# SHRI VIJAY DEVASTHALE

## Hemetek Techno Industries Ltd.

# WEL COME

all

Guests

Delegates

Members

*Two Days Short Course*

*On*

# *"Flexible Packaging"*

*From*

## Indian Plastics Institute

## Mumbai

*Procedure of*

# Testing

&

## Significance

For

## Mechanical Properties

# Properties

- Density
- Strength
- Resistance to Puncture
- Elongation
- Stiffness
- Friction
- Seal-ability

…… and other

# *How Properties are getting affected?*

**Molecular Structure**

**and**

**Composition affect**

**Properties**

**and**

**Process-ability**

# *What is effect on Film ?*

Three basic molecular properties

- average molecular weight
- molecular weight distribution
- crystallinity or density

affect most of the properties essential for

high quality film extrusion

# *How they affect ?*

**Effects of LDPE Resin Physical Properties on film's Mechanical Properties**

| Film Property | As Density Increases |
|---|---|
| Elongation at rupture | Decreases |
| Film impact strength (toughness) | Decreases |
| Flexibility | Remains the same |
| Gloss | Remains the same |
| Heat resistance (softening point) | Increases |
| Impermeability to gases/liquids | Increases |

# *How they affect ?*

**Effects of LDPE Resin Physical Properties on film's Mechanical Properties**

| Film Property | As Density Increases |
|---|---|
| Tensile strength at rupture | Increases |
| Stress cracking resistance | Decreases |
| Resistance to film blocking | Increases |
| Mechanical flex life | Decreases |
| Clarity | Increases |

# *What we do to improve ?*

***Additives Used With Polyolefin Film Extrusion Resins***

| Additives | Primary Benefit |
|---|---|
| Anti-Static | Static buildup resistance |
| Slip/Anti-block Agents | Improved film to film slip |
| UV Stabilizers | Resistance to effects of sunlight |
| Color | Add color pigment concentrates to film |

# *Properties of Different Materials*

| Property / Material | SEALABILTY | WVTR | OTR |
|---|---|---|---|
| Nylon | BAD | BAD | GOOD |
| EVOH | BAD | GOOD | GOOD |
| BOPP | NOT GOOD | GOOD | NOT GOOD |
| CPP | NOT GOOD | GOOD | NOT GOOD |
| Blown PE | GOOD | GOOD | O.K. |
| Polyester | BAD | GOOD | GOOD |

# *What decides the selection of Material ?*

## *Application*

| Application | Material |
|---|---|
| Packaging Materials for Processes Food, Sea Food, Dried Food, Soya & Bean Paste | NY/PE, NY/L-LDPE<br>PET/PE<br>PET/VMPET/COMPOUND FILM<br>OPP/CO-CPP<br>OPP/PE etc |
| Packaging Materials for Refill Pouch Such as Liquid Shampoo & Rinse, Detergent Powder<br>Packaging Materials for Spout Cap Pouch | PET/L-LDPE<br>NY/L-LDPE<br>PET/PE/L-LDPE<br>PET/NY/L-LDPE etc |
| Packaging Materials for Soap, Shrink Film & Label<br>Packaging Materials for Agricultural usage | PET/PE<br>PEARL/PAPER/WAX<br>S-OPP etc |
| Packaging Materials for Retortable Pouch<br>Packaging Materials for Snacks, Instant Food & Noodles | OPP/PE<br>OPP/VMPET/PE<br>PET/PE<br>PET/PE/L-LDPE<br>PET/PE/AL/PE |

# *Selection of Material ?*

**Film or Laminate Property is important and must suit the Application**

***OR***

**Films / Laminates manufactured which has desired Properties for Application**

*How to make sure ?*

*that everything is Right as per Requirement*

# TESTING

# *Aim of Testing*

## Quality Assurance

- ✓Check Quality of Incoming Material
- ✓Check Quality during process
- ✓Check Quality of End product

# *Aim of Testing*

## Cost Cutting

- ✓Develop Material to meet the specific requirement
- ✓Sourcing just right Material
- ✓Reduce Waste
- ✓Reduce Rejections

A

**TEST**

IS

WORTH

THOUSAND

OPINIONS

# *NEEDS FOR A TEST*

## INSTRUMENTS

- ✓Accurate
- ✓Reproducible
- ✓Reliable Results
- ✓Calibrated

# *NEEDS FOR A TEST*

## SOFTWARE

- ✓Easy Setup,
- ✓Quick Testing,
- ✓Customised Reporting & Graphics
- ✓Upgradeable to Future needs and Software demands

# *NEEDS FOR A TEST*

## Data Management

- ✓Seamless DATA Transfer
- ✓ERP / Network

## Traceability of Results

- ✓International Standards
- ✓National Standards

# *Testing Instruments*

- Instruments for various Testing
- Standards for Testing
- Preferred Features for System

# *Properties of Material for*

# *Films or Laminates*

- Density
- Melt Flow Index
- Tensile Strength
- Elongation
- Resistance to Puncture
- Coefficient of Friction
- Hot-Tack

- Seal & Peel Strength
- Bond Strength
- Falling Dart Impact
- Tear Strength
- Stiffness
- Water Vapor Permeability
- Gas Permeability

# *Density*
# ASTM-D792

- Two / three Graduated Columns
- Reference Method
- Two Liquids used to make Density Gradient
- Standard Floats with UKAS Certification
- High accuracy up to 0.0001 g/ml
- Column Sweeping
- Column Filling
- Illumination
- Cathetometer

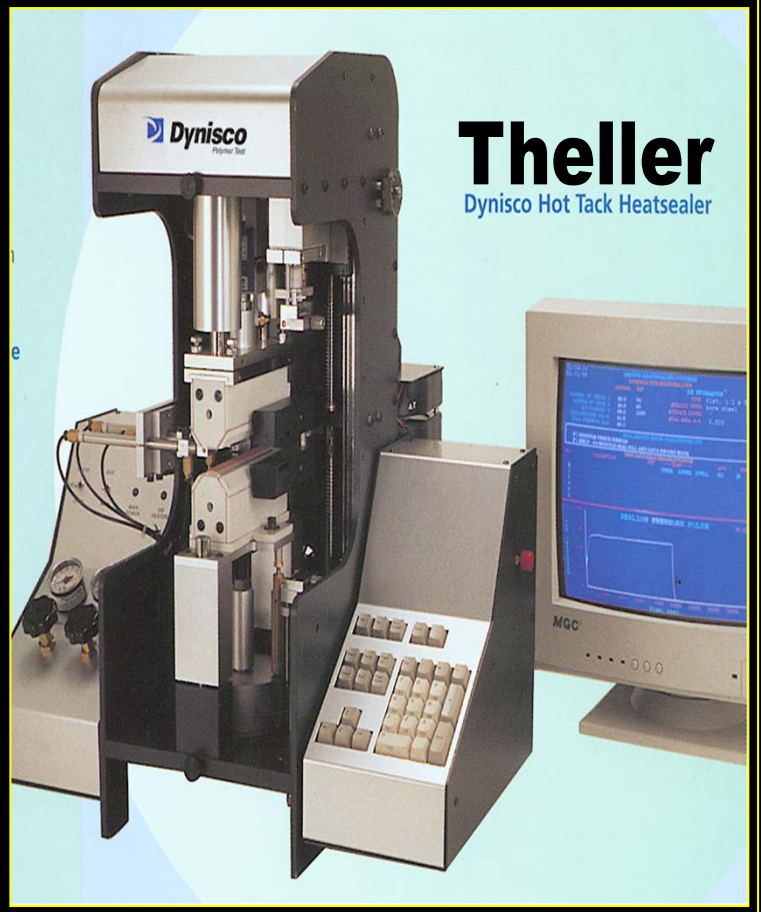
# *Melt Flow Index*

# ASTM-D1238 Method A & B


- Fully Microprocessor Based
- Modular Systems
- Digital Flow Rate Timer for Method B
- MFI, MVI, Melt Density Calculations
- Precision Die, Barrel, Piston
- Precise Temperature Control
- Accrediation like ISO, CE..
- ISO TICK IT accrediated True WINDOWS program

# *Hot-Tack Index*

# ASTM-F1921




- PC controlled Instrument
- Gives Value of Ho-Tack
- Very Fast and Accurate
- Force Vs. Cooling time
- Adjustable
  - Upper Die Temp
  - Lower Die Temp
  - Dwell Time
  - Sealing Pressure
  - Peeling Speed

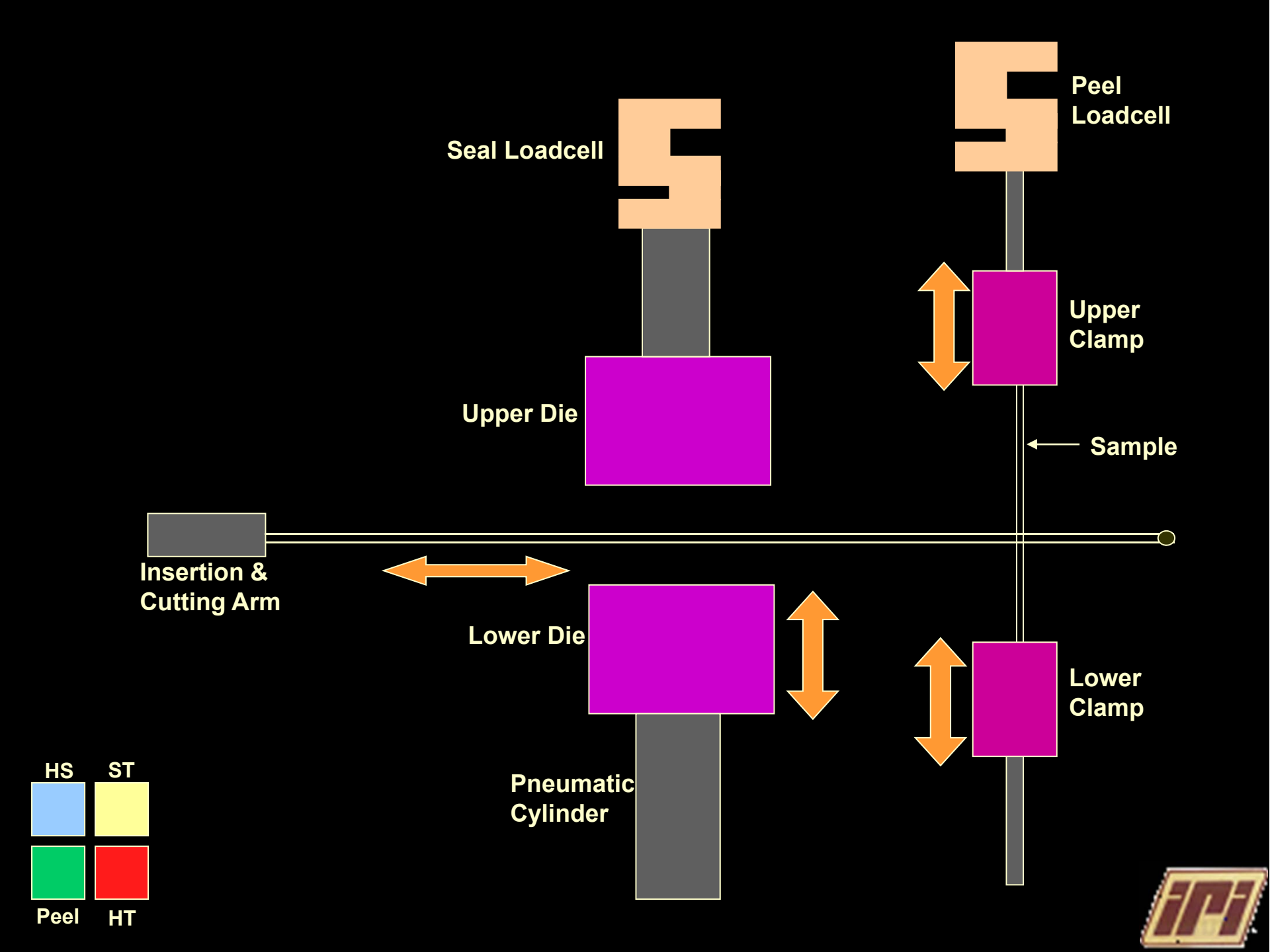
# *Hot-Tack Tester*

- 1978 Mr. Hut Theller designed and developed first Laboratory Heat Sealer with millisecond control of sealing time
- 1980 First Accurate Test Method and Hardware to Test Heat Sealability as function of interface Temperature
- 1999 First Time ASTM Standard came out ASTM F 1921

# *Hot-Tack Tester*

## A Four in One Instrument

- ✓Heat Sealing
- ✓Peel Strength of Heat Seals/Laminates
- ✓Heat Sealing + Ultimate Seal Strength
- ✓Hot Tack


Seal Loadcell
Peel Loadcell
Upper Clamp
Upper Die
Sample
Insertion & Cutting Arm
Lower Die
Lower Clamp
Pneumatic Cylinder
HS
ST
Peel
HT

# *HEAT SEAL*

'Behavior of Film or material when sealed'

- Manual Operation
- Wide Strip of up to 5.25" – 13.3cm can be Sealed
- Seal Characteristics and Quality is observed

# *HEAT SEAL*

- Useful for Studding Quality of Seal – Visual Check
- Various type of Die Serrations and designed Faces and their Sealing Ability
- Can be used to as Sample Preparation for  seal Strength and Peel Tests

# *HEAT SEAL*

## User Selectable

- ✓Upper Die Temperature
- ✓Lower Die Temperature
- ✓Die Faces & Serrations
- ✓Sealing Pressure
- ✓Dwell Time

# *PEEL*

**‘Strength Required to Separate two sealed Films or Laminates’**

**Computer Controlled Operation**

1. **Strip is clamped**
2. **Peeled**
3. **Results are Calculated**

# *ULTIMATE SEAL STRENGTH*

**'When Seal reaches Ambient Temperature it achieves its Ultimate Strength'**

**Computer Controlled Test Sequence**

1. **Pulled**
2. **Sealed**
3. **Cooled**
4. **Strip is clamped**
5. **Peeled**
6. **Ultimate Seal Strength Calculation**

# *ULTIMATE SEAL STRENGTH*

**User Selectable**

- ✓ **Temperature of Upper & Lower Dies**
- ✓ **Dwell Time – Sealing Time**
- ✓ **Sealing Pressure**
- ✓ **Peeling Speed**
- ✓ **Cooling Air Velocity & Time**

# *HOT TACK*

**‘Seal Strength Developed immediately after the Dies are opened.’**

## Computer Controlled Test Sequence

1. Strip is clamped
2. Pulled
3. Sealed
4. Peeled under controlled Cooling
5. Seal Strength Vs. Cooling Time is plotted.
6. Results are Calculated

# *HOT TACK*

**User Selectable**

- ✓ **Dwell Time – Sealing Time**
- ✓ **Sealing Pressure**
- ✓ **Peeling Speed**
- ✓ **Cooling Air Velocity**
- ✓ **Temperature of Upper & Lower Dies**

*Seal Strength at 250 ms after opening of Dies is known as*

# Hot Tack Index

**In addition Hot Tack Index, it also measures Seal Strength at user defined time**

**Also gives Seal Strength at ZERO ms by Regression Method**

# *FEATURES*
# *HOT TACK TESTER*

- ✓ Fast Cycle :Total Cycle Time is less than a second + Sealing Time.
- ✓ Higher Data Sampling Rate : 800 points per Second.
- ✓ Higher Peeling Speeds : up to 425 cm/sec.
- ✓ Minimum Mechanical Lag : first result available at 120ms or so.
- ✓ Auto Calibration before start of Cycle.

# *FEATURES*
# *HOT TACK TESTER*

- ✓ **Excellent Temperature Stability**
- ✓ **Dwell Time accuracy of +/- 1 ms**
- ✓ **Controlled Sealing Pressure using Accurate Loadcell**
- ✓ **Closed Loop Peeling Speed control**
- ✓ **Except Cutting Strip and mounting No manual operation.**

# *Temperature Curves*

**Normally studies are made at different Temperature in Hot Tack and Ultimate Strength Modes**

- ✓ **Seal Strengths Vs. Sealing Temperature**
- ✓ **Hot Tack Vs. Sealing Temperature**

# *Water Vapor & Oxygen Permeability Tester*

- Reference Method
- Computer Controlled
- Graphics and Results
- Adjustable Temperature
- Adjustable RH
- IR-Sensor (as per ASTM)
- Validity as per CFR 21 Chapter-11 is must.
- NIST Traceable STD Samples for Calibration

# *Permeability*

## Why do we care about Permeation?

# *Why Permeability Important ?*

**Because…**

**Without proper barriers products will fail.**

# *Why Permeability Important ?*

- 80% of all food products demand a barrier to gases, flavors and odors.
- 10,000 new food products were introduced in the U.S. last year.

# *Why Permeability Important ?*

## Many, many applications

- Food and drug packaging
- Medical devices
- Personal care products
- Electronics and semiconductors
- Paints and coatings
- Chemical Packaging

…… many others

# *What is Important ?*

**Today's Challenge…**

**Understand, quantify and work with permeation**

# *Why Measuring Permeability is Important ?*

**Barrier quality varies, BUT**

**With testing you are sure that barriers WILL do what's promised**

# *What is Permeation ?*

- Solution of penetrant into polymer
- Diffusion of penetrant through polymer
- Desorption and evaporation of penetrant from the surface of polymer

# *What is Permeation ?*

**P - Permeability Coefficient**

permeation of penetrant through polymer

**D - Diffusion Coefficient**

movement of penetrant inside polymer

**S - Solubility Coefficient**

dissolution of permeant into polymer

# *Permeation of what ?*

**Permeation rates of**

- **Water Vapor**
- **Oxygen**
- **Carbon Dioxide**
- **Aromas**
- **Hydrocarbons**
- **Volatile Gases**

**Through barrier materials and packages are**

***Important***

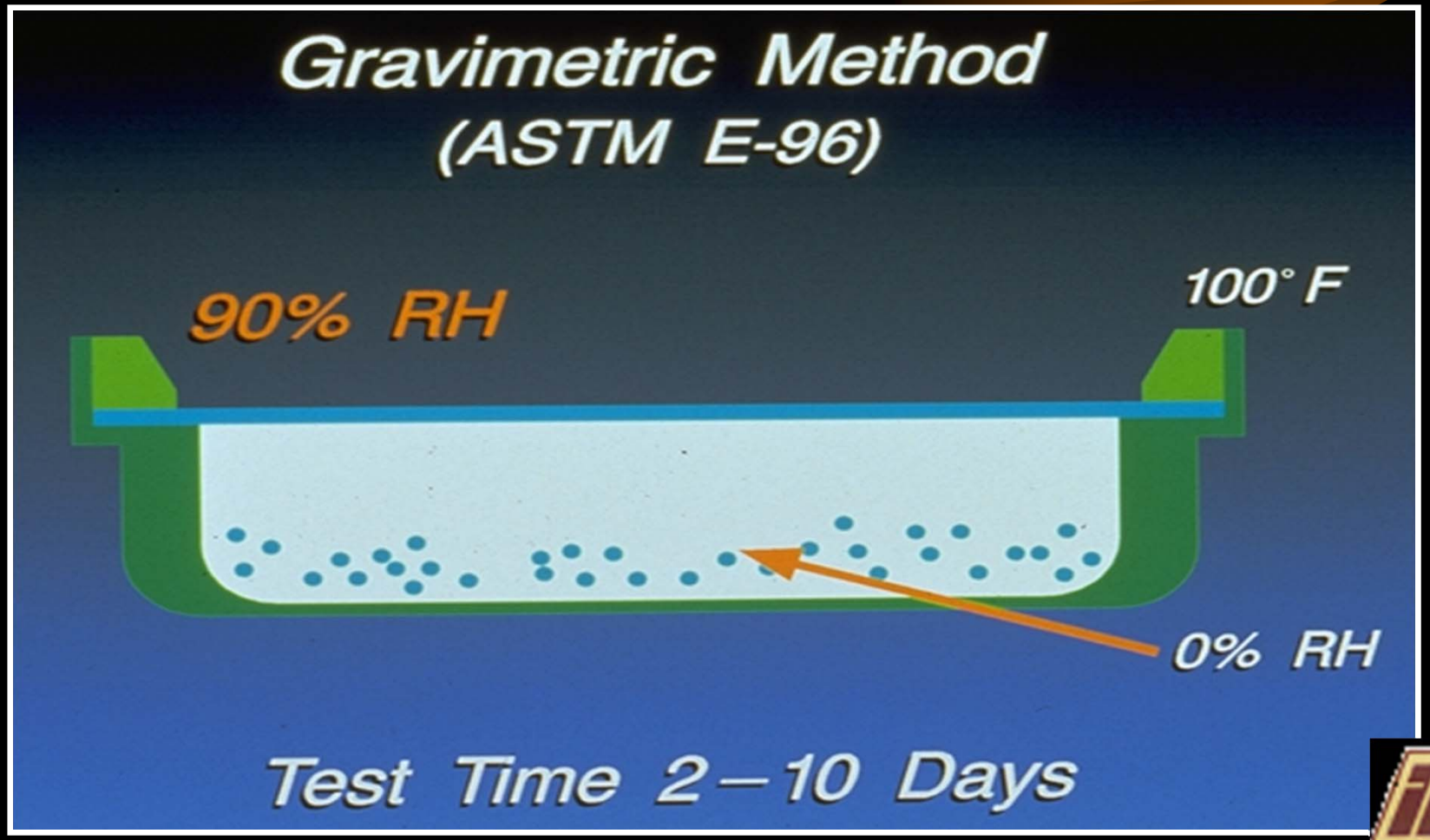
# Factors Affecting Permeation Rate Testing…

- Material thickness
- Relative humidity
- Temperature
- Time
- Barometric Pressure

# Basic test methods for permeation

- Gravimetric
- Manometric
- Isostatic
- Transorption$^{SM}$

# *Gravimetric Method*

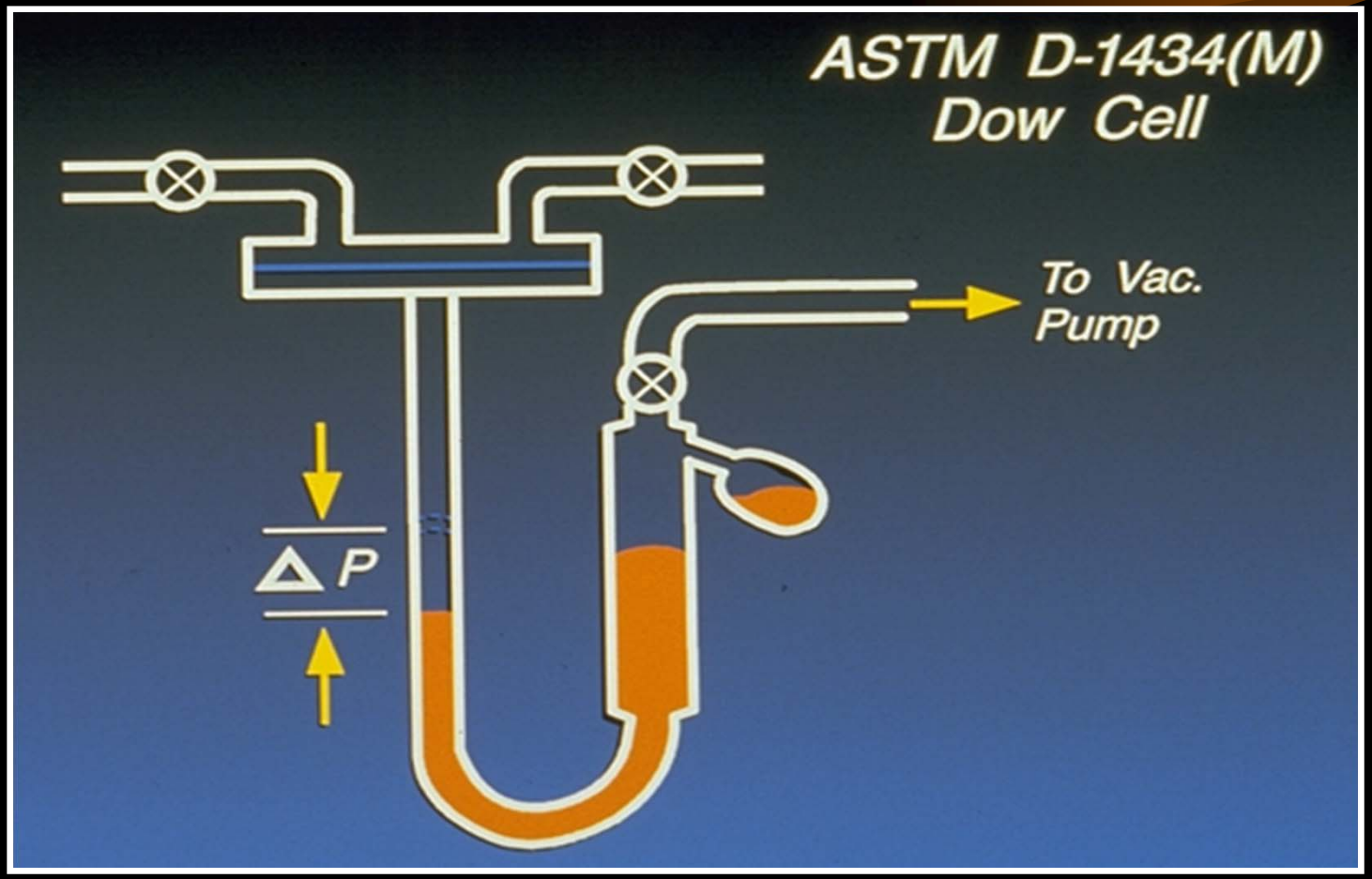


# *Gravimetric Method*

**Short Comings…**

- **Too much operator attention in:**
  **- Calculations**
  **- Set up**
- **Poor precision and repeatability**
- **Slow answers (2-10 days)**

# *Manometric Method*

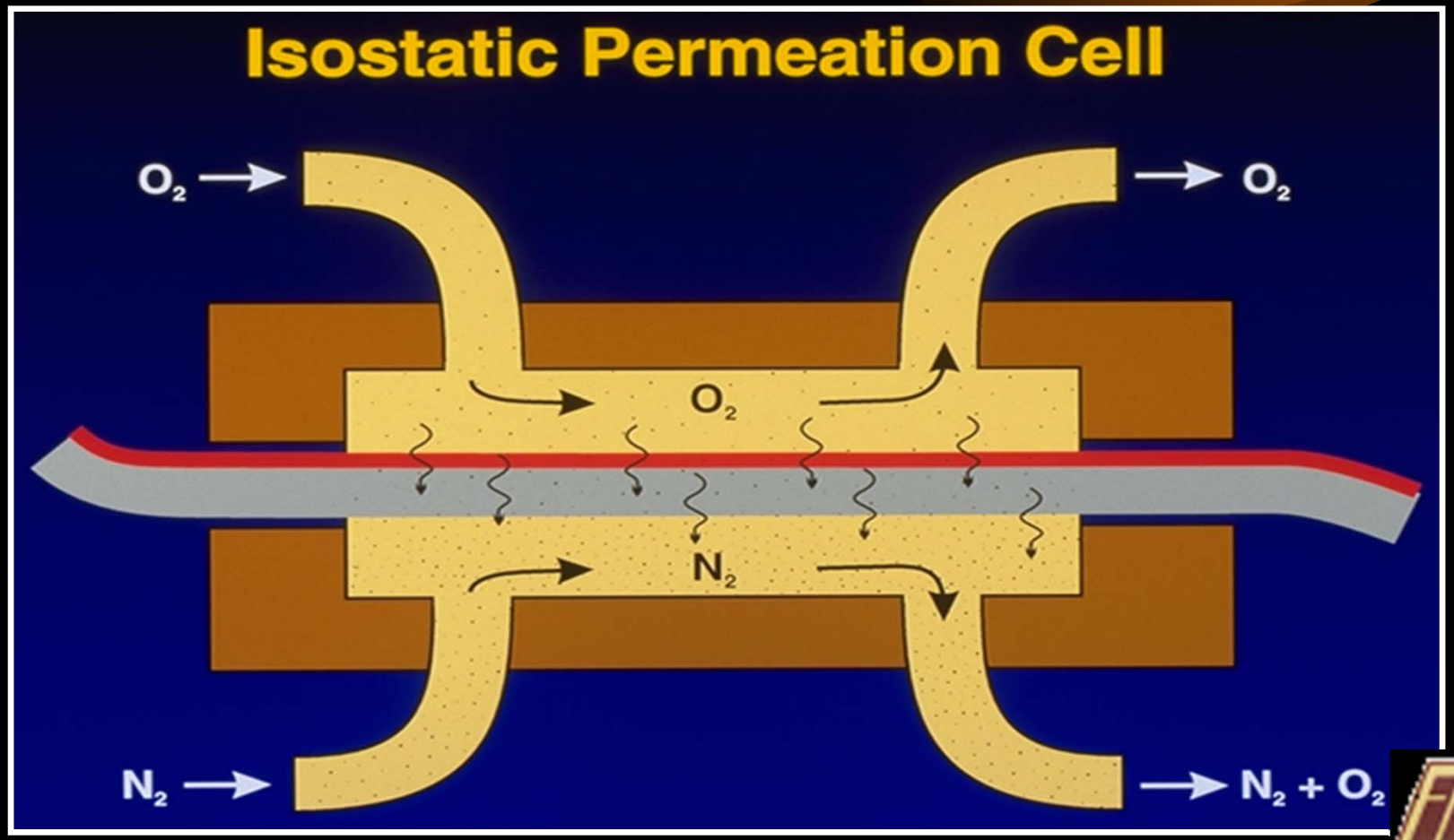


# *Manometric Method*

## Short Comings…

- Too much operator attention in:
  - Calculations
  - Set up
- Poor precision and repeatability
- Could not test at one atmosphere
- Could not test wet
- Could not test packages

# *Isostatic*



# *STANDARDS - WVTR*

| Technique | ASTM | TAPPI | JIS |
|---|---|---|---|
| gravimetric (1941 - 1976) | E-96 dish or cup test | T-464 | Z-0208 |
| early instruments (1978 - 1989) | F-372 MOCON IRD F-378 Honeywell | T-523 | |
| current standards (1990 - Current) | F-1249 MOCON Permatran-W | T-557 | K-7129 |

# STANDARDS - OTR

| | | | |
|---|---|---|---|
| ASTM | D-3985 | Films | USA |
| DIN Germany | 53380 | Films | |
| JIS | K-7126 | Films | Japan |
| ASTM | F-1307 | Packages | USA |

# *Coefficient of Friction -1*

# ASTM-D1894


- Accurate measurement
- Static & Kinetic Friction
- Suitable for Metal to Film & Film to Film
- Vacuum Film Holding Bed is ideal
- Speed Selection
- Static Force Display
- Possible to Computeri

# *Falling Dart Impact Test*

- Simple Test
- No Automation
- Different Clamping Options like,
  - Vacuum
  - Pneumatic
  - Manual Clamps
- Two Height or Single Height
- Hand Switch for safety

# *Stiffness*

- Digital & Analog Instruments
- Simple Instruments

# *Universal Testing Machine - UTM*

- Tensile Strength
- Elongation
- Resistance to Puncture
- Coefficient of Friction
- Seal & Peel Strength
- Bond Strength
- Tear Strength

# *Tensile Strength, Elongation*

# ASTM-D882


- Fully Microprocessor Based
- Small Foot Print
- Full Function Control Console
- Memory for Test Set Up
- Accurate Force Measuring accuracy
- Precision Ball Screw
- Accurate Extension Measurement
- Precise Speed Control
- Accrediation like ISO, UKAS,CE..
- ISO TICK IT accrediated True WINDOWS program

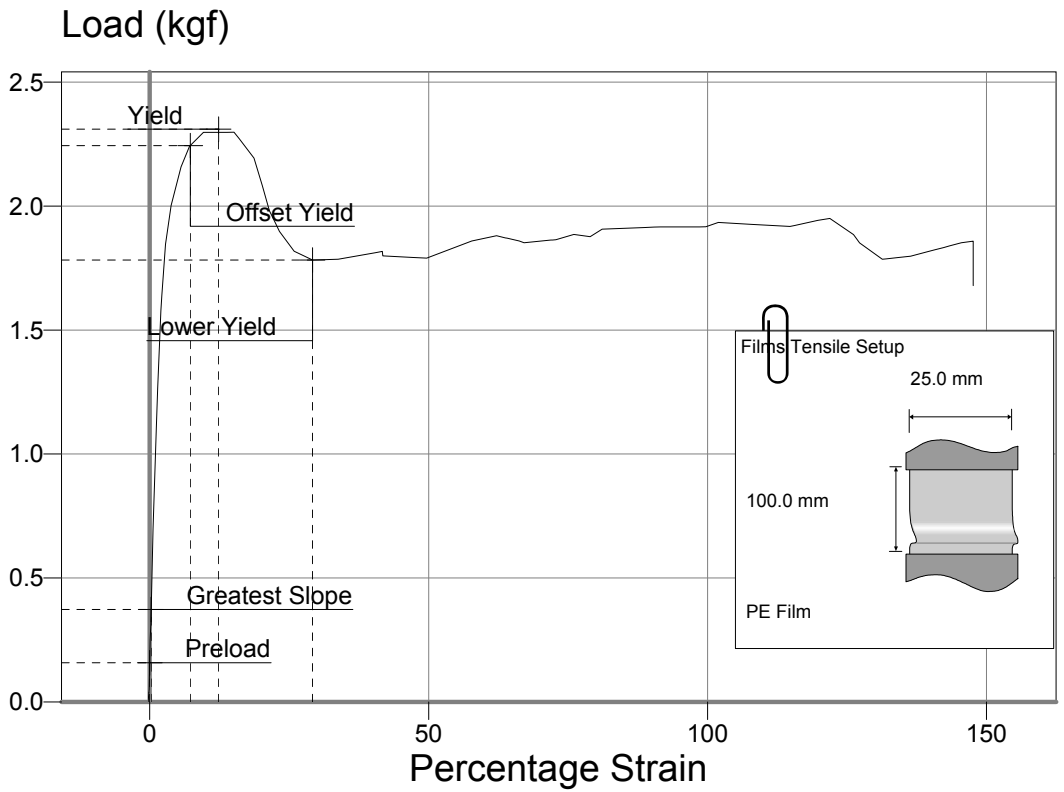
# *Tensile Strength, Elongation*

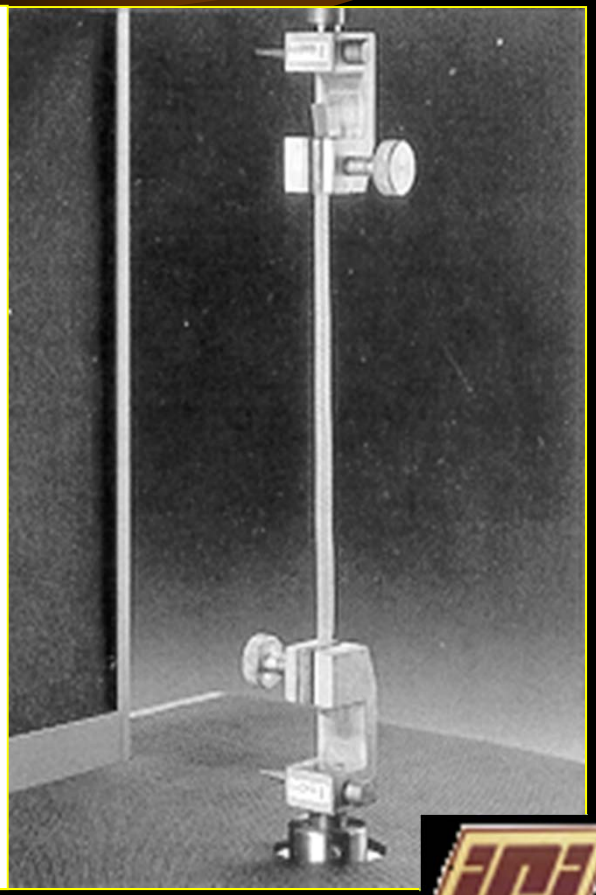
# ASTM-D882

- Tensile Test
- Load @ Peak & Yield
- Load @ Break
- Elongation @ Peak & Yield
- Elongation @Break
- Modulus
- Other Related Results

# *Tensile Strength, Elongation*

# ASTM-D882



# *Puncture Resistance*

# ASTM-D

- Possibility to Perform on UTM
- Puncture Testing Jig
- Two diameters 50mm or 80mm depending on the standard.
- Speed Selectable as required
- Software to calculate the Results

# *Coefficient of Friction*

# ASTM-D1894

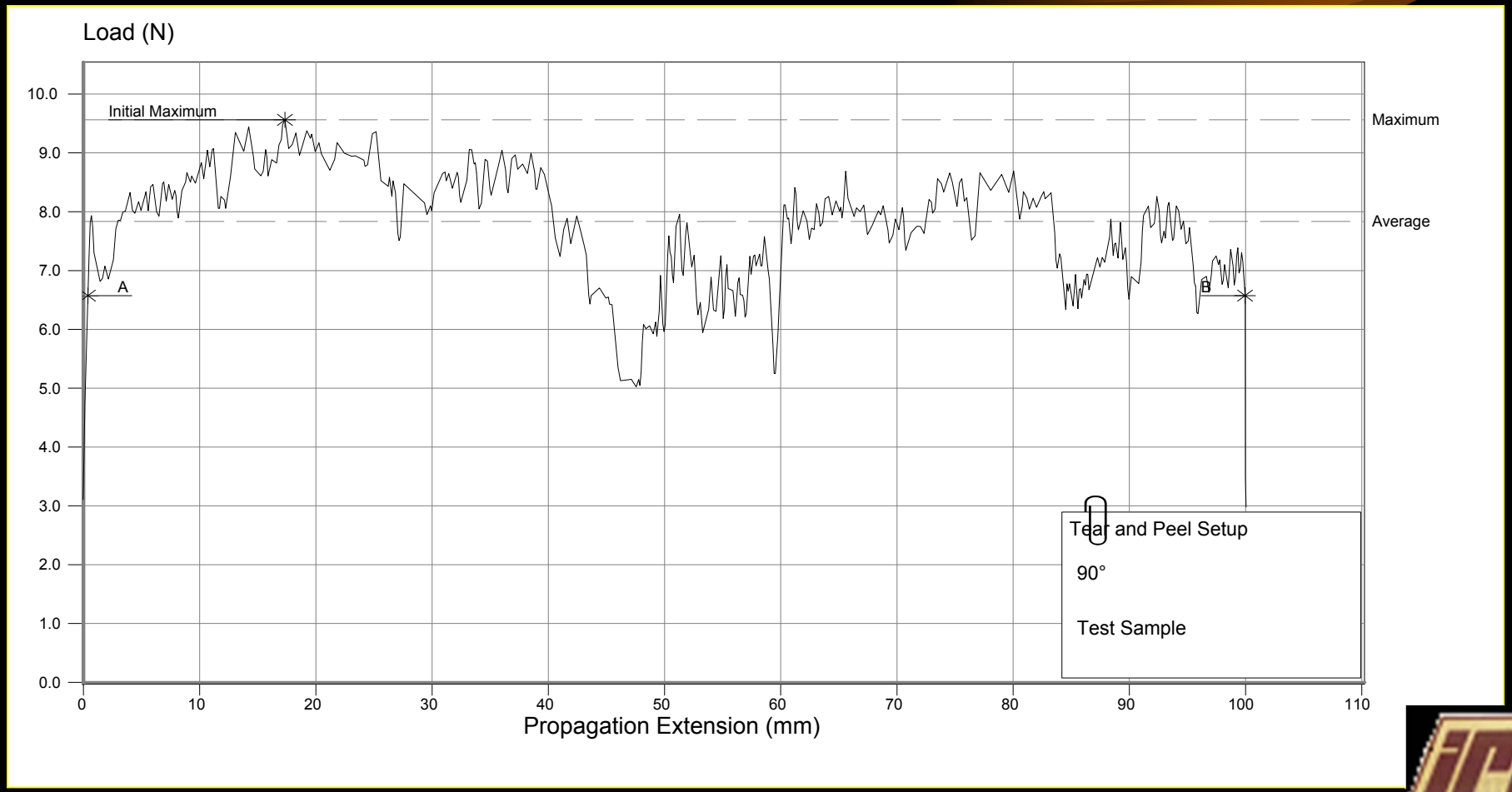
- Possibility to Perform on UTM
- Friction Testing Jig
- Accurate and convenient
- Speed Selectable as required
- Software to give results of Static & Kinetic Friction
- Graphics Presentation possible

# *Seal Strength*

- Possible to perform on UTM
- Normal Tensile Grips can be used
- Standard Test Set up can be used
- All Test parameters adjustable
- Graphs and Results
- Important to have good quality Seal

- Possible to perform on Hot-tack Tester
- Ultimate Seal Strength Mode
- Predefined cooling time
- Graphics & Results available
- Sealing here is very good because its done on same Instruments

# Seal Strength



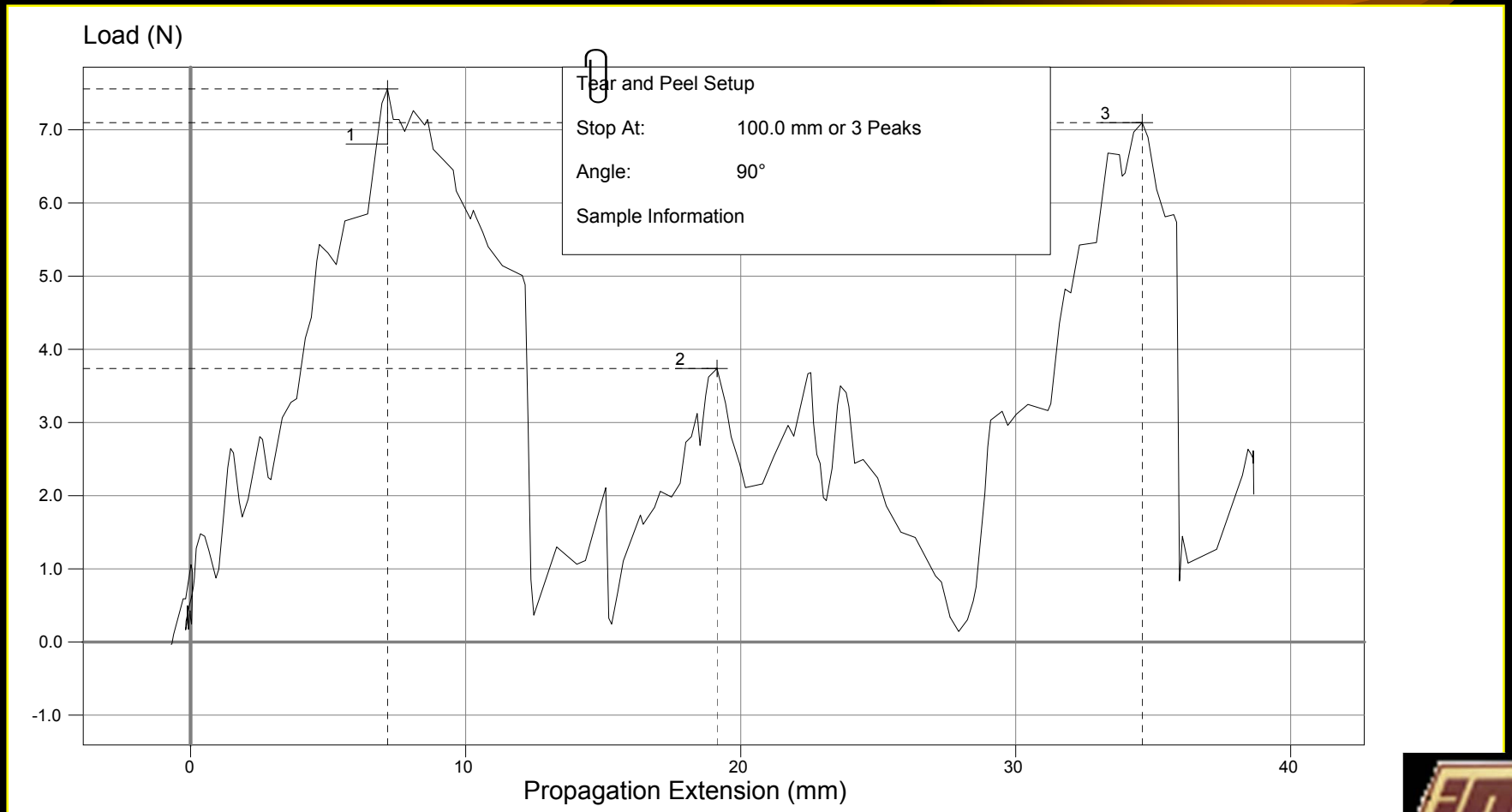
# *Heat Sealer*

- **Adjustable**
  - **Upper Die Temp**
  - **Lower Die Temp**
  - **Dwell Time**
  - **Sealing Pressure**
- **Digital Display for Temps, Dwell Time, Sealing Pressure.**

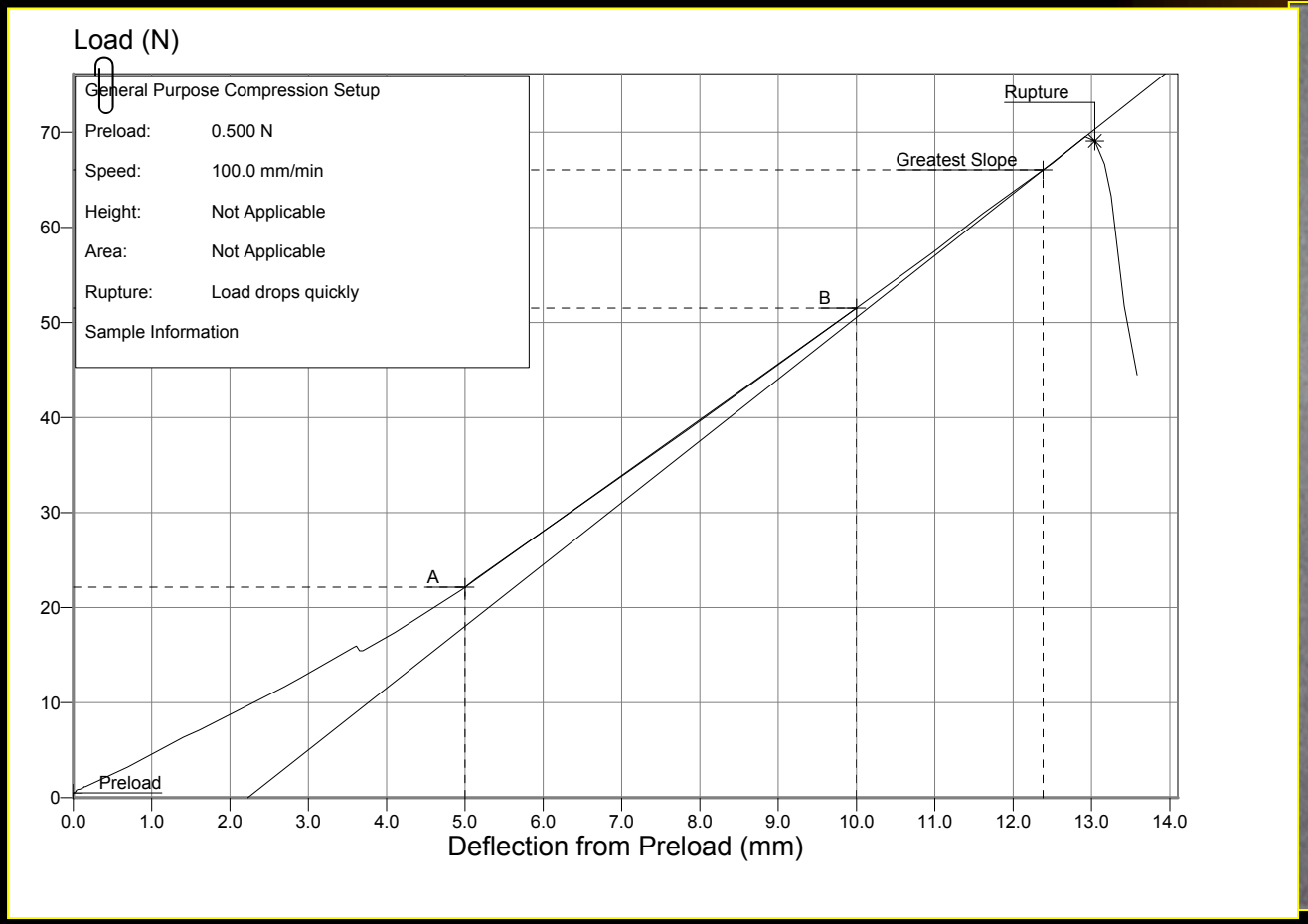
# *Peel Strength*

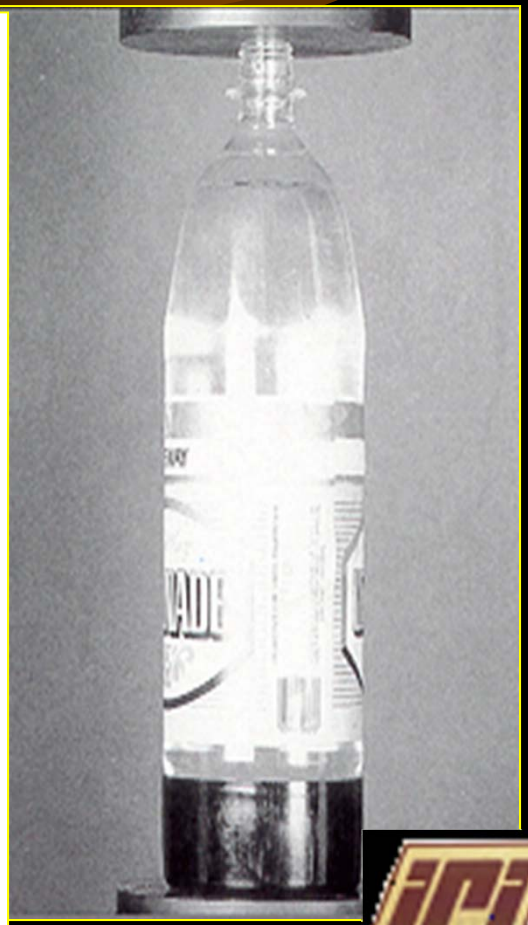
- Possible to perform on UTM
- Normal Tensile Grips can be used for 180deg Peel
- Special fixture used for 90 deg Peel
- Standard Test Set up can be used
- All Test parameters adjustable
- Graphs and Results

# Peel Strength

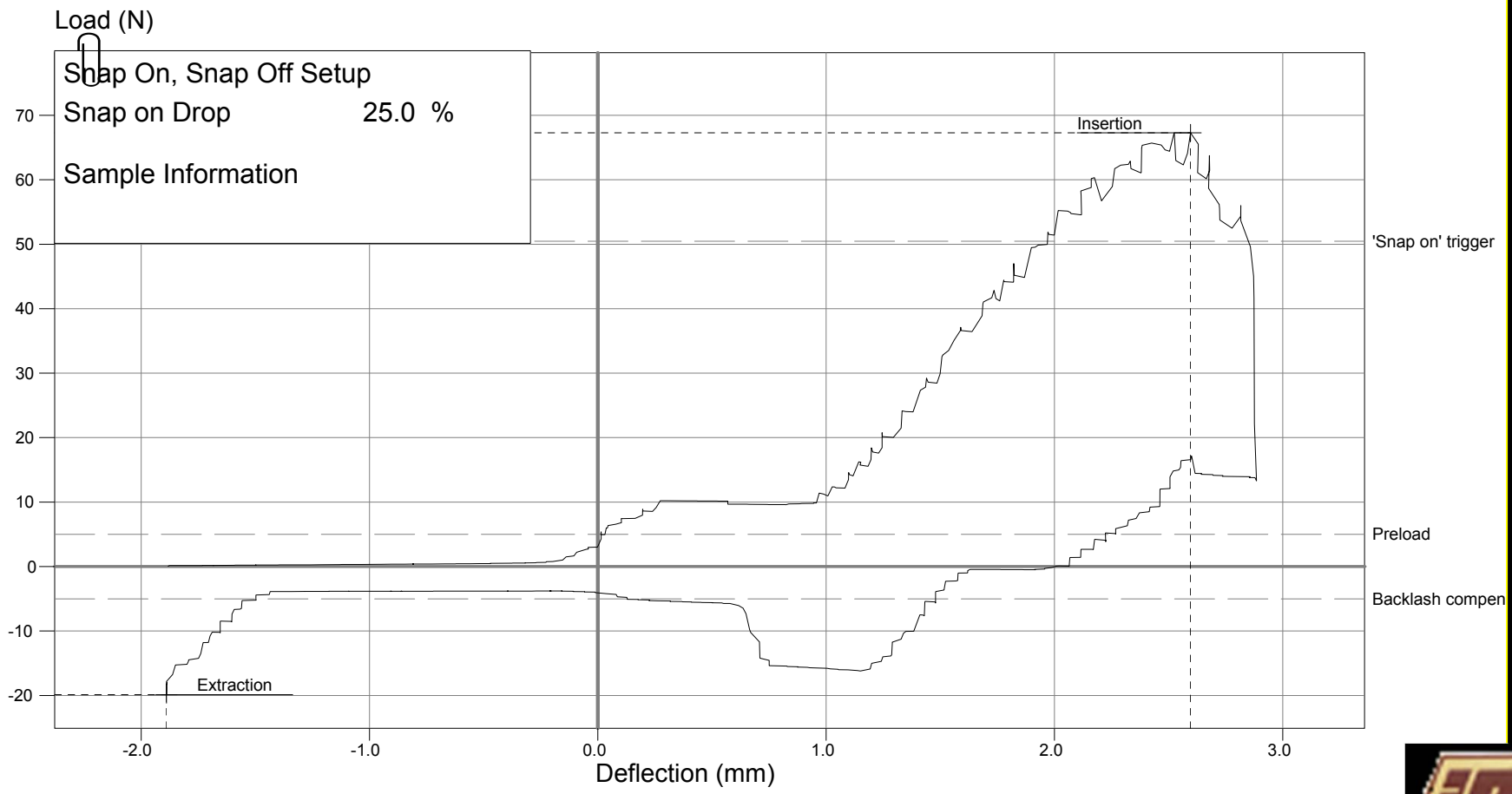


# Compression Test On Bottles



# *Snap on snap Off Test*



# *Tear Strength*

## Tear Test

(Elmendorf Type )

- Elmendorf  Tester
- Digital Display
- Simple to use
- Various Loads for different material

## Tear Test

(Trouser Type )

- Possible to perform on UTM
- Normal Tensile Grips can be used
- Standard Test Set up can be used
- All Test parameters adjustable
- Graphs and Results

# *Software*

## Test Set Up

- ✓Ready to Use
- ✓Can be Modified
- ✓Create New

# *Software*

## Routine Testing

- ✓Quick
- ✓Easy
- ✓Customised Front End
- ✓Customised Reporting

# *Software*

## Futuristic Requirement

- ✓SPC
- ✓Robotics Control
- ✓Direct Email of Results
- ✓Seamless Data Transfer

# *Software*

**Cyclic**

**Relaxation**

**Creep**

**Multistage**

- ✓ **Flexible approach**
- ✓ **User defined Testing for practically any application**