



pti

Inspection Systems



Institute of
**Packaging
Professionals**

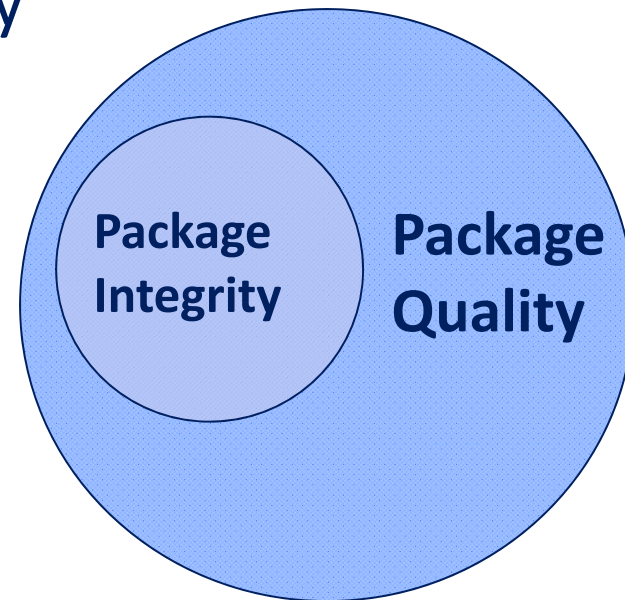
Non-Destructive Package Testing: Driving Sustainable Operations

Overview

- Sustainability
- True Cost of Destructive Testing
- Six Sigma Perspective
- Cost Effective Solutions

Package Integrity

- Package integrity – the ability to maintain a sterile barrier.
- Package integrity is a sub-category of quality and is exclusive of:
 - Peel Strength
 - Burst Testing
 - Visual Inspection



Environmental Perspective

Minimal impact on the environment, reducing resource consumption and waste.

Operational Perspective

Operate today without compromising tomorrow.

Two Main Goals:

Eliminate Waste

Improve Quality

Non-Destructive Testing

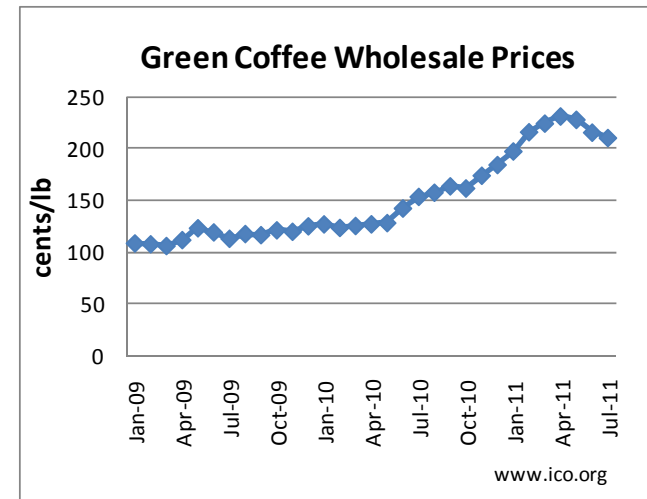
→ Two birds with one stone.

Common Method

Water Bath - Bubble Leak Test

ASTM F2096-04

- Water Bath – Flexible Barrier Systems
- Moisture/Flavor critical defect size – 15 microns
- Water bath sensitive to 25-50 microns
- Typically test 20 pouches/line/hour
- Current market price of coffee > \$2.00/lb

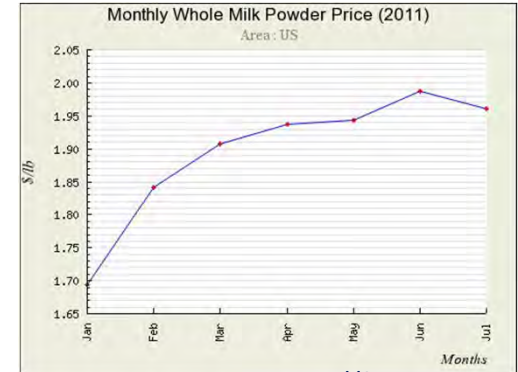


$$\begin{array}{ccccccc} \text{Bags Tested} & \text{1lb Bags} & \text{\$/lb} & \text{Hours, Days, Weeks} & \text{Up-Time} & & \\ \hline 20 & \times & 1 & \times & \$2 & \times & 24 \times 7 \times 52 \times 0.5 = \$174,720 \end{array}$$

Common Method O₂ Head Space Analysis

ASTM F2714-08

- 6 day dwell.
- 3% pass/fail limit.
- 50 micron defect 700 gr. dry fill pouch.
- O₂ shifted from ~1% to ~2.5%.



<http://future.aae.wisc.edu>

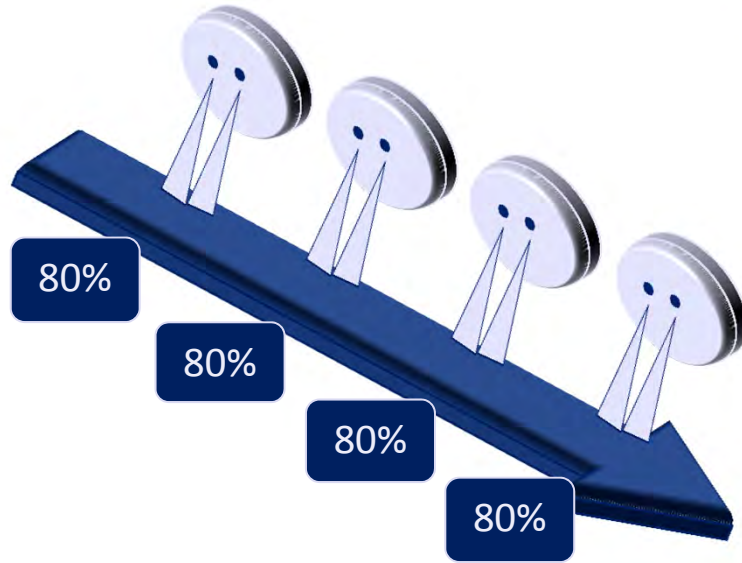
$$\begin{array}{ccccccc}
 \text{ppm} & \text{Up-Time} & \text{Minutes, Hours, Days} & & \text{Units} & & \\
 \hline
 60 & \times & .5 & \times & 60 & \times & 24 & \times & 6 & = & 259,200
 \end{array}$$

\$4.41/kg

$$\begin{array}{ccccccc}
 & & \text{kg/unit} & & \text{Cost/kg} & & \\
 & & \hline
 259,200 & \times & .7 & \times & \$4.41 & = & \$800,150
 \end{array}$$

Manual Visual Inspection

ASTM F1886



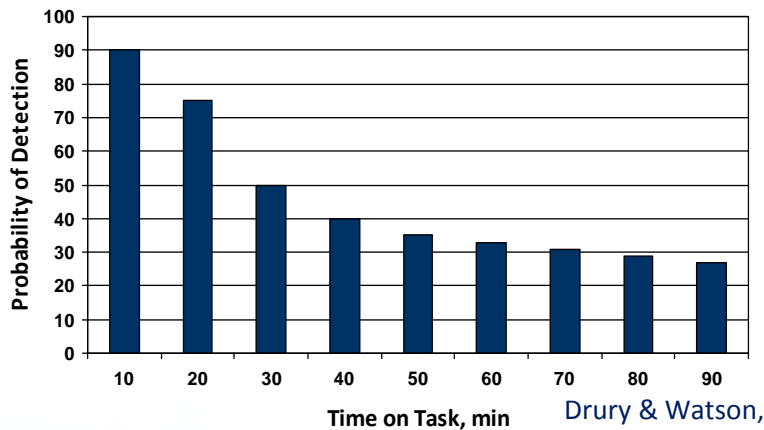
➤ Channel leaks down to “75 μm [0.003 in.] with a 60–100 % probability”¹.

Assumptions

1,000 Packs/Day 1% Defect Rate
10 Defects/Day ~2,500 Defects Per Year
80% POD (Above Average)

100% Inspection = 500 Defects/Year
200% Inspection = 100 Defects/Year

400% Inspection (4 Operators)
4 Undetected Defects/Year
0.16% probability that a defect will go undetected.



Drury & Watson,
2002

¹<http://www.astm.org/Standards/F1886.htm>

Non-Destructive is Cost Effective

Product	Cost of Raw Materials	Quantity Tested	Frequency	Cost/8 Hour Shift	Cost/Year (2 Shifts, 250 Days)
Dry Fill Soup Mix	\$0.23	8	Every 30 min.	\$29.44	\$14,720
Effervescent Tablets	\$0.04	80	Every 30 min.	\$51.20	\$25,600
Coffee Singles Pod	\$0.06	200	Every Hour	\$96	\$48,000
Luer-Lok Syringe	\$0.20	50	Every 30 min.	\$160	\$80,000
Pharma Blister Pack	\$1.12	10	Every 30 min.	\$179.20	\$89,600

Consider Better Alternatives

- Non-Destructive vs. Destructive
- Quantitative vs. Attribute
- Non-Subjective vs. Operator Dependent
- Calibration Capability
- Validation Effectiveness
- Simple Methodology (no sample prep)

Six Sigma Framework - DMAIC

➤ Define

➤ Measure

➤ Analyze

➤ Improve

➤ Control

Foundation of Quality Control

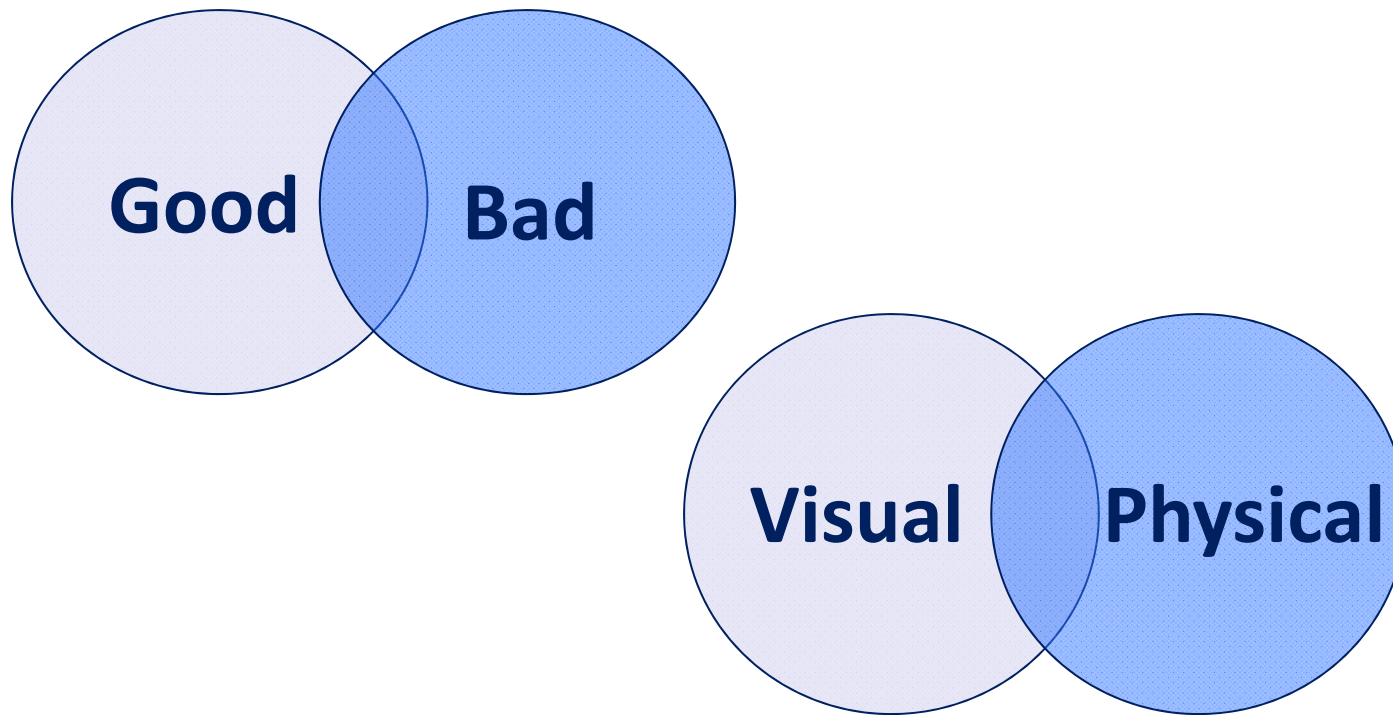
Define

Quality cannot be controlled without discrete and measurable characterizations of quality.

Measure

Quality cannot be controlled without accurate and definitive measures of quality.

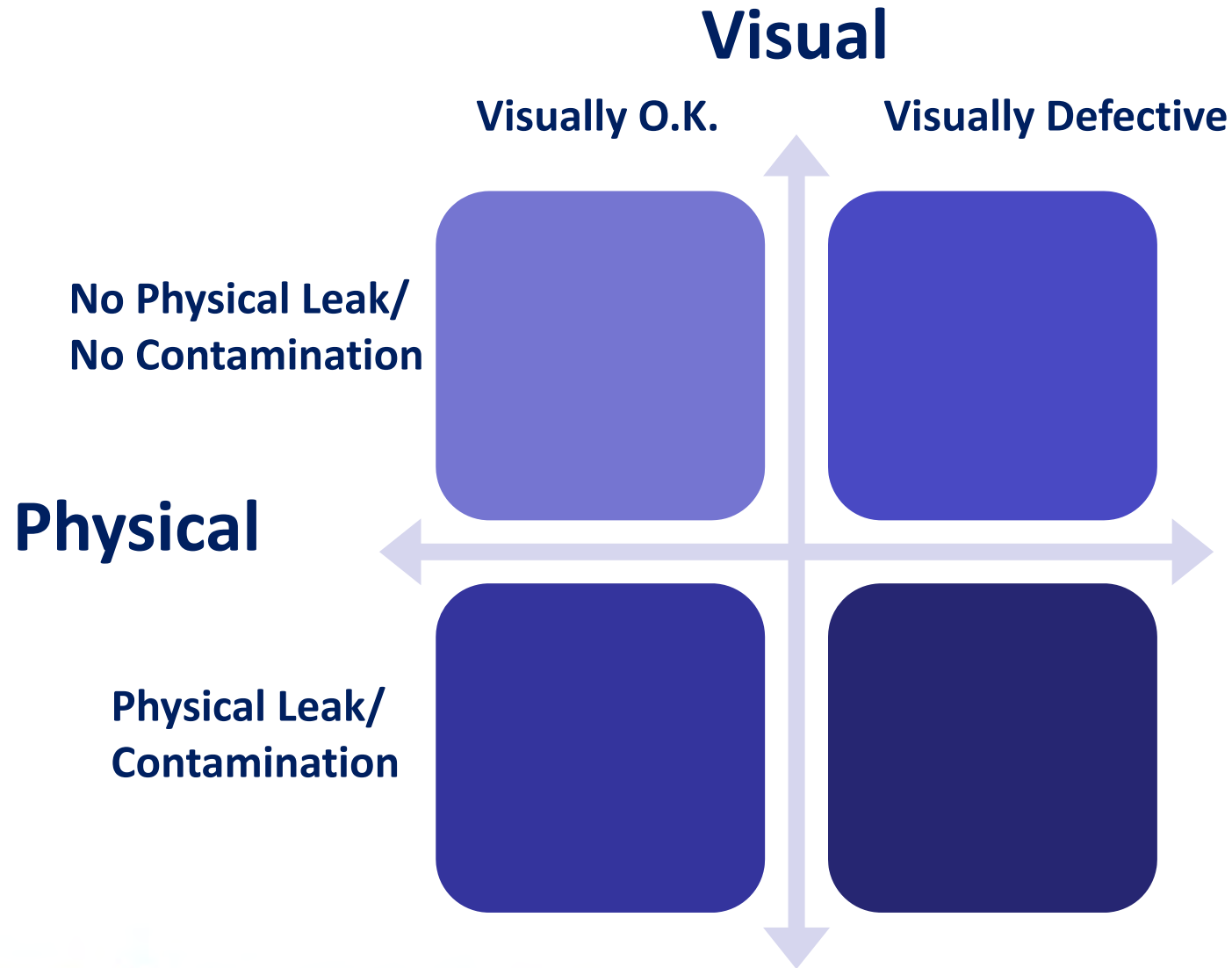
How is Quality Defined?



What gray area definitions pervade your operation?

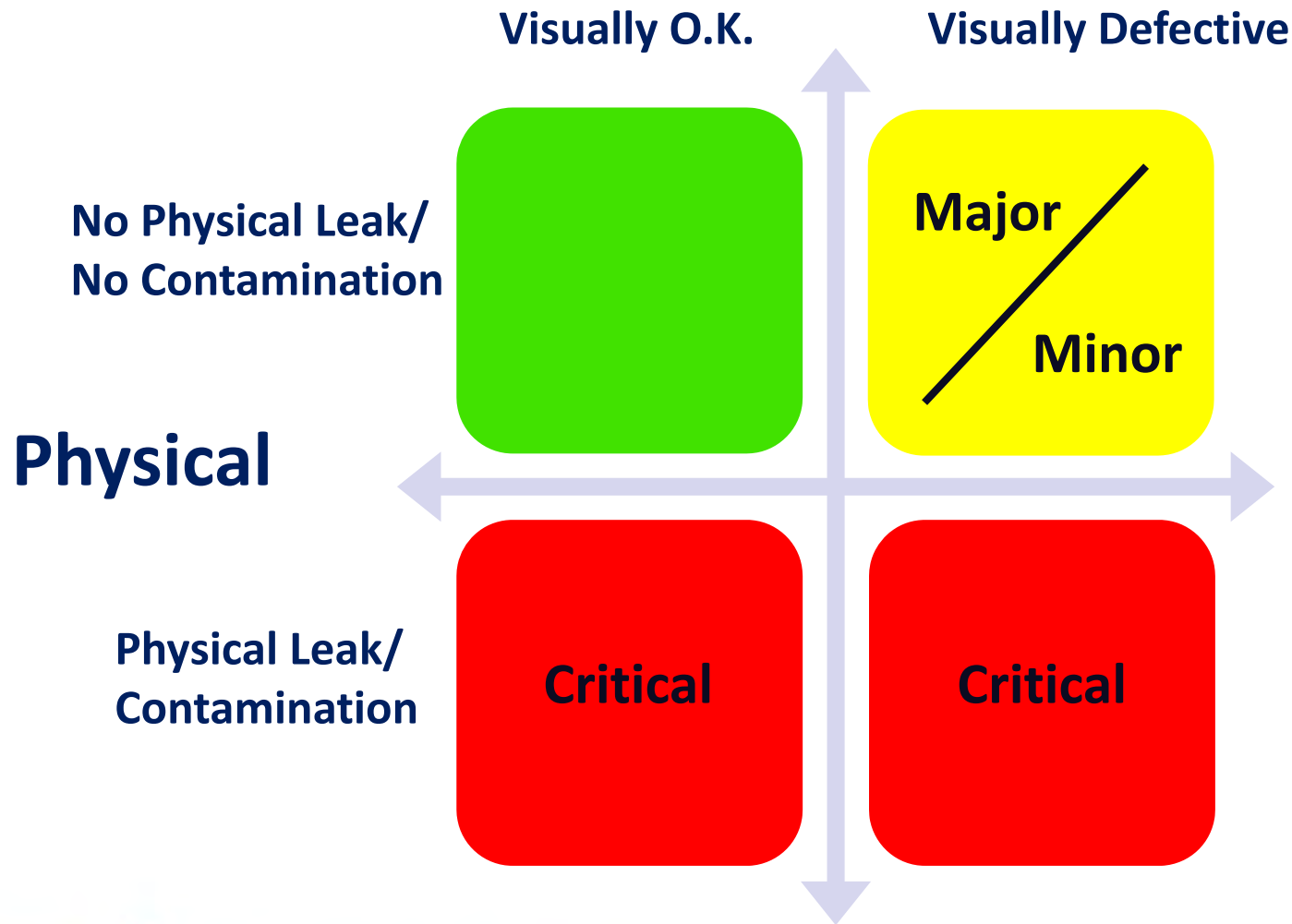
Common Approaches to Defining Package Integrity

- “Looks good”
- Capability (Best Available Technology)
- Equal to/Better than
- Third Party White Papers
- Grandfathered Industry Standards
- “Critical, Major, Minor”



Codify Quality

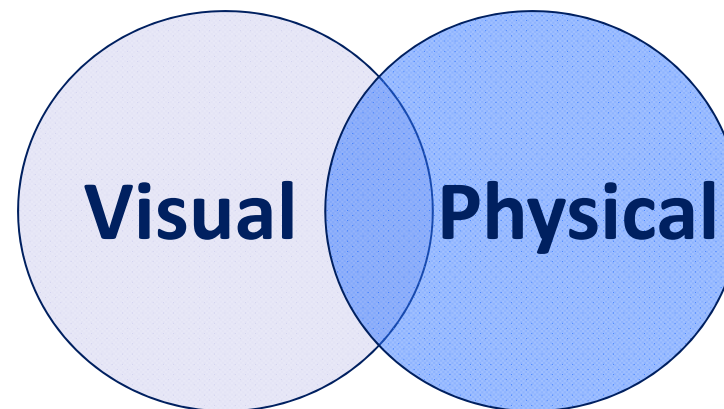
Visual



Develop measurable definitions.

Measuring Quality

- Industry Standards (ASTM, ISO)
- Manual Visual Inspection
- Grandfathered Methods
- Implied Quality Measures



Know Your Package Physics

- Blue dye ingress works for rigid and semi-rigid packaging, NOT flexible packaging.
- Water bath bubble leak test requires that vacuum be pulled to a point beyond the maximum expansion of your package.

$$P_1V_1 = P_2V_2 = P_3V_3$$

Direct Measures of Quality

ISO 11607 – Annex B

- Vacuum Decay (ASTM F2338)
- Seal Strength (ASTM F88)
- Airborne Ultrasound Seal Inspection*
- Visual Inspection (ASTM F1886)
- Dye Migration (F1929)
- High Voltage Leak Detection*
- Burst Strength (ASTM F2054)
- Bubble Immersion (ASTM F2096, D3078)

* Not listed in ISO 11607 or ASTM

Non-Subjective, Quantitative

- Vacuum Decay (ASTM F2338)
- Seal Strength (ASTM F88)
- Airborne Ultrasound Seal Inspection

- High Voltage Leak Detection
- Burst Strength (ASTM F2054)

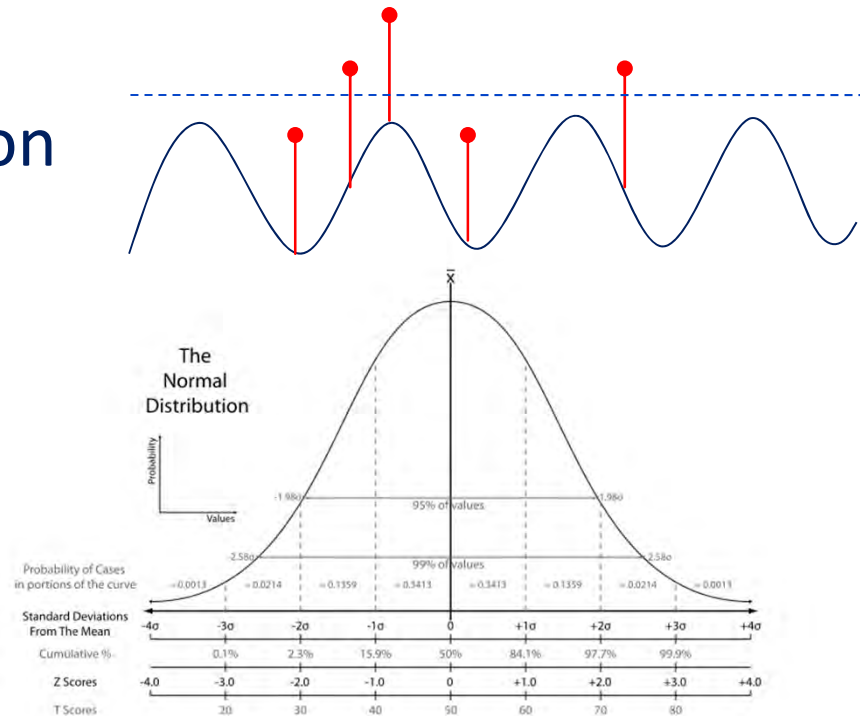
Non-Destructive

- Vacuum Decay (ASTM F2338)
- Airborne Ultrasound Seal Inspection
- High Voltage Leak Detection

Quantitative Measures Provide Greater Access to Statistical Tools

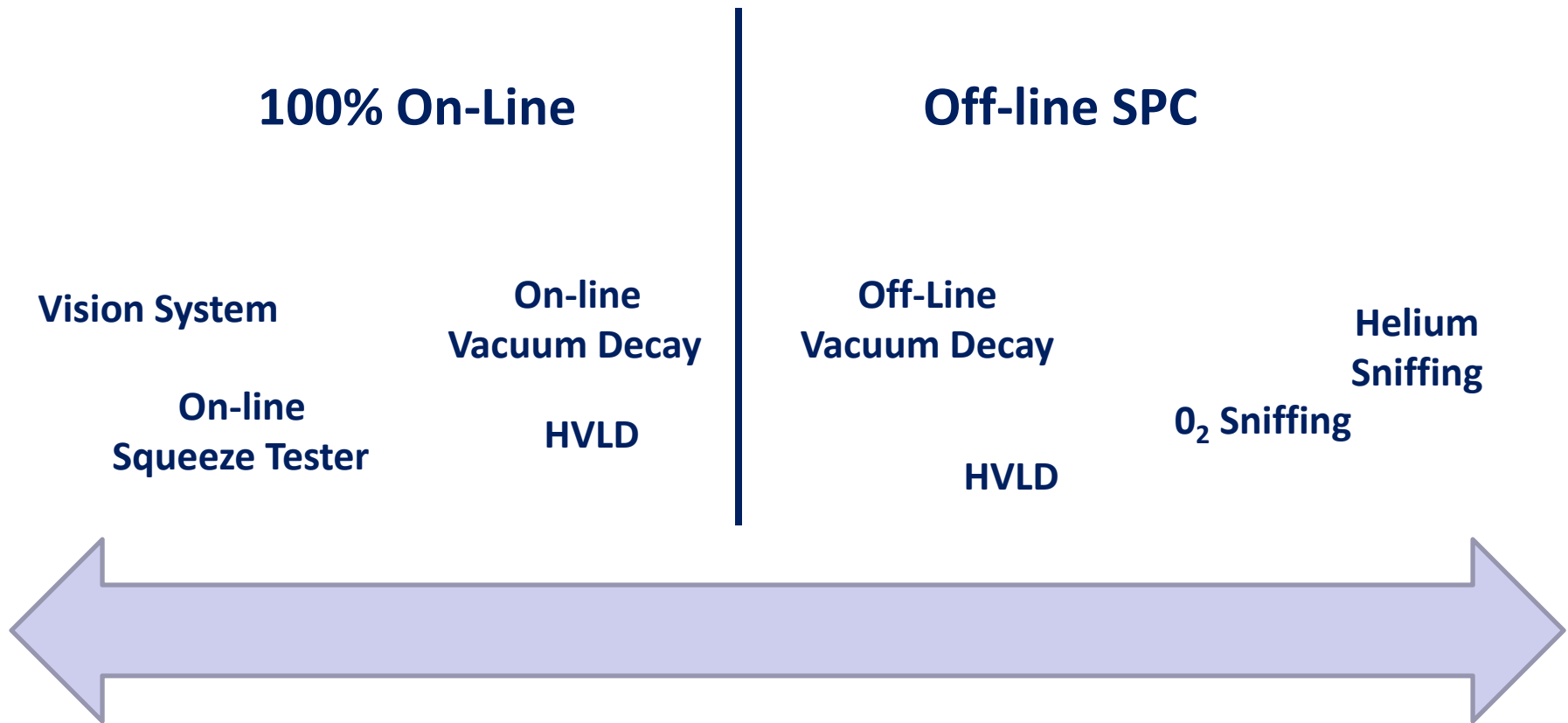
DMAIC

- Ultrasonic Attenuation
- Thickness
- Peel Strength
- Permeation
- Leak Rate



Attribute data fails to produce predictive measures of quality.

Capability Approach vs. Critical Requirement



Improve

Gray Measures

→ Gray Responses

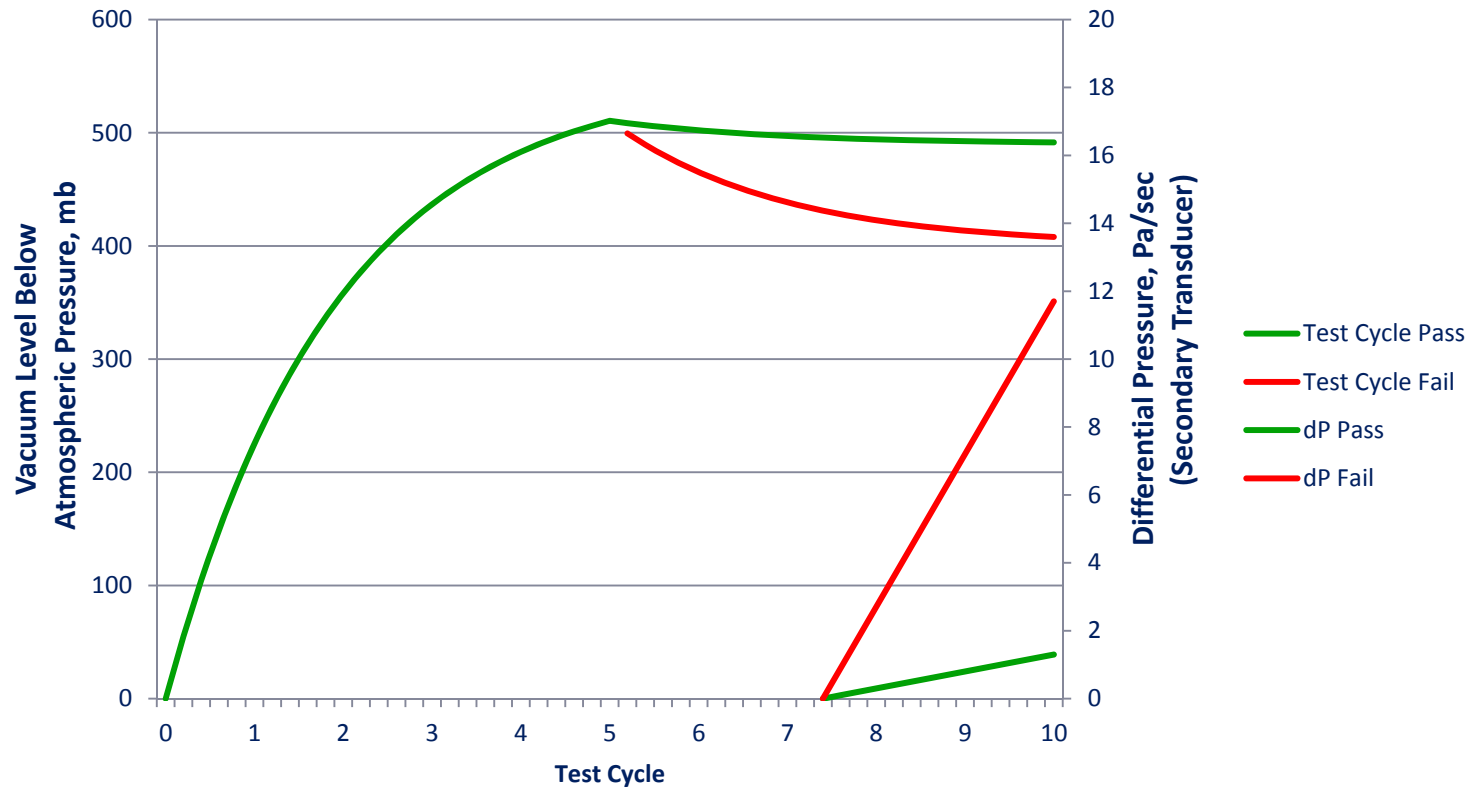
Control

The final stage of the
DMAIC process.

Vacuum Decay Leak Testing

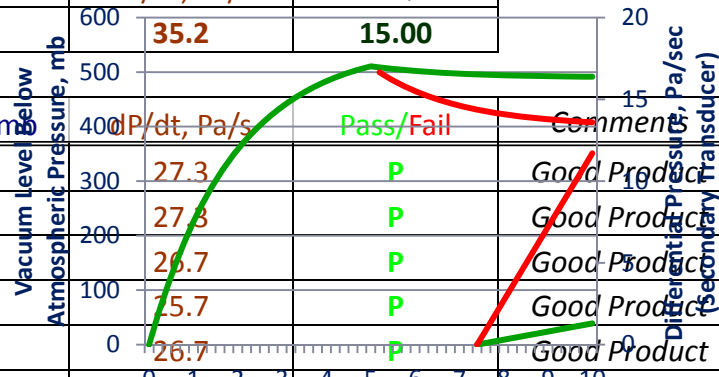


Vacuum Decay Test Method



Vacuum Decay for Flexible Packaging

TEST PARAMETERS		TStroke	1.50	
		TEqual	20.00	
Vac.	700.2	TTest	5.00	
	Vacuum, mb	dP/dt, Pa/s	TFill, s	
Ref	450.2	35.2	15.00	
Test #	Vacuum, mb	dP/dt, Pa/s	Pass/Fail	Comments
1	644.8	27.3	P	Good Product
2	639.3	27.8	P	Good Product
3	635.7	26.7	P	Good Product
4	638.0	25.7	P	Good Product
5	633.7	26.7	P	Good Product
6	586.6	95.4	F	25 micron
7	576.8	90.5	F	25 micron
8	638.0	56.6	F	15 micron
9	634.7	52.4	F	15 micron
10	636.0	40.4	F	10 micron
11	641.6	39.4	F	10 micron



Vacuum Decay Applications

- Hermetically Sealed Packaging
(Flexible, Rigid, Semi-Rigid)
- Tyvek® Lidded Trays
- Components & Fixtures

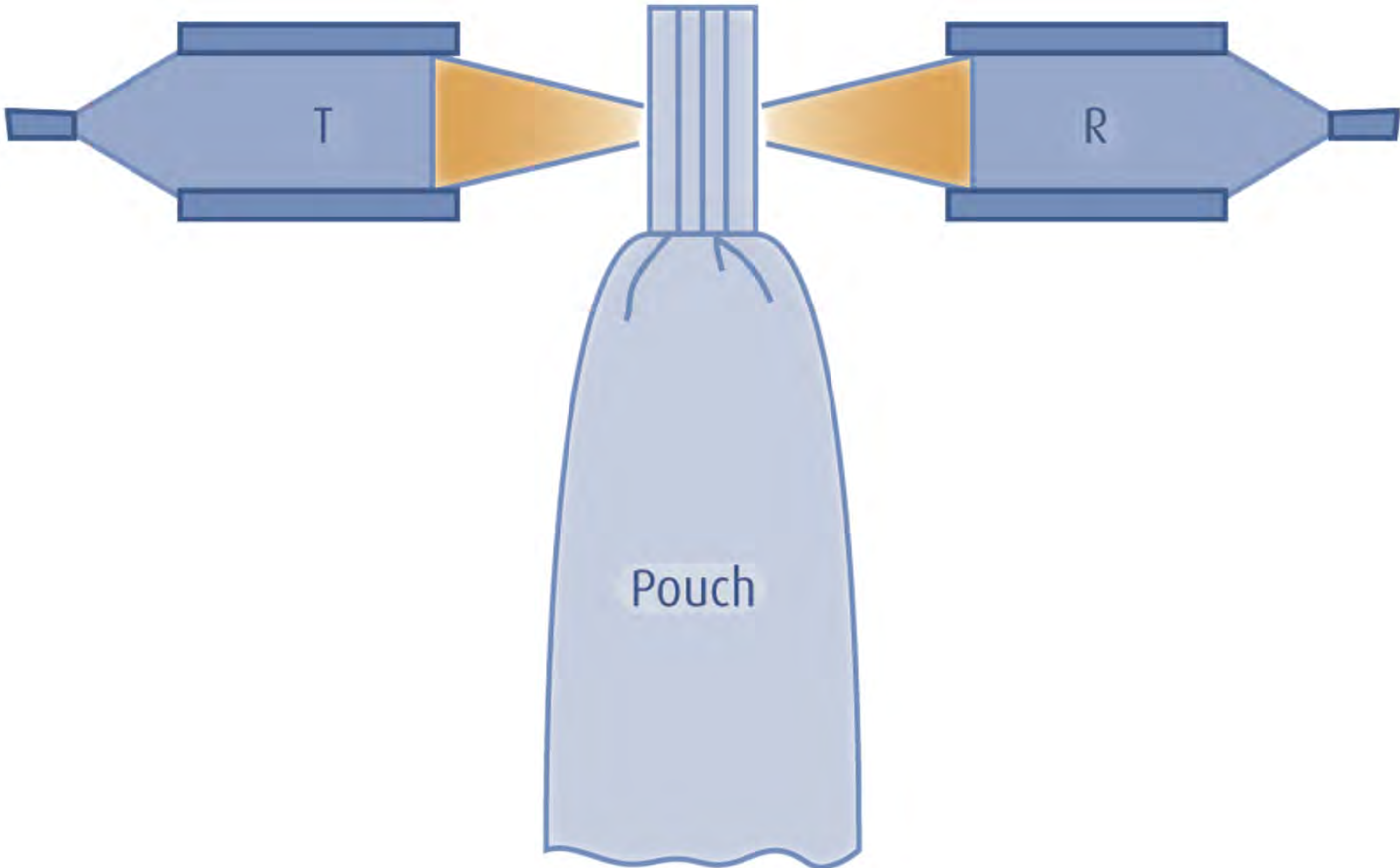
Vacuum Decay Summary

- Dye Ingress
- “Thumb Test”/Visual
- Bubble Leak Test
 - Subjective Results
 - One Chance to Observe
 - Costly Long Term



- Simple/No Package Preparation
- Quantitative Results
- Repeatable
- Non-Subjective
- Zero Waste

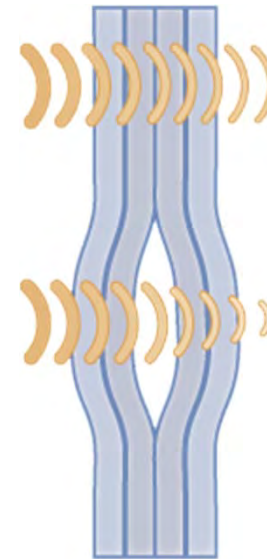
Airborne Ultrasound Through Transmission



Ultrasonic Signal

Propagate through single or multiple layers of well bonded materials.

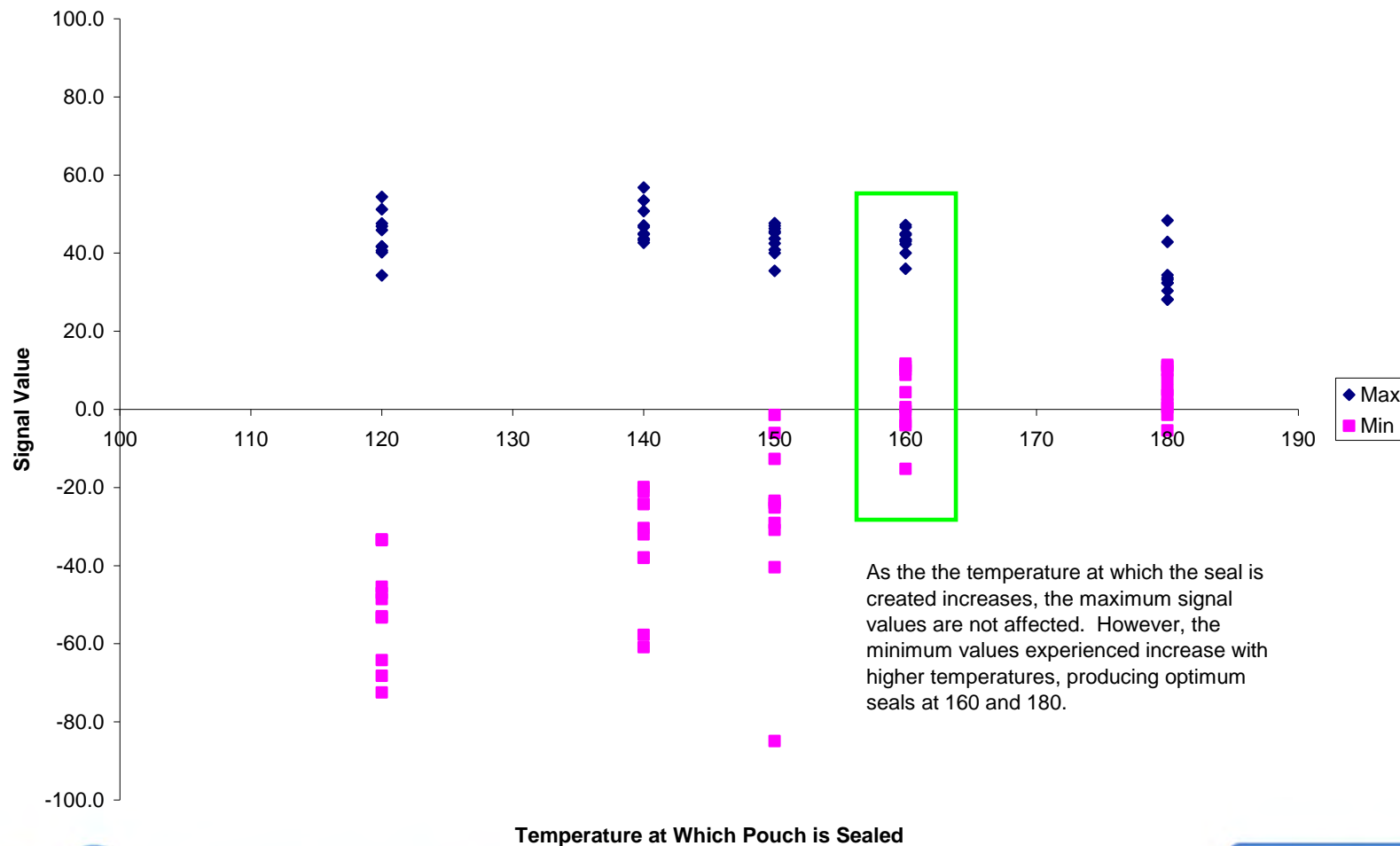
Reflection/absorption of sound waves by multiple layers.



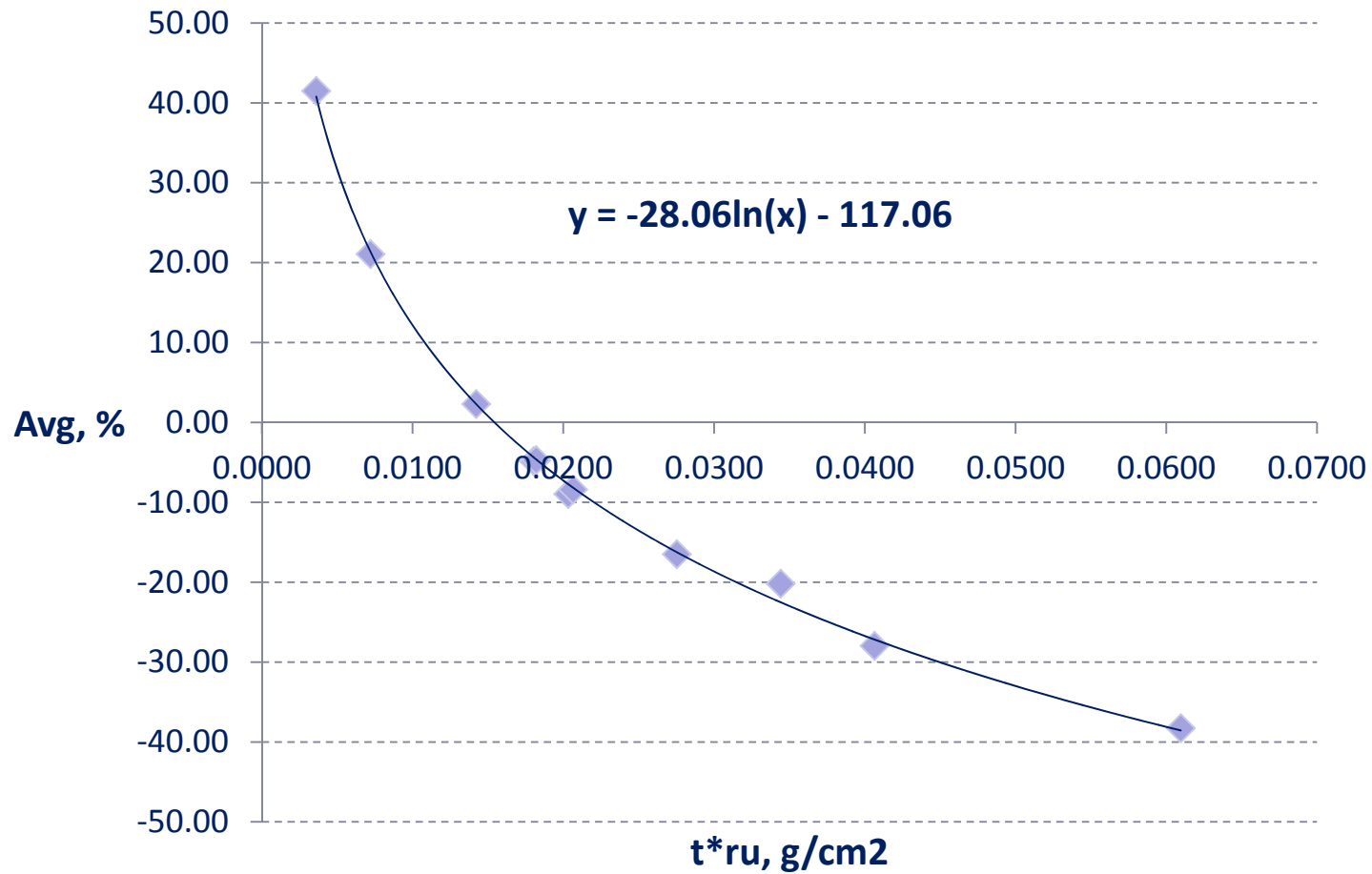
Seal-Scan® Online Pouch Seal Inspection



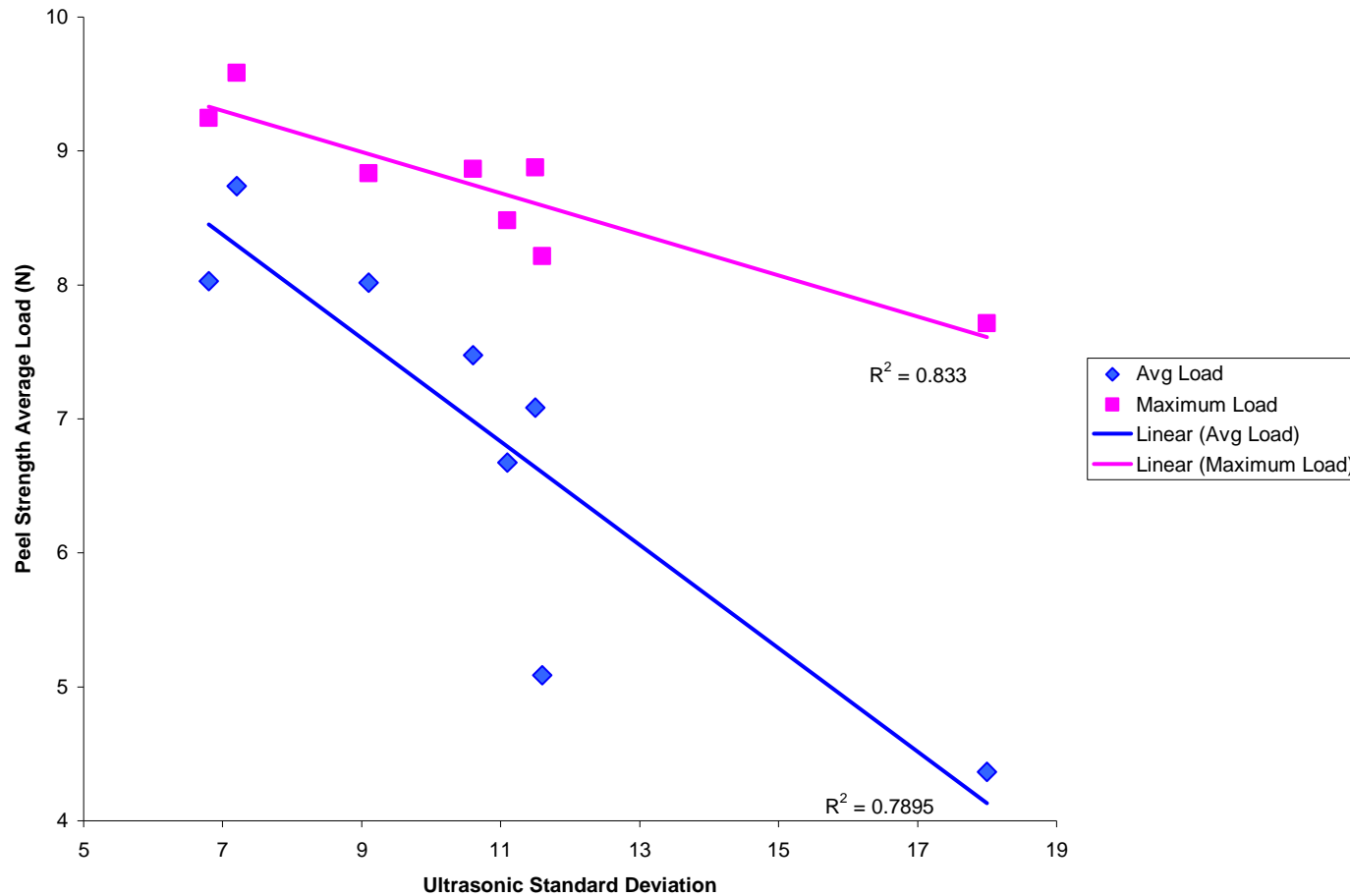
Optimizing the Sealing Process



Mass Pressure Analysis (g/cm²)



Seal-Scan[®] and Peel Strength Testing



Airborne Ultrasound Applications

- Seal Inspection
- Materials Analysis
- Flexible and Semi-Rigid Packaging
- On-line defect detection
- Off-line seal analysis
- Ideal for porous flexible packaging.

Ultrasound Summary

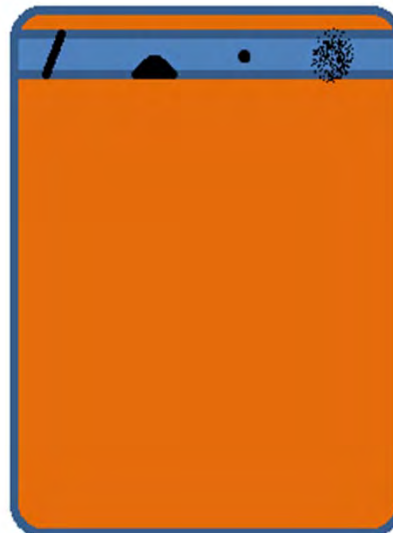
- Non-destructive
- Quantitative
- Optimize Process
- Characterize Materials
- On-Line Capability
- Traceable Standards
- Analyze, Improve, Control

High Voltage Leak Detection (HVLD)



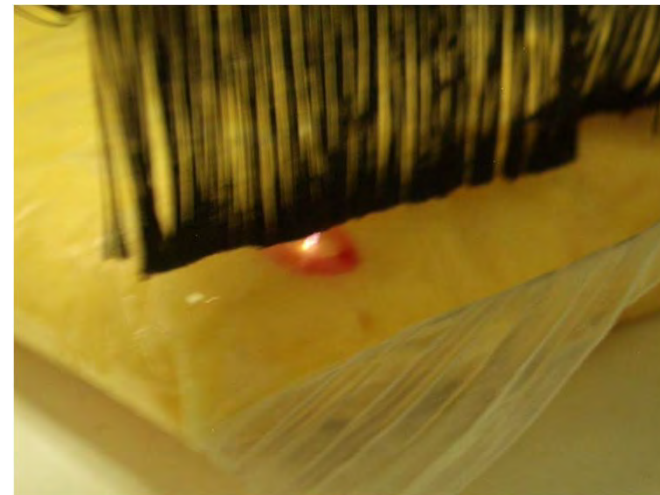
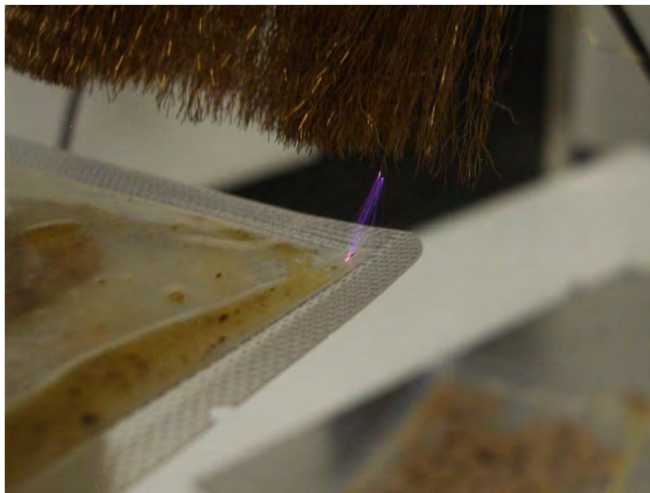
HVLD Defect Detection for Pouches

- Micro leaks down to 5 microns
- Pinholes
- Cracks
- Crystallized leaks
- Channel defects



HVLD Technology

- High voltage applied to container
- Ideally non-conductive materials
- Liquid triggers conductivity spike



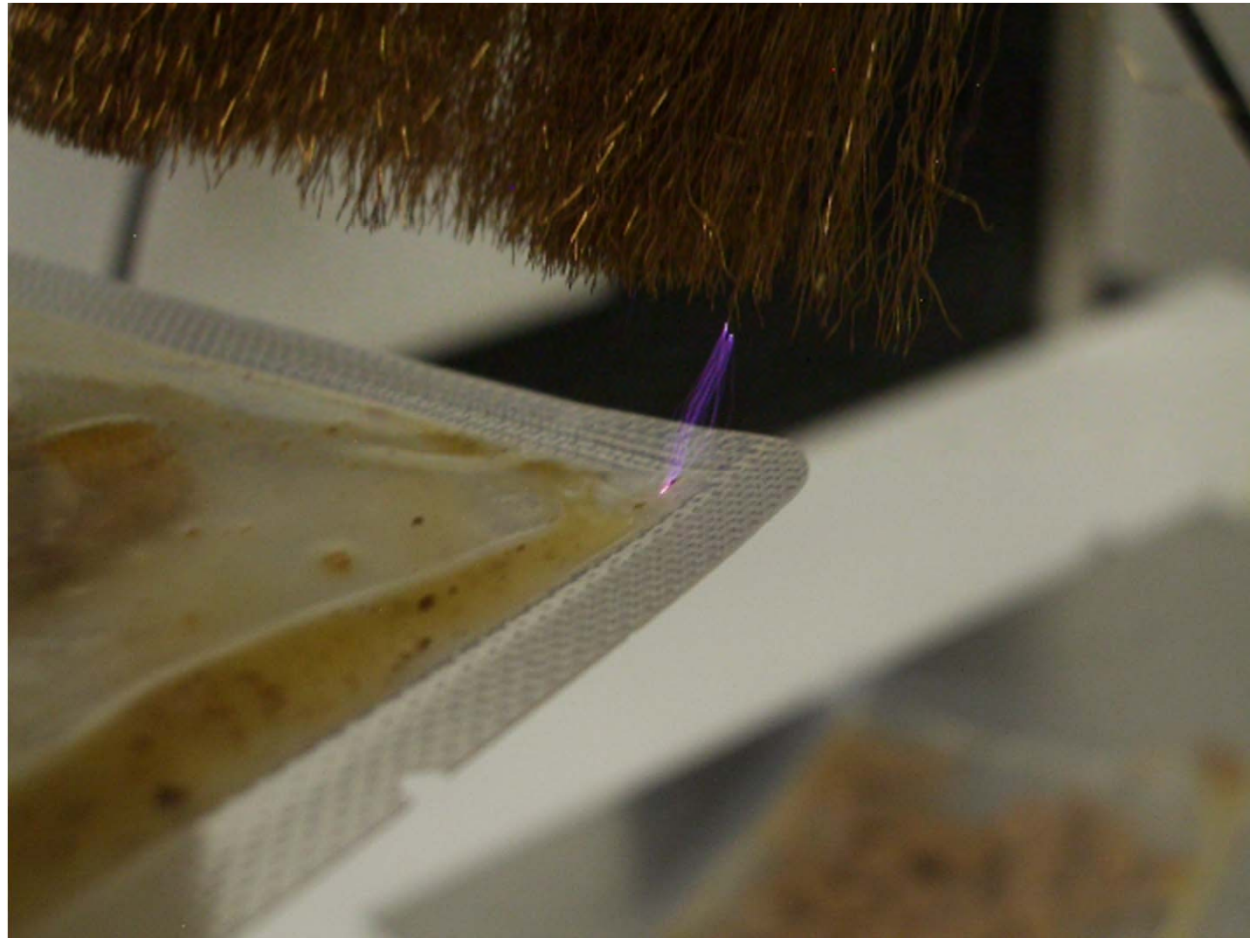
HVLD Online Pouch Inspection

Designated electrode design for critical ports and welds.



Size	Capacity
100~1,000 ml	6,000/ bags hr.

HVLD Detection



HVLD Applications

- Non-porous, Non-conductive
- Package Contents:
 - liquid products
 - protein based liquids
 - suspensions or emulsions
- Flexible or Rigid Barrier

HVLD Summary

- High Speed 100% On-line
- Liquid Fill Packaging
- Targeted Inspection
- Quantitative
- Detects Critical to Quality Defects

Two Main Goals:

Eliminate Waste

Improve Quality

Non-Destructive Testing

→ Two birds with one stone.

The Ideal Test Method

Informative

Accurate

Simple

Cost Effective

Reduces Waste

Increases Productivity

Six Sigma Framework

➤ Define

➤ Measure

➤ Analyze

➤ Improve

➤ Control

Thank You!

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