Interpreting The Typical Properties in Data Sheet

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Typical Properties in Data Sheet

- ✓ **Data sheet values are usually obtained with specimens that are designed and molded at conditions optimized for that test.**
- ✓ **The properties of plastic parts are seldom as high as data sheets values.**
- ✓ **Data sheet values should not be used for design purposes unless the application conditions are similar to the test conditions in term of size, shape, strain rate, temperature and etc.**
- ✓ **Data sheet values can be used as preliminary guides for comparing the property sets of different plastics.**
- ✓ **To use the versatile properties of plastics to the fullest extent, the designer must understand the limitations of data sheet values, the nature of the plastic and the end-use service conditions.**

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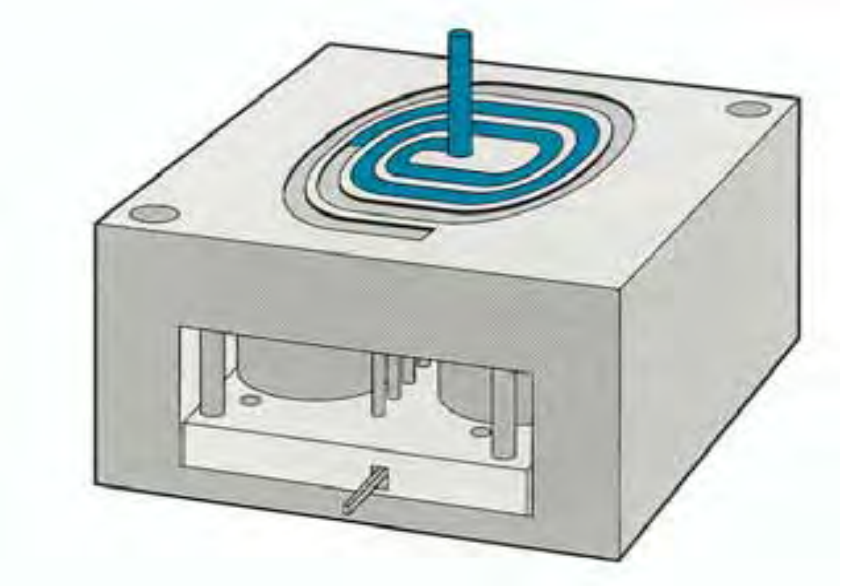
Typical Properties in Data Sheet

Properties are classified into the following categories:

- Rheological properties
- Mechanical properties
- Thermal properties
- Electrical properties
- Other properties

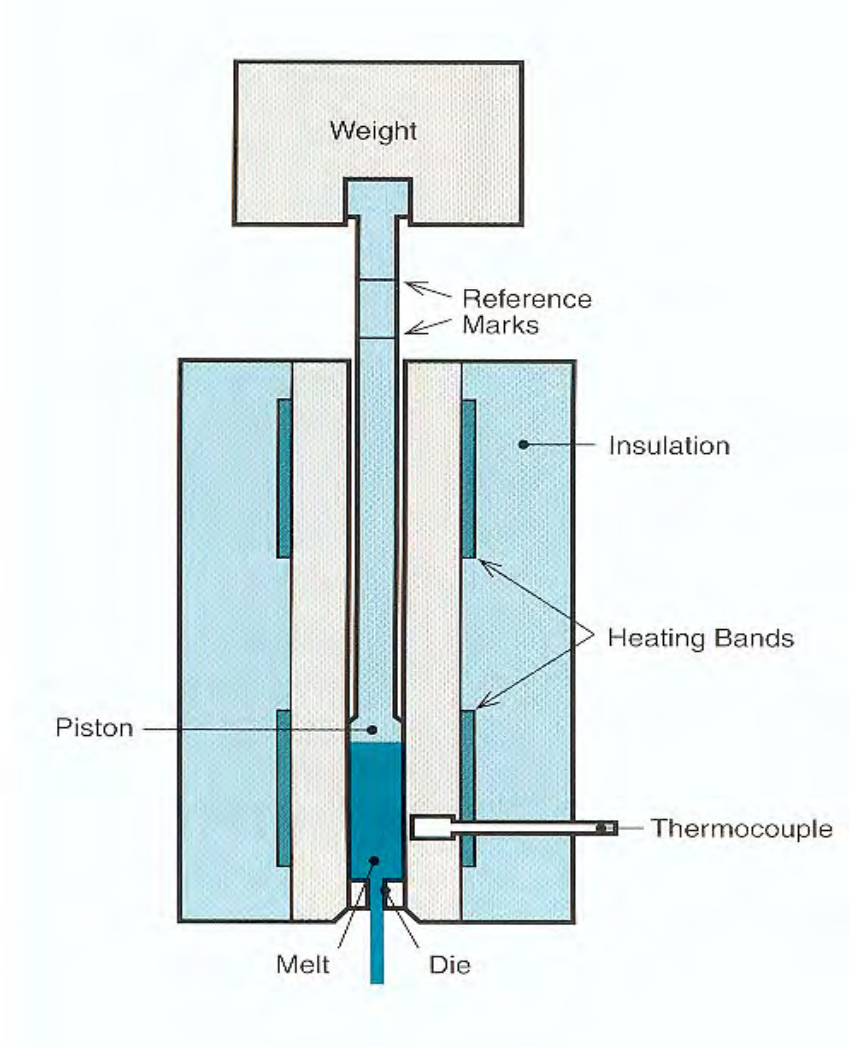
Rheological Properties

Spiral Flow



The **spiral-flow length** records the resin's flow length at the stated thickness and processing conditions.

Melt Flow Rate



The amount of a resin extruded through a standard die in ten minutes by a weight-driven plunger determines the **melt flow rate** (mass or volume).

- Test is performed at a single temperature and single load value.
- Does not account for the relationship of viscosity as a function of shear rate and temperature.
- Do not reliably predict the ease of flow in a mold.
- Good tool to check uniformity in production batches or as a quick check for degradation in molded plastics parts.

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Viscosity

- ✓ A material's **viscosity**, its internal resistance to flow, determines mold-filling rates.
- ✓ The viscosity of a polymer dissolved in solvent provides an indirect measure of molecular weight and relative melt flow behaviour of the base resin.
- ✓ Relative viscosity, the ratio of the viscosity of the dilute polymer solution of specified concentration to the viscosity of the solvent is commonly used as a quality control guide during resin production.

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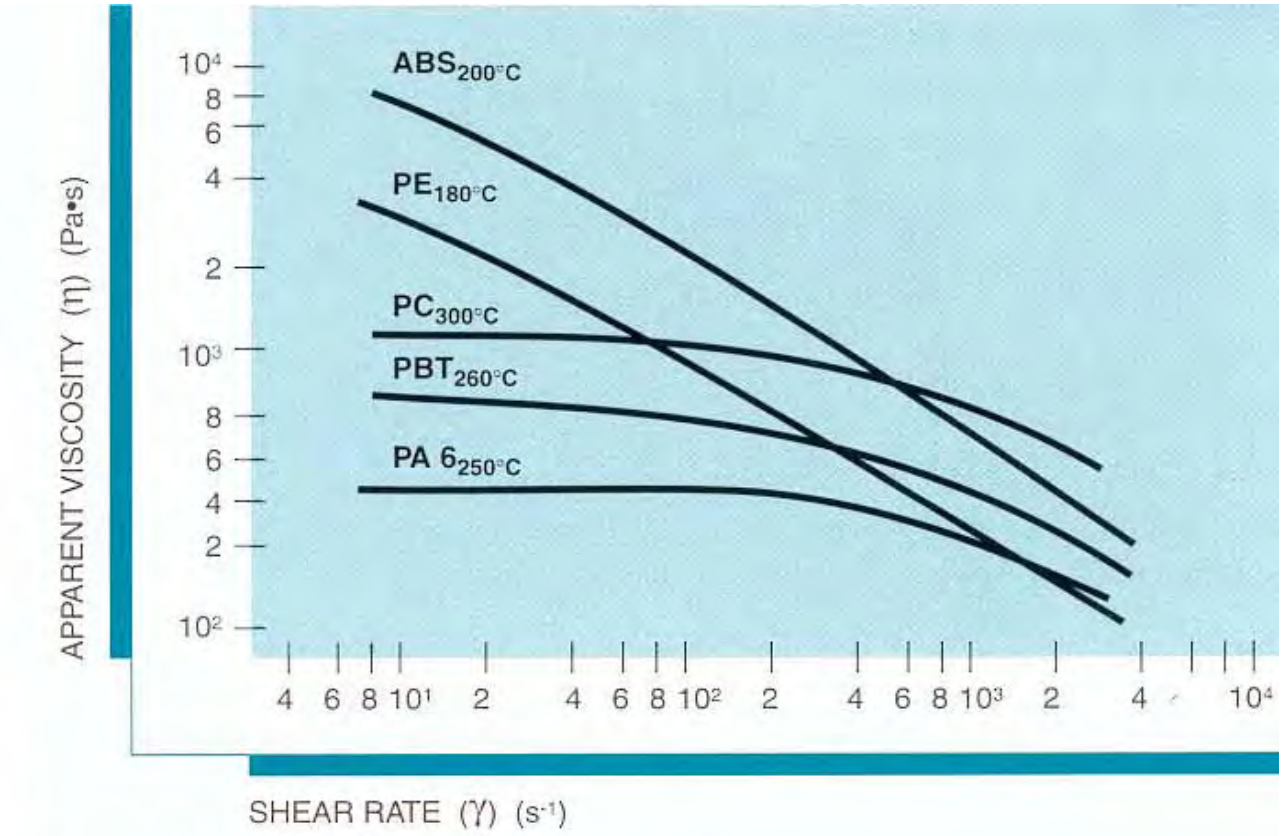
Viscosity versus Shear Rate



Apparent viscosity as a function of shear rate.

Viscosity versus shear-rate curves, more relevant than melt flow rate for comparing moldability in thermoplastic materials, are seldom used in resin selection.

These data are used mainly in computerized mold-filling simulation programs.

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Mold shrinkage

Plastics shrink significantly during the cooling cycle in molding. A mold designer uses mold-shrinkage values to compensate for part shrinkage during molding.

$$\text{Shrinkage} = \frac{[\,(\text{Mold Dimension}) - (\text{Part Size})\,]}{(\text{Mold Dimension})}$$

Value are typically listed as length-per-unit-length or as percentage

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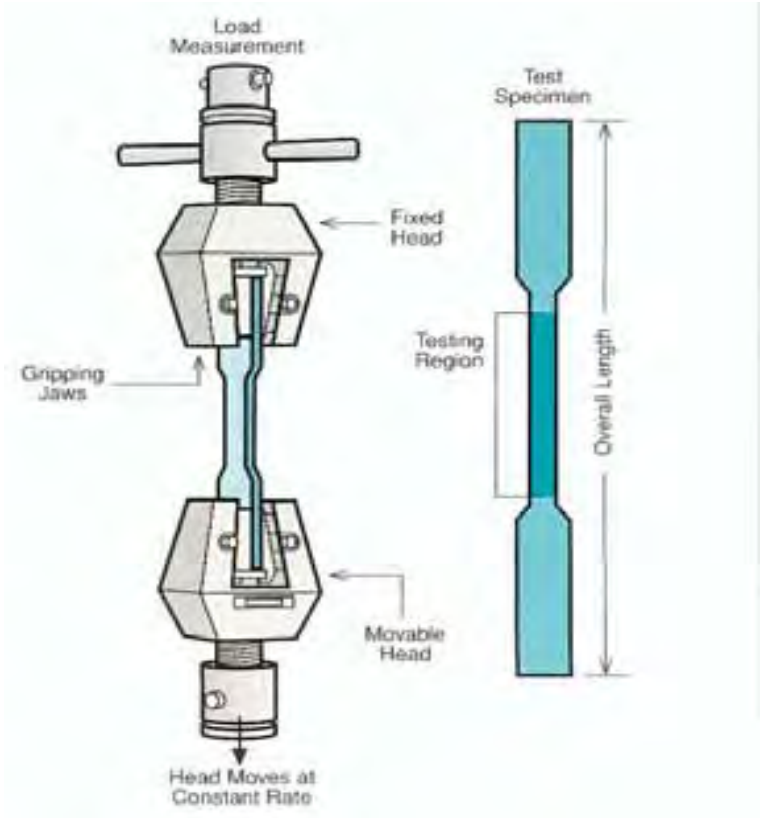
Mechanical Properties

Tensile Properties



Testing device and typical dumb bell specimen used to test the tensile properties of most plastics

- Tensile properties are used to compare the relative strength and stiffness of plastics.
- The standard tensile test for rigid thermoplastics are **ASTM D638** and **ISO 527**.
- Pulling rate used is typically 5mm/min for glass-filled materials and 50mm/min for unfilled plastics.

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Tensile Properties

Tensile stress at yield

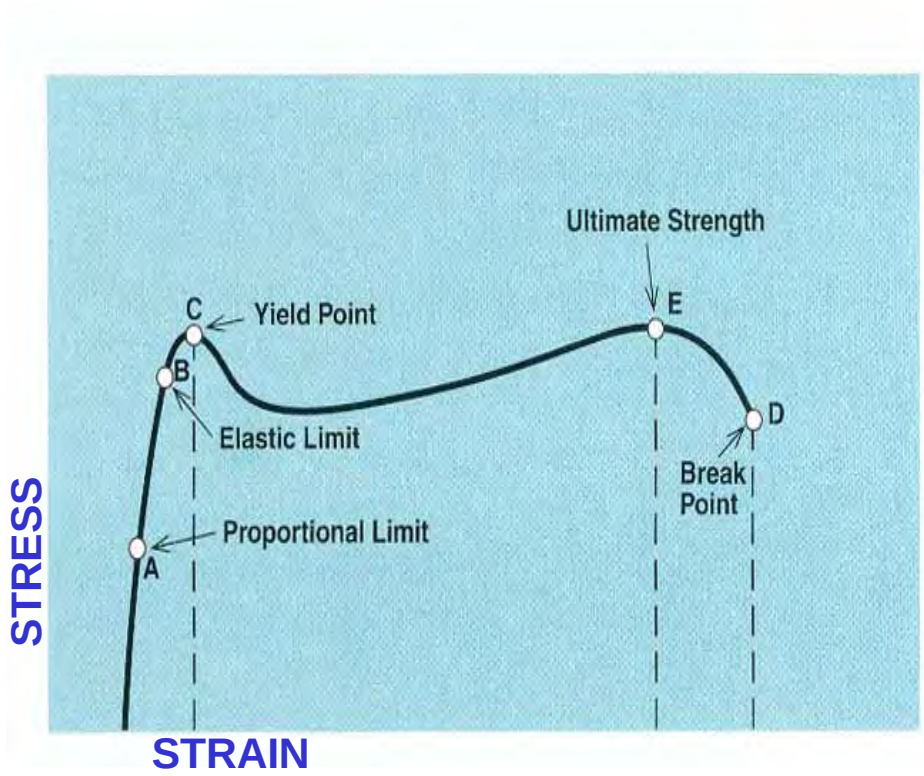
The stress level corresponding to the point of zero slope on the stress-strain curve.

Tensile stress at break

The stress applied to the tensile bar at the time of fracture during the steady-deflection-rate tensile test.

Tensile modulus

The ratio of stress to strain as measured below the proportional limit on the stress-strain curves. It's measures the resin stiffness.



Typical stress-strain behaviour of unreinforced plastics.

Tensile Properties

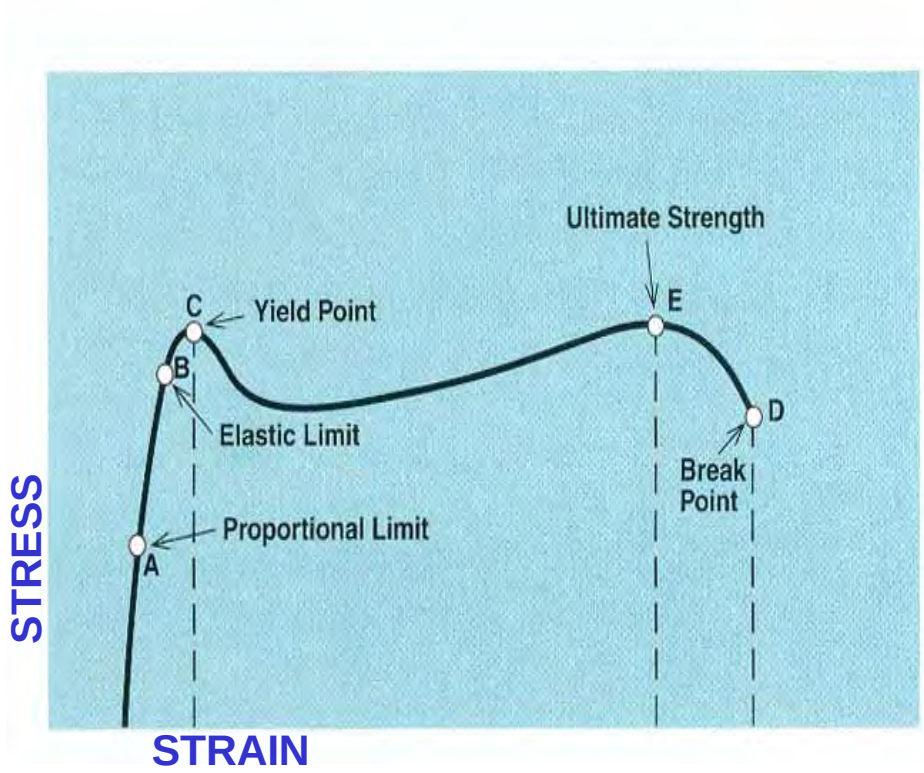
Elongation at yield

The strain value at the yield point. Its determine the upper limit for applications that can tolerate the small permanent deformations that occur before yield.

Elongation at break

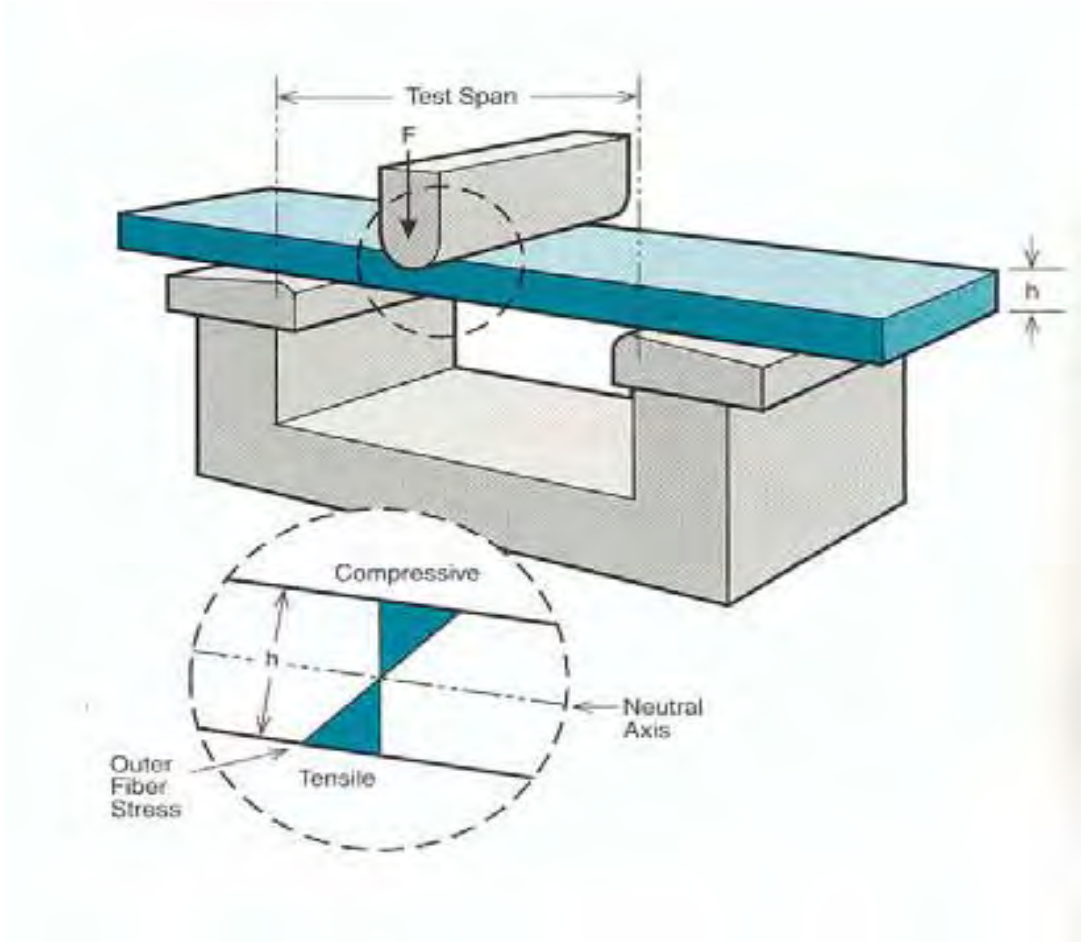
The strain at fracture as a percentage of elongation.

Brittle material break at low strain levels; ductile and elastic materials attain high strain levels before breaking.



Typical stress-strain behaviour of unreinforced plastics.

Flexural Properties



Flexural test set-up and stress distribution in specimen under load.

- **Flexural properties** relates to a plastic's ability to bend or resist bending under load.
- The standard flexural properties test methods used are **ASTM D790 and ISO 178.**
- The deflected rate is usually 2 mm/min for glass-reinforced materials and 20 mm/min for unfilled plastics.
- **Flexural modulus** is defined as the ratio of stress to strain in the elastic region of a stress-strain curve.

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Impact Properties

Impact Strength, a plastic part's ability to absorb and dissipate energy, varies with its shape, thickness and temperature.

While impact properties can be critical in some applications, test results are among the most difficult to relate to actual part performance.

In general, **impact strength** and **tensile modulus** properties provide insight into the plastic's basic mechanical nature.

- **High impact strength + large tensile modulus = tough material.**
- **High impact strength + small tensile modulus = ductile material.**
- **Low impact strength + large tensile modulus = brittle material**

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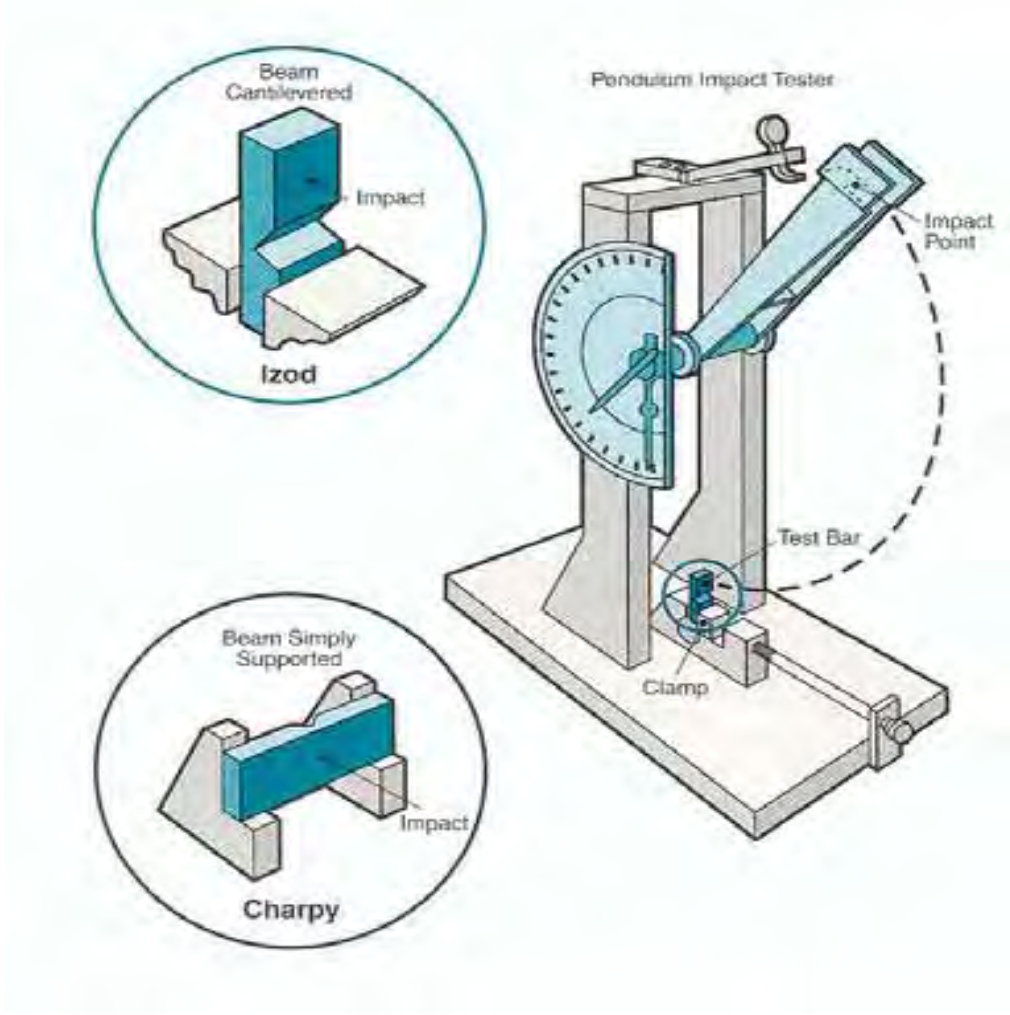
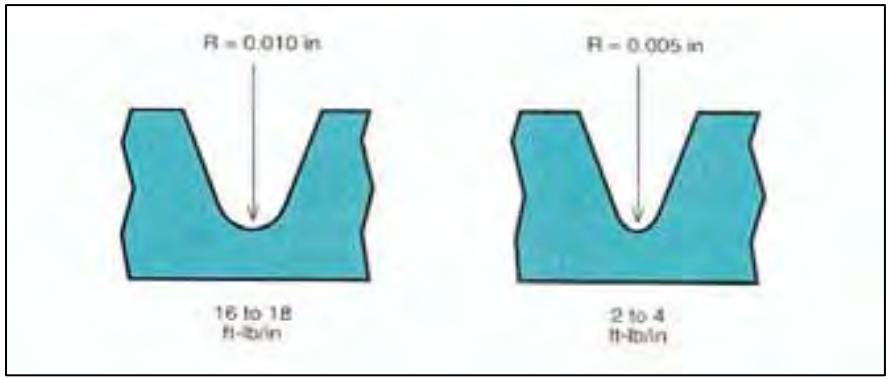
Impact Properties



Izod and Charpy impact tests.

Test Methods:

- Izod - ASTM D256, ISO 527
- Charpy - ISO 179



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Thermal Properties

Deflection Temperature Under Load (DTUL)

- **DTUL or HDT** values are used to compare the evaluated temperature performance of materials under load at the stated test conditions.
- The values do not represent the upper temperature limit for a specific material or application.
- Molding factors, sample preparation and test bar thickness significantly influence DTUL/HDT values.
- Compare data from different test labs and suppliers cautiously.

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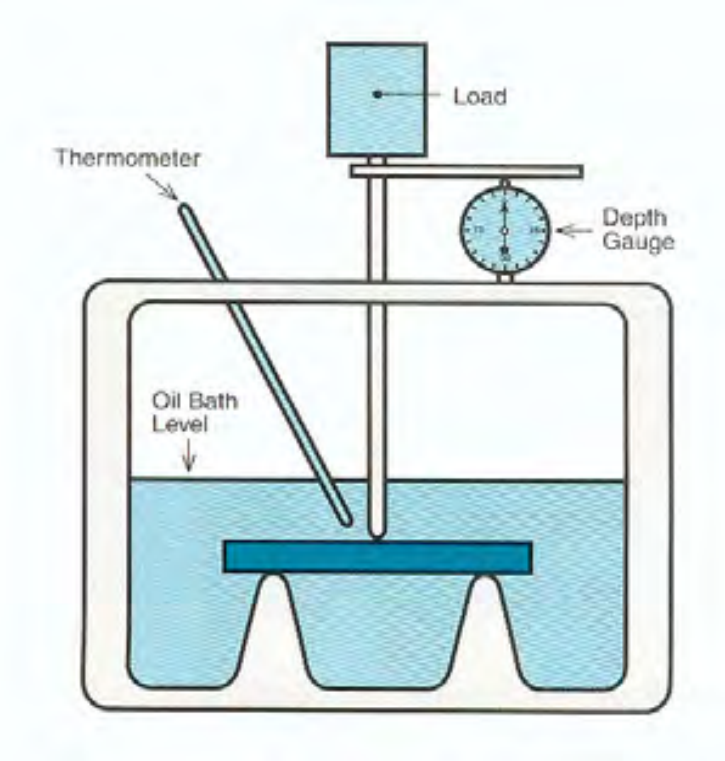
Deflection Temperature Under Load (DTUL)



Test apparatus for deflection temperature under load (DTUL).

- The specimen is loaded to an outer- fiber stress of either 66 or 264 psi (0.45 or 1.8 Mpa).
- The temperature in the test chamber rises at 2^0 C per minutes until the applied load causes the bar to deflect an additional 0.010 inch .

Test Methods :

- ASTM D 648 - thickness 1/8 to 1/2 inch (3.2 to 12.7mm) flat across supported 4 inch apart.
- ISO 75 - 110 x 10 x 4 mm test bar rests edgewise supported 100 mm apart.
  - 80 x 10 x 4mm test bars rest flat across supported 64mm apart.

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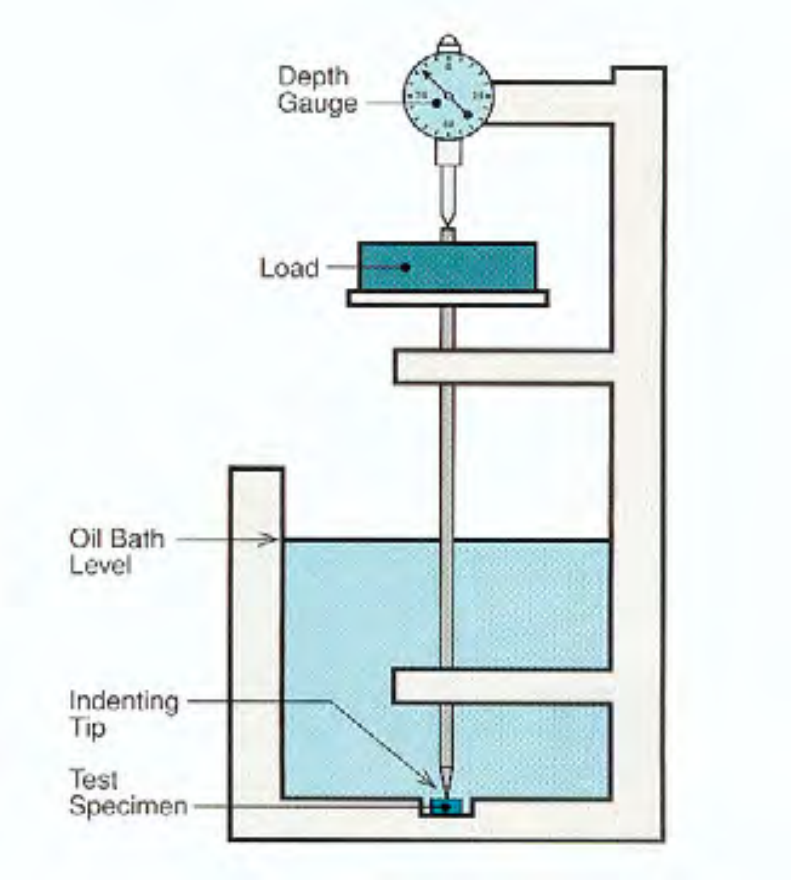
Vicat Soft Temperature

- Ranks the thermal performance of plastics according to the temperature that causes a specified penetration by a lightly loaded probe (10N or 50N).
- A general indicator of short-term, high-temperature performance.
- Less sensitive to sample thickness and molding effects than DTUL.

Vicat Soft Temperature



Vicat softening point test apparatus

A flat-ended probe with a 1mm^2 cross section contacts a plastic specimen submerged in a heating bath. After a specified load (10N or 50N) is applied to the probe, the oil bath temperature rises at a slowly, steady rate (50 K/h or 120 K/h).

The **Vicat softening temperature** is the temperature of the oil bath when the probe reaches a 0.04 inch (1mm) depth.

Test Methods:

- ASTM D 1525
- ISO 306

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Flammability - Underwriter Laboratories Yellow Card

The Underwriters Laboratories (UL) has devised several classification to describe the flammability of plastics (UL 94)

- UL94HB = Horizontal burning test
- UL94V-0,V-1,V-2 = Vertical burning test
- UL94V-5VA, 5VB =Vertical burning test

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Flammability - Underwriter Laboratories Yellow Card

http://data.ul.com/ULiQ_Link/index.asp

UL iQ for Plastics Yellow Card

QMFZ2 Component - Plastics

Friday, April 15, 2005

E245249

LANXESS AG
RHEINUFER STR 7-9 47829 KREFELD GERMANY

Material Designation: **B4235+**

Product Description: Polybutylene Terephthalate (PBT), designated "POCAN" furnished as pellets.

Color	Min. Thick. (mm)	Flame Class	HWI	HAI	RTI Elec	RTI Imp	RTI Str	IEC GWIT	IEC GWFI
ALL	0.75	-	-	-	130	-	-	-	960
	1.5	V-0	2	2	130	130	140	-	960
	3.0	V-0, 5VA	1	2	130	130	140	-	960
	6.0	V-0, 5VA	0	2	130	130	140	-	960

D495: 7

IEC Ball Pressure (°C): -

Dielectric Strength (kV/mm): 39
ISO Tensile Strength (MPa): -
ISO Tensile Impact (kJ/m^2): -

Volume Resistivity (10^x ohm-cm): 12
ISO Flexural Strength (MPa): -
ISO Izod Impact (kJ/m^2): -

Dimensional Stability (%): 0.0
ISO Heat Deflection (°C): -
ISO Charpy Impact (kJ/m^2): -

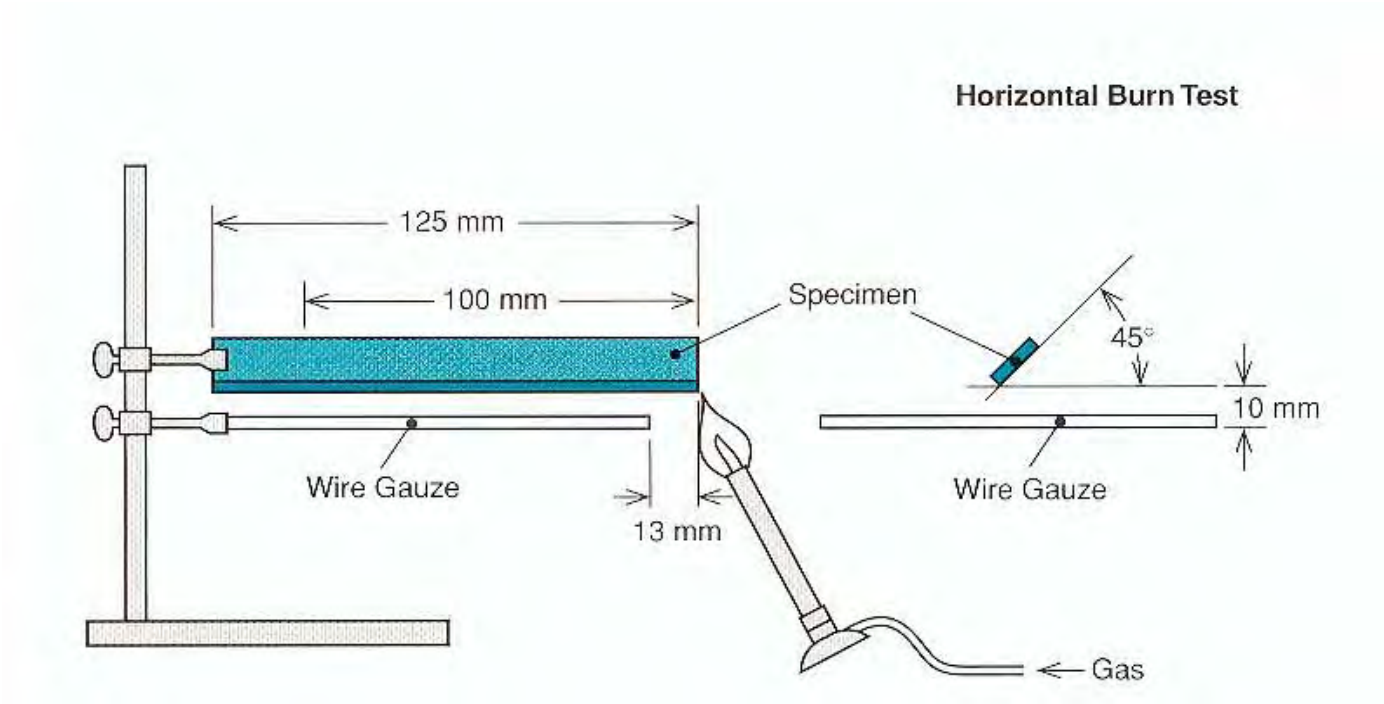
\+ Material designations may be followed by suffix numbers and/or letter(s) denoting color.

Report Date: 12/2/1975

Underwriters Laboratories Inc®

UL94 small-scale test data does not pertain to building materials, furnishings and related contents. UL 94 small-scale test data is intended solely for determining the flammability of plastic materials used in components and parts of end-product devices and appliances, where the acceptability of the combination is determined by ULI.

Flammability - Underwriter Laboratories Yellow Card

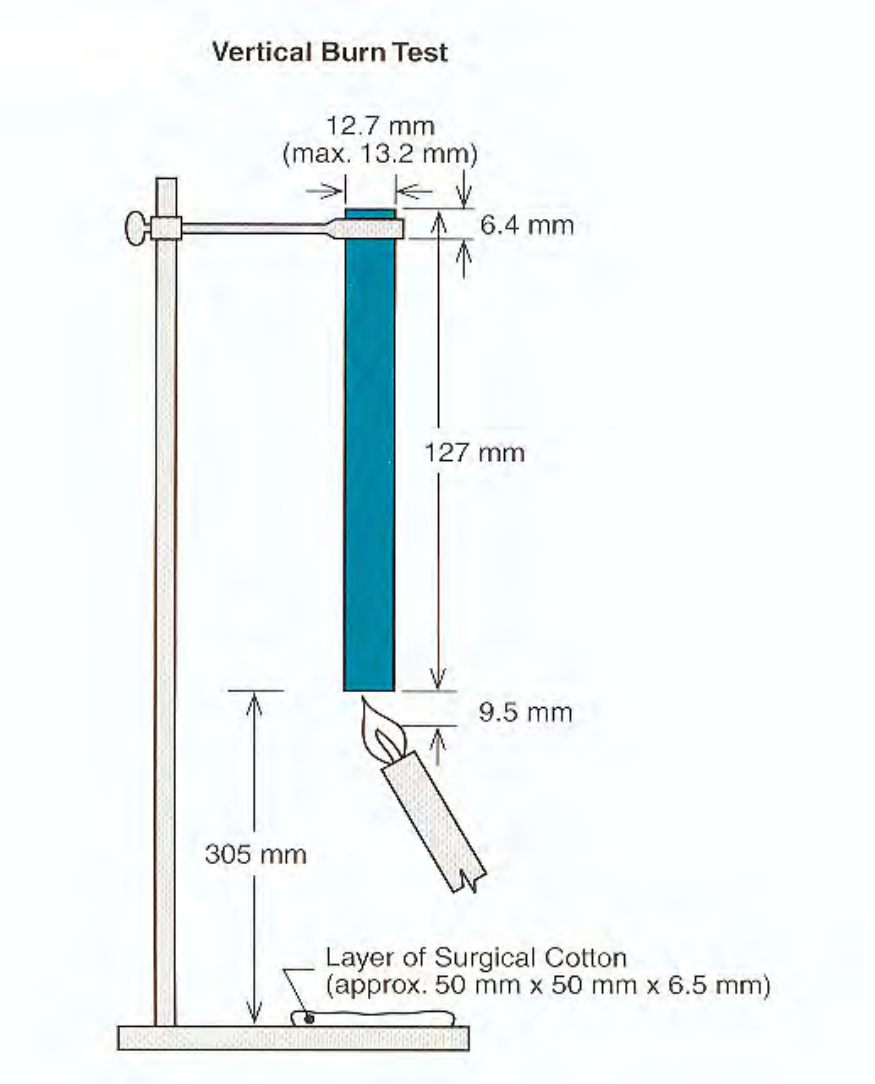


Horizontal Burning Test for Flammability
Classification 94HB

Specimen Thickness	Burning Rate
≥ 1/8 in	≤ 1 – 1-1/2 in/min
≤ 1/8 in	≤ 3 in/min

or material ceases to burn before flame reaches the second reference mark

Flammability - Underwriter Laboratories Yellow Card



Vertical Burning Test for UL Flammability Classifications
94V-0, 94V-1, 94V-2

Test Criteria	Flammability Classification		
	94V-0	94V-1	94V-2
Flaming combustion time after each application of flame	≤ 10 s	≤ 30 s	≤ 30 s
Total flaming combustion time for each set of 5 specimens (10 flame applications)	≤ 50 s	≤ 250 s	≤ 250 s
Flaming or glowing combustion up to the holding clamp	no	no	no
Duration of glowing combustion after second removal of test flame	≤ 30 s	≤ 60 s	≤ 60 s
Ignition of surgical cotton by dripping flaming particles	no	no	yes

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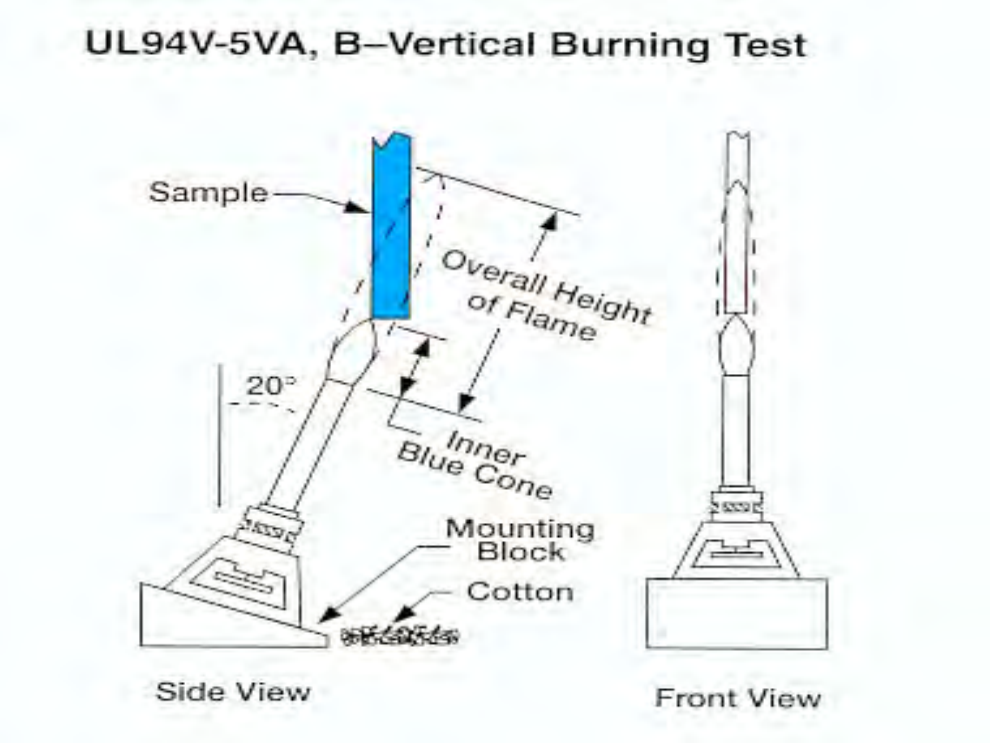
Flammability - Underwriter Laboratories Yellow Card

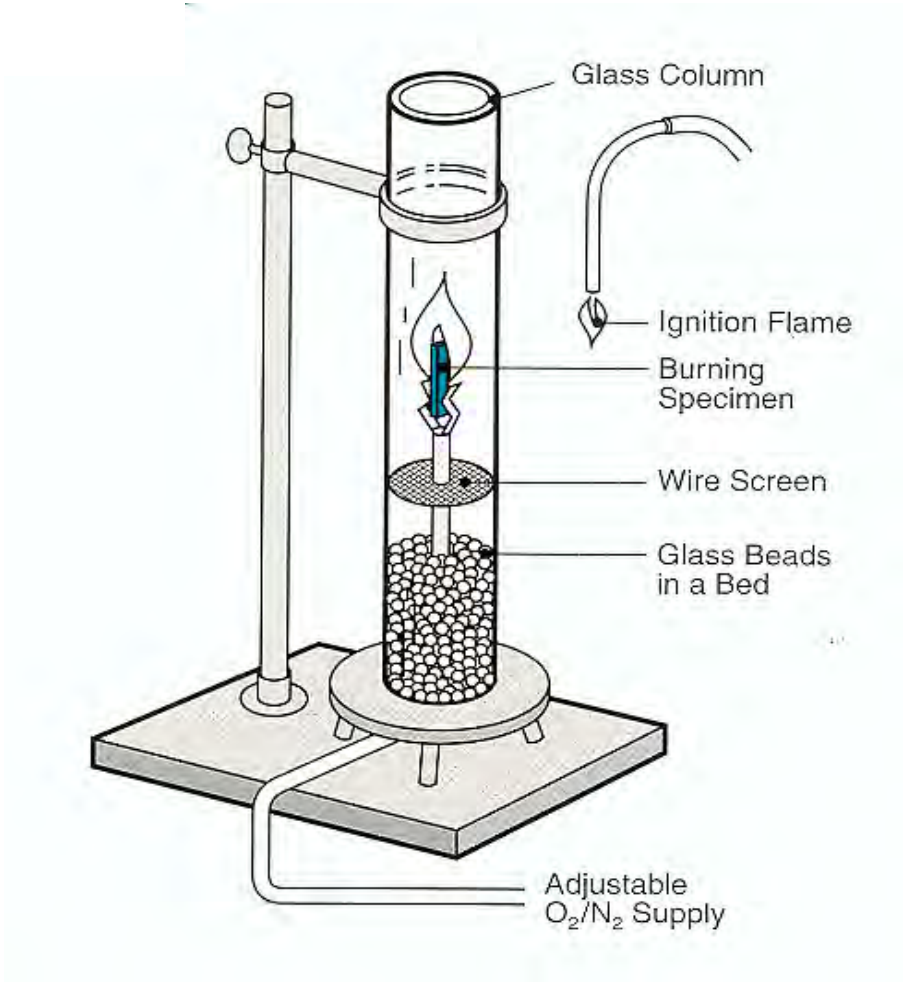


UL94V-5VA, B–Vertical Burning Test

Material Classifications

Criteria	94-5VA	94-5VB
Afterflame time plus afterglow time after fifth flame application for each bar specimen	≤60s	≤60s
Cotton indicator ignited by flaming particles or drops from any bar specimen	No	No
Burn-through (hole) of any plaque specimen	No	Yes

Flammability by Oxygen Index



Oxygen-index test apparatus

The **oxygen index** measures the minimum percentage of oxygen and nitrogen needed to support flaming combustion in a plastic at room temperature.

Open-air combustion is more likely in materials with oxygen-index rating os less than 21.

Test Methods:

- ASTM 2836
- ISO 4589

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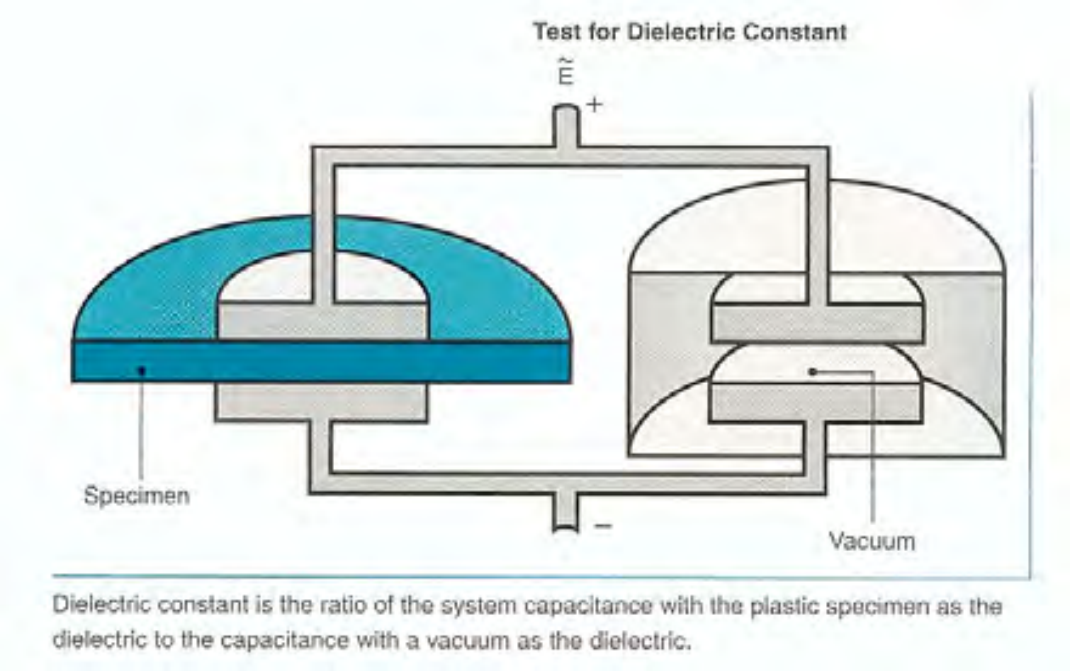
Electrical Properties

Dielectric Constant/ Relative Permittivity



Dielectric constant is the ratio of the system capacitance with the plastic specimen as the dielectric to the capacitance with a vacuum as the dielectric.

Dielectric constant or **relative permittivity** is the ratio of the capacitance of a plate electrode system with a test piece as the dielectric to the capacitance of the same system with a vacuum as the dielectric.

Lower values indicate better insulating characteristics.

Test Methods:

- ASTM D 150
- IEC 250

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Dissipation Factor

- **Dissipation factor** measures a resin's tendency to convert electric current into heat.
- Lower dissipation values indicate less power loss and heat generation and desirable for electrical insulation materials.
- The dissipation factor measures the ratio of the parallel reactance to the parallel resistance of a test material at specified frequencies and temperature.

Test Methods: (same test apparatus as dielectric constant)

- ASTM D 150
- IEC 250

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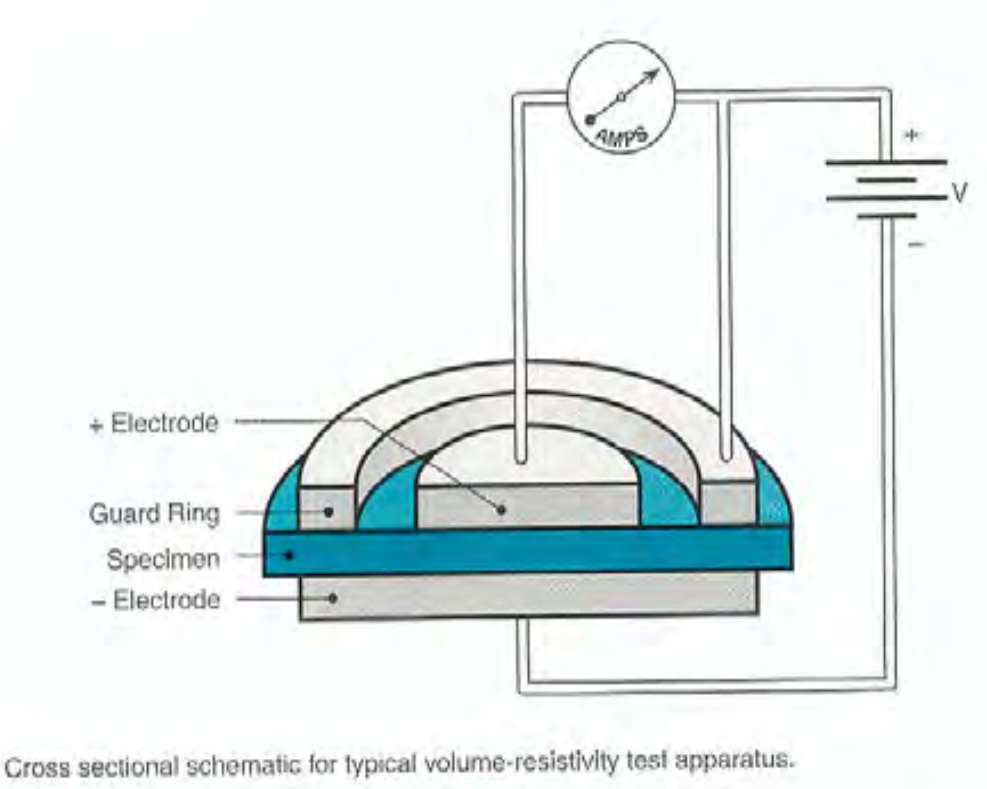
Volume Resistivity



Cross sectional schematic for typical volume-resistivity test apparatus.

Volume resistivity, a measure of a resin's electrical insulating properties. The electrical resistance between opposite faces of a unit cube of material, volume resistivity indicates current-leakage resistance through an insulating body.

A resin's volume resistivity should be at least 10^8 ohm-cm to be considered an insulating material.

Test Methods:

- ASTM D 257
- IEC 93

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Surface Resistivity

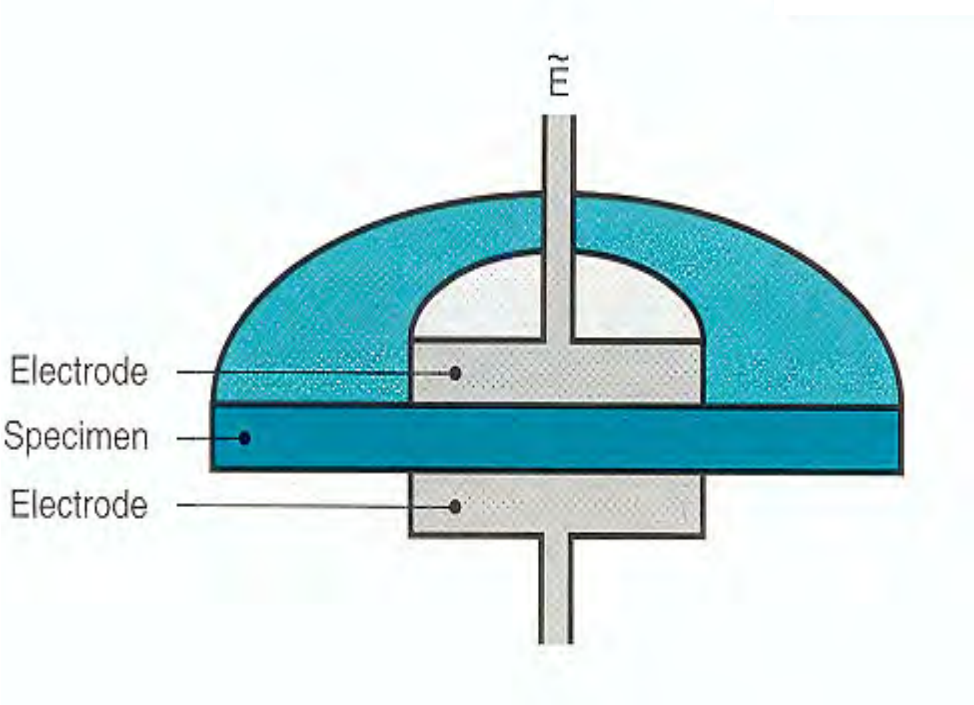
Surface resistivity measures a resin's surface-insulating performance.

- Higher values indicate better insulating properties.
- Test results are sensitive to humility, surface contamination and surface contour.

Test Methods:

- ASTM D 257
- IEC 93

Dielectric Strength



Cross sectional view of dielectric strength test.

A resin's **dielectric strength** measures the voltage an insulating material can withstand before electrical failure or breakdown occurs.

Higher dielectric-strength values indicated better insulating characteristics.

The values varies inversely with thickness: thinner specimens yield higher values. The values also tend to be higher at elevated temperatures.

Test Methods:

- ASTM D 149
- IEC 243

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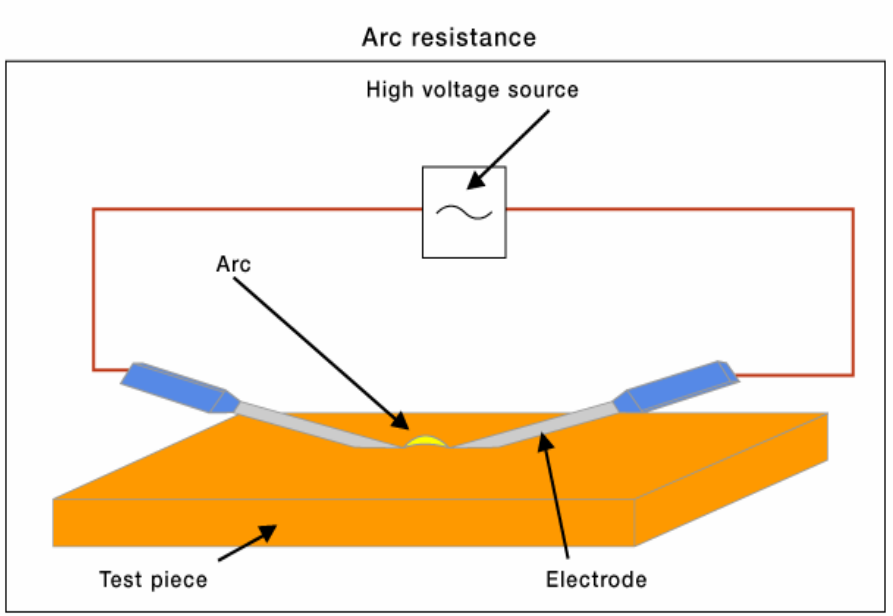
Arc Resistance

classification:
current at high voltage

evaluation of
resistance to an arc at high voltage

passed, if
- no formation of conductive path
- no burning, melting and hole formation



Test Methods:

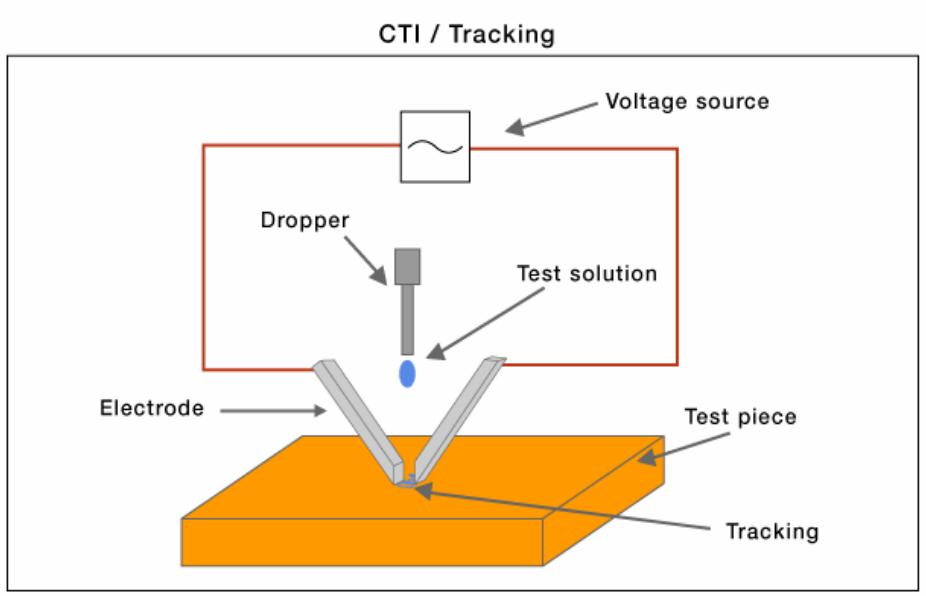
UL 746 A, ASTM D495

Comparative Tracking Index (CTI)

classification:
relative resistance to tracking

evaluation of
current in test solution

passed, if
- no current >0,5A for >2s
- no burning



Test Methods:

UL 746 A, ASTM D 3638, IEC 112)

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