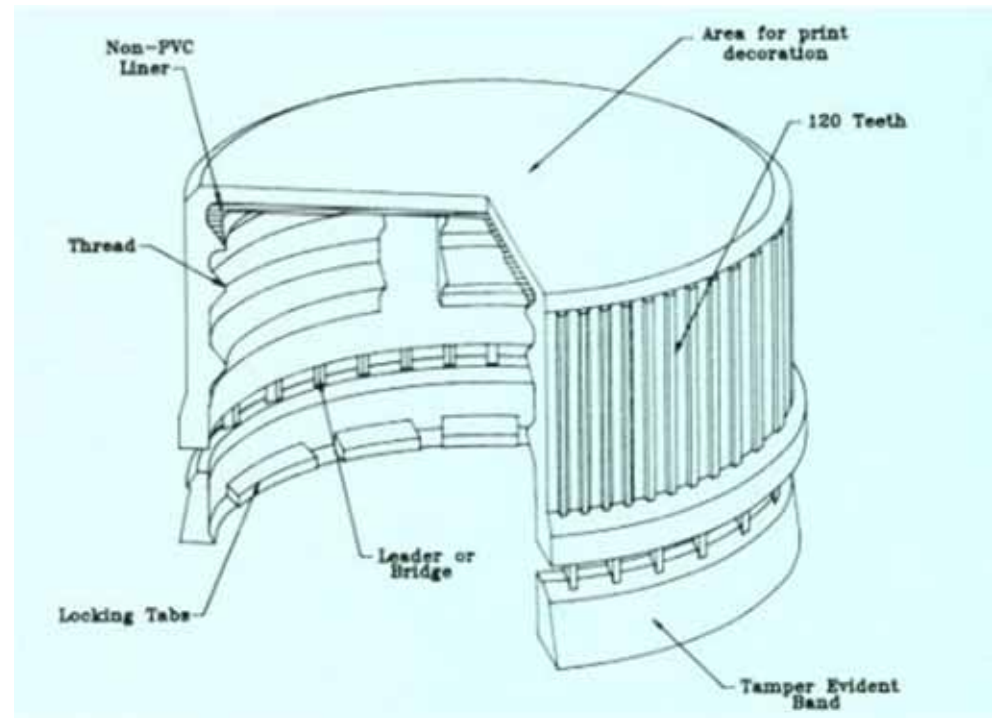


- Continuous Thread (CT)
- Child-Resistant Closure (CRC)
- Snap Cap (PE milk bottles)
- Dispensing (water bottles, dish washing soaps)
- Hinged dispensing (ketchup bottles)
- Hybrid plastic threaded ring with metal insert (peanuts, sauces)



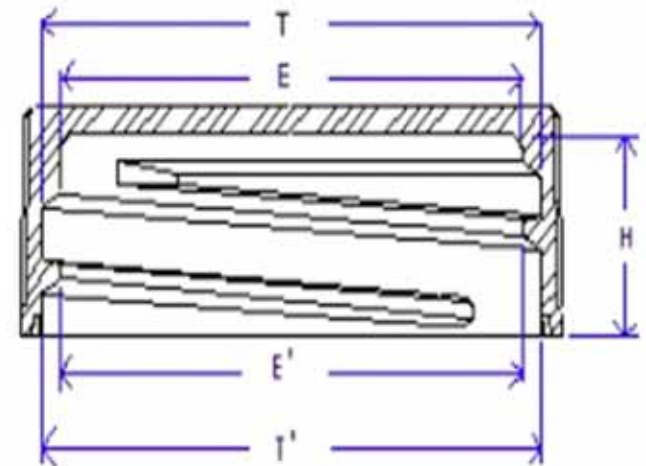
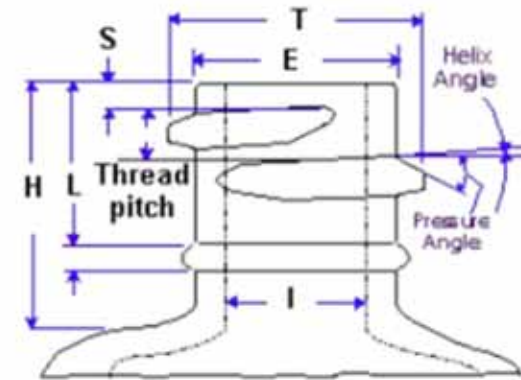
Plastic Closure Terminology

- Closure Body
- Threads
- Liner
- Tamper Band



Closure/Bottle Finish Dimensions

- Bottle Finish
 - “T”: thread diameter
 - “E”: sidewall diameter
 - “D”: finish to tamper-band hgt.
 - “J” : band drop dimension
 - “A”: tamper band diameter
 - “A1”: diameter under bead
- Closure
 - “E”: thread open diameter
 - “T”: inner sidewall diameter
 - defines closure size in mm
 - “B”: tamper-band diameter



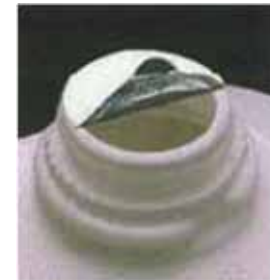


Plastic Closures - Materials

- Thermoset Materials
 - Very strong, rigid closures
 - Threads formed into the closure during molding
- Thermoplastic Materials
 - PP, PS, HDPE and LDPE
 - Threads formed into the closure during molding
- Closure Additives
 - Nucleation agents, Antioxidants, Anti-Static agents
 - Slip agents (lubricants), Pigments
 - affect closure impact resistance
 - can alter shrinkage and final dimensions

Plastic Closures - Sealing Mechanisms

- How do closures effectively seal the containers they are applied to?
- Sealing Structures include:
 - Gasket style
 - Liners
 - Linerless
- Sealing Geometries include:
 - Top Seal on Finish
 - Top Corner Seal on Finish
 - Plug Seal Inside Finish ID





Product Function & Requirements

- Limit loss of desired Gas volumes
 - e.g. maintaining carbon dioxide in CSD
- Limit ingress of oxygen
 - e.g. preventing spoilage of juice
- Etc...

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Testing – General Dimensional & Performance

- ❑ Closure dimensions: Critical dimensions of the closure are measured and compared to the specifications. Critical dimensions are those that could affect application and function.
- ❑ Filled Package Drop Impact: The ability of the closure to remain intact on the bottle finish after a six-foot drop onto the bottom and side of filled packages is evaluated.
- ❑ Ball Impact: A steel ball is dropped from a fixed height onto applied closures in several impact orientations. Effect of impact on closure (nature and degree of damage, full or partial closure release, etc.) is documented.



Testing – General Performance

- ❑ Removal Torque: The amount of torque required to remove the closure from the finish in a filled package is measured.
- ❑ Secure Seal Test (SST): Closure/finish assemblies are cut from bottles and pressurized to measure the ability of the closure/finish seal to hold pressure, providing a measure of how well the closure seals to the finish.
- ❑ Strip Torque: The amount of torque required to strip the closure by over-application onto the finish is determined.

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Testing– Carbonated Soft Drink or Pressurized Non-Carbonated

- ❑ Elevated Temperature Cycle: Filled packages are run through a thermal cycle at elevated temperature to make sure that the closure will remain applied during temperature swings such as would be expected in day-to-night transitions in warm weather markets.
- ❑ Opening Performance: Closures are removed from filled packages to determine if the closures will remove properly from the finishes on first opening by a consumer. Tamper band breakage and proper venting of the closures are noted and reported.
- ❑ Pressure Retention (Shelf Life): Retention of pressure in filled packages is measured over time to determine if shelf life needs are met.



Testing– Carbonated Soft Drink or Pressurized Non-Carbonated

- ❑ Topload Vent: Filled packages are toploaded under water after storage at elevated temperature to determine the ability of the plastic closure to maintain seal, simulating storage on pallets stacked in a warm warehouse.



Testing – Hot Fill

- ❑ Back-Off: Closures are applied under hot fill conditions and the degree to which they back-off (“loosen”) is measured.
- ❑ Pull-Up: Closures applied under hot fill conditions are visually checked to see if they have been applied to sufficient application angle to ensure adequate seal.
- ❑ Security: Closures applied under hot fill conditions are removed and re-applied to finger-tight position to give an indication of liner resiliency.
- ❑ Vacuum Retention: Vacuum in hot filled packages is measured 12-24 hours after filling to determine ability of package to hold vacuum.

Testing – Permeation – Oxygen

- Closure
- Bottle
- Bottle + Closure



Testing – Permeation – CO₂



Testing – Permeation – CO₂



Bottle w/ Closure: 1.05 cc/day

Bottle w/ Epoxy over closure: 0.62 cc/day

Bottle w/ Epoxy over closure and finish 0.57 cc/day

(When using a high barrier bottle, choose a high barrier closure)

Testing – Permeation – CO₂





Summary:

- Closures are designed with many different styles and features
- Test methods exist for measuring a variety of closure attributes
- Test methods exist for measuring characteristics of the closure/bottle systems (how well do they work together)
- Permeation test methods are key for isolating the source of gas loss/ingress; whether it's the bottle, closure or a leak at the interface



Thank You!

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Questions?

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MOCON's Next Webinar....

New Demands on Medical Device/Pharmaceutical Testing

Wednesday, September 14th

10:00am Central