

Imp = Topic - Dielectric Strength.

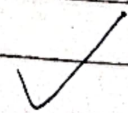
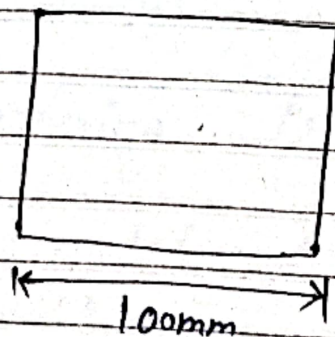
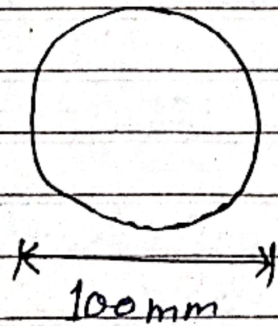
Dielectric Strength determines the electric strength of a material as an insulator.

Dielectric strength of an insulating material is defined as the maximum voltage require to produce a dielectric breakdown.

Test method :- ASTM D149

Test specimen and Conditioning :-

Moulded or Cut specimen from sheet in the form of disc of 100 mm diameter. Or 100 x 100 mm square is used. Thickness of specimen is 3.0 ± 2 mm.

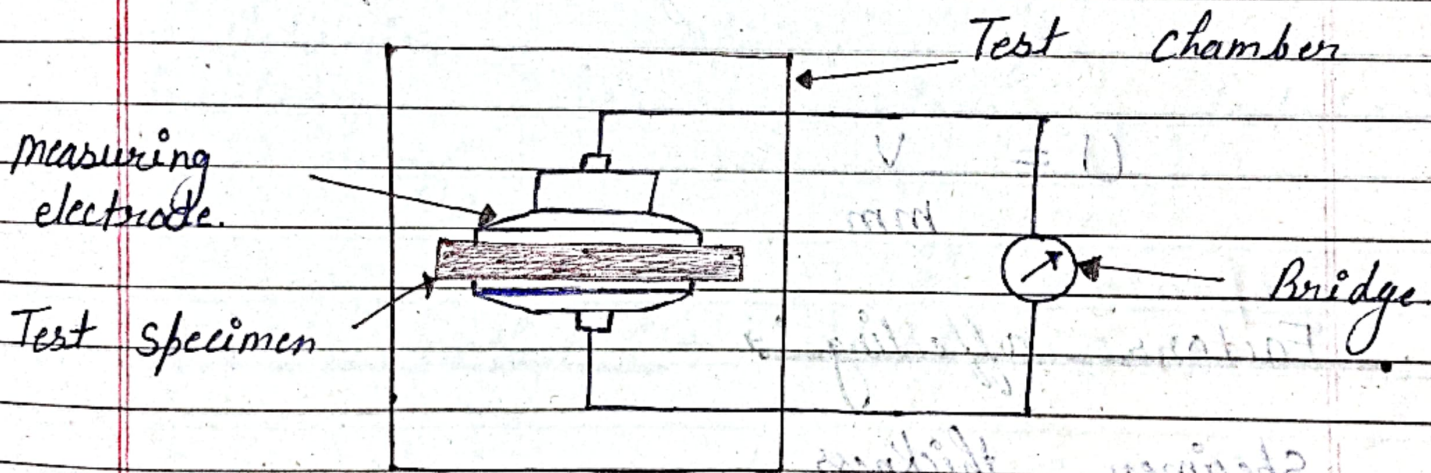


Test specimen are conditioned at $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ RH in at least 40 hours.

Equipments :- Test Method

Voltage Source :-
Voltage measurement
Test Chamber
Thickness gauge.

Procedure :-



- The test Chamber is opened and Specimen is placed between heavy cylindrical brass electrode which carry electrical current.
- The main supply to the equipment is switched ON and checked for voltmeter shows zero reading.

The voltage is slowly raised till by an regulator the flashover occurs.

The voltage at flashover which is the breakdown voltage is noted.

Result :-

$$U = \frac{\text{Breakdown Voltage}}{\text{Thickness of the specimen}}$$

$$U = \frac{V}{\text{mm}}$$

Factors affecting :-

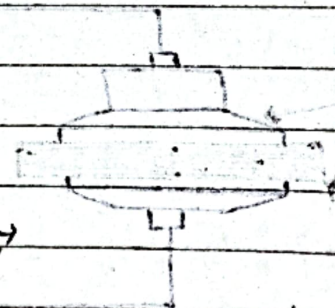
Specimen thickness

Temperature

Electrodes

Time

Humidity



Topic - Di-electric Constant

The Di-electric Constant of an insulating material is defined as the ratio of charge stored between two metallic plates to the charge that can be stored in the same material when it is replaced by air or vacuum.

Di-electric Constant is used to determine the ability of an insulator to store electrical energy.

Test method $\Rightarrow$ "ASTM D 150"

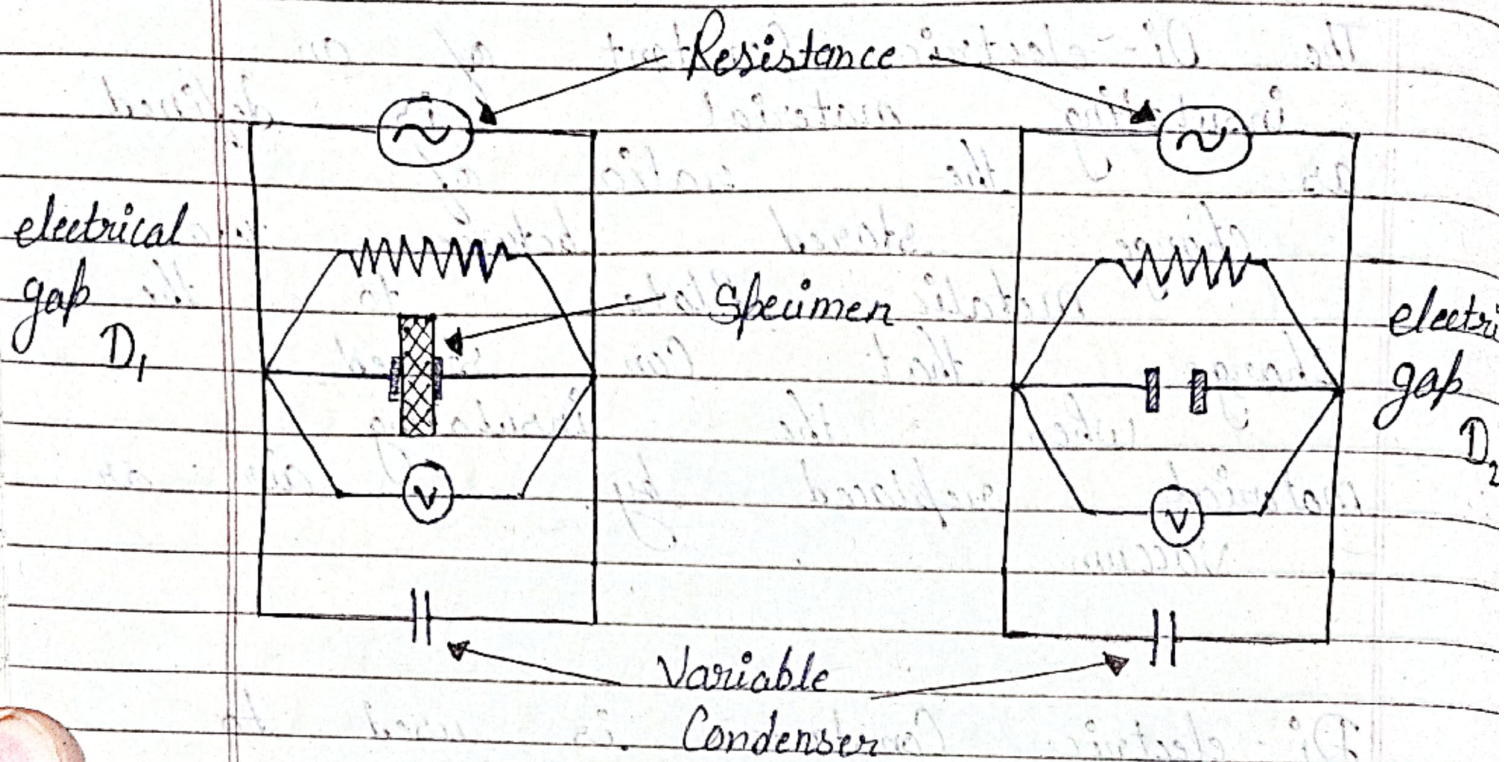
Test specimen and Conditioning $\Rightarrow$

Specimen disc 50 mm Diameter and Thickness upto 3mm.

All the sample are free from humidity.

Sample is kept in air oven, maintain at 105 to 110°C Period of 1 hour.

Equipment :-



Capacitance :- Used to Determine Dielectric Constant.

Test Procedure :-

A sample is placed between two metallic plates and the capacitance is measured.

The second step is made without a sample between two metallic plates or electrode.

The Ratio of this two value is called Di-electric Constant.

Result $\Rightarrow$

$$\text{Di-electric Constant} \Rightarrow \frac{\text{Capacitance material}}{\text{Capacitance Air } (C_2)}$$

Factors Affecting $\Rightarrow$

- Thickness
- Voltage
- Temperature
- Humidity

Some Plastics Dielectric Constant

Plastic	Dielectric Constant
Malemine	5.2 to 7.3
HIPS	2 to 4
Nylon	3.5 to 3.8
ABS	3.2

Topic - Surface and Volume Resistivity

Surface Resistance :-

It is the ratio of the direct voltage applied at the electrode to that portion of the current between them, which flows through the surface layers.

It is Expressed in "Ohms (Ω)"

Volume Resistance :-

It is the ratio of the direct voltage applied at the electrode to the portion of the current between them, that is distributed through the volume of the specimen.

It is Expressed in "Ohms (Ω)"

Test Method :-

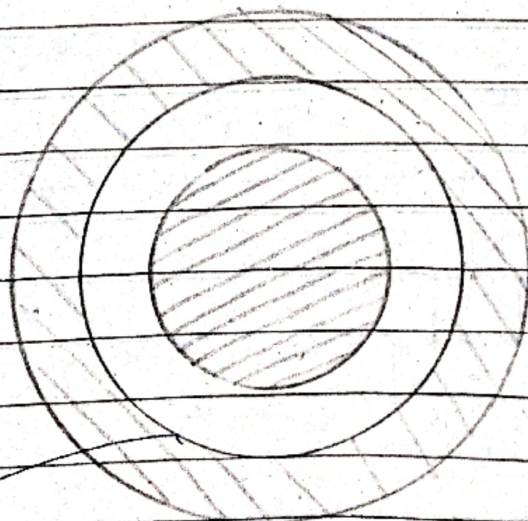
"ASTM D 2305" Test method for Polymeric electrical film used for insulation.

"ASTM D 257" Test method for the insulating material.

Test specimen and Conditioning :-

The test specimen should be a disc of "110 mm" Diameter with "3mm" Thickness.

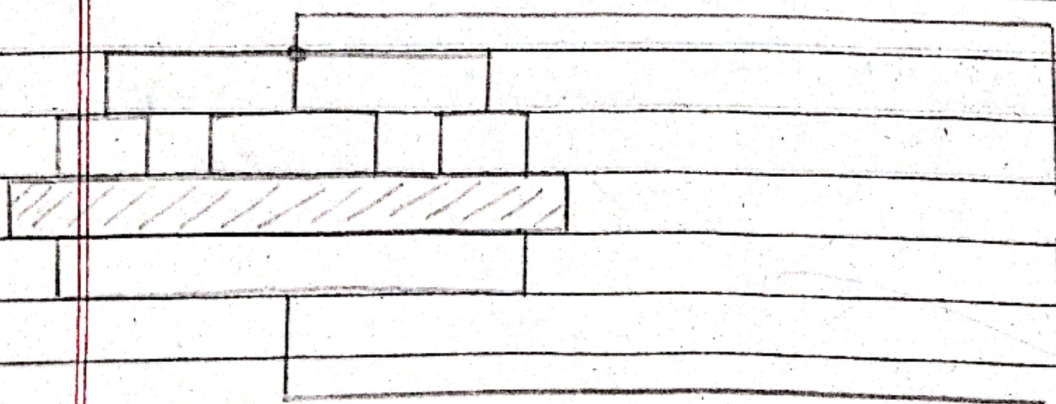
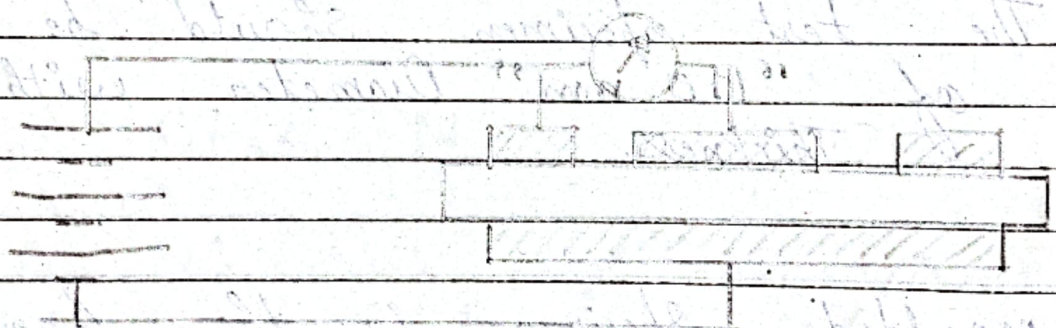
moulded specimen in the form of disc is conditioned at $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ RH for 24 hours.



Equipment :-

- Mega Ohm (Ω) meter is used to determine the Volume and surface Resistivity.
- Vernier Caliper and micrometer used to give the accuracy.
- electrode System.

Test Procedure :-



- Any necessary intimate electrodes and contacting medium are applied. If the intimate electrodes are applied by vacuum metalizing, the specimen is conditioned after application.
- The specimen is mounted on the specimen holder electrode assembly and the test potential is applied via the charging position of the instrument switch for at least about 10% of the specified electrification time. Usually about "5 seconds."
- The instrument connection switch is moved to the "read" position and the range switch set to an appropriate level at least 10 seconds before reading the resistance at the specified electrification time. The time of electrification is usually 1 minute and the applied voltage is "500 $\pm$ 5 volt." The indicated resistance will steadily increase.
- If necessary, the capacity using the electrode specimen assembly is measured.

Result $\Rightarrow$ Volume Resistivity

$$\rho_v = R_v \times \frac{A}{t}$$

$\rho_v \Rightarrow$ Volume Resistivity [Ohm-cm]

$R_v \Rightarrow$ Volume Resistance [Ohm]

$A \Rightarrow$ Area of electrode [cm²]

$t \Rightarrow$ Thickness of specimen [cm]

Result $\Rightarrow$ Surface Resistance

$$\rho_s = R_s \times \frac{A}{G}$$

$\rho_s \Rightarrow$ Surface Resistivity Ohm-cm

$R_s \Rightarrow$ Surface Resistance Ohm

$A \Rightarrow$ Area of electrode cm²

$G \Rightarrow$ Gap between electrode cm

Factor affecting -

A small amount of impurity
humidity
Thickness.

Temperature

Topic - Dissipation factor

The Dissipation factor is defined as the ratio of the Conductance of a Capacitor with material as the dielectric to its substance. It represents the amount of energy dissipation with when voltage is applied to its insulating material.

Test method - "ASTM D 150"

Test Procedure - for determination of Dissipation factor the value of Parallel Capacitance or equivalent Parallel Resistance has to be measured.

This value can be measured by the same way of Dielectric Constant.

Result :-

$$D = \tan \delta = \cot \theta = \frac{1}{\omega C_p R_p} = \frac{1}{2\pi f C_p R_p}$$

θ = loss angle
 D = Dissipation factor
 δ = loss angle
 ω = Angular frequency
 C_p = equivalent Parallel Capacitance
 R_p = " " Resistance

Factor affecting $\rightarrow$

- Applied voltage
- Humidity
- Temperature

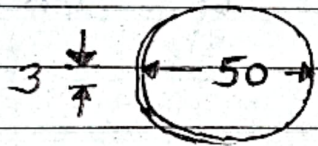
Topic :- Arc Resistance

The ability of a plastic material to resist the action of a high voltage electric arc is defined as the arc resistance.

It is expressed in Sec.

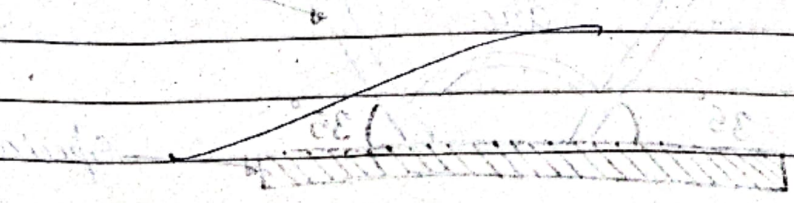
Test Specimen and Conditioning :-

A flat surface disc "50mm" diameter with "3mm" thickness is used.



The test specimen shall be conditioned at 50°C in air oven for about 30 min. to remove the moisture from the surface.

Test method :- "ASTM D 495"



Equipments:

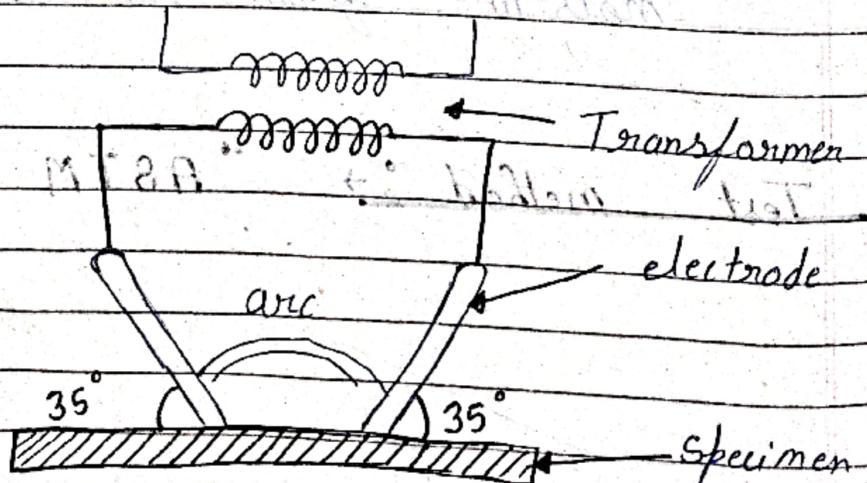
- Voltage generation and Control device
- Volt meter - to read voltage
- milliammeter
- Timer
- electrodes. - In this test method we use two electrode system

- SSS (Stainless Steel Strip) test
- Tungsten electrode

SSS electrode system is used where arc resistance is less than "180 Sec."

Tungsten Rod electrode system is used where arc resistance is more than "180 Sec"

Procedure →



- The test Chamber is open & The Specimen is placed between the electrode assembly.
- The spacing between the electrode is checked and angle of 35° from the horizontal surface of the specimen.
- The main supply to the equipment switched ON.
- The equipment is adjusted at voltage of 12.5 kb and current is adjusted 10 mili Amp.
- Once arc is maintain as the test condition the timer is on.
- Initially arc intensity is maintain at 10 mA for 1 min at the end of each min.
- The timer for the formation of failure is recorded.
- failure is characterized by the carbonization of the surface heating to burning.

Result :-

The total time to failure is recorded and arc resistance is measured in Sec. to failure.

Factor affecting :-

- Thickness
- Humidity
- Voltage
- Temperature
- Surface Contamination

Topic - Specular Gloss

Specular Gloss is defined as the relative luminous reflectance factor of a Specimen at the specular direction.

Gloss is a measure of light reflected by the surface of a Plastic film.

Test method $\rightarrow$ "ASTM D 523"

Specimen and Conditioning $\rightarrow$

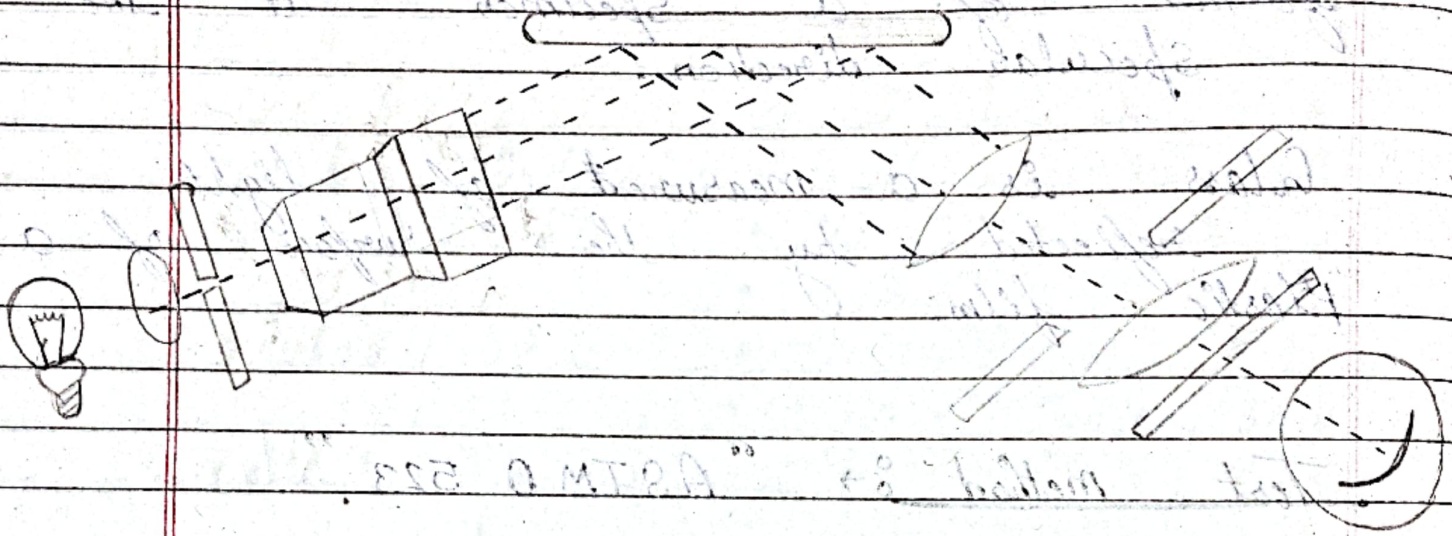
The test specimen should be in the form of disc.

The test specimen is conditioned at $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ RH for not less than 40 hours.

Equipment $\rightarrow$

- Gloss meter - used for the determination of specular gloss of surface.
- Photo detector.
- Light Source.

Test Procedure →



- The instrument is turned on and placed on a black glass.
- The Control Knob is adjusted so that meter indicates primary reading.
- Then the sensor is placed on the specimen surface and the glass value is directly read from the analog or digital display.
- The instrument is calibrated at regular intervals to ensure the reading is constant.

Factor affecting →

- Surface Property
- Surface of the material should be perfectly smooth
- Incidence Angle.

Topic - Refractive Index

Refractive Index is a measure of velocity of light through vacuum to the velocity of light through medium.

It is also a ratio of sine of the angle of incidence to the sine of angle of Refraction

Index of Refraction (n) $\Rightarrow \frac{\text{Sine of angle of incidence}}{\text{Sine of angle of refraction}}$

$$\Rightarrow \frac{\sin I}{\sin R}$$

Test method -

"ASTM D542"

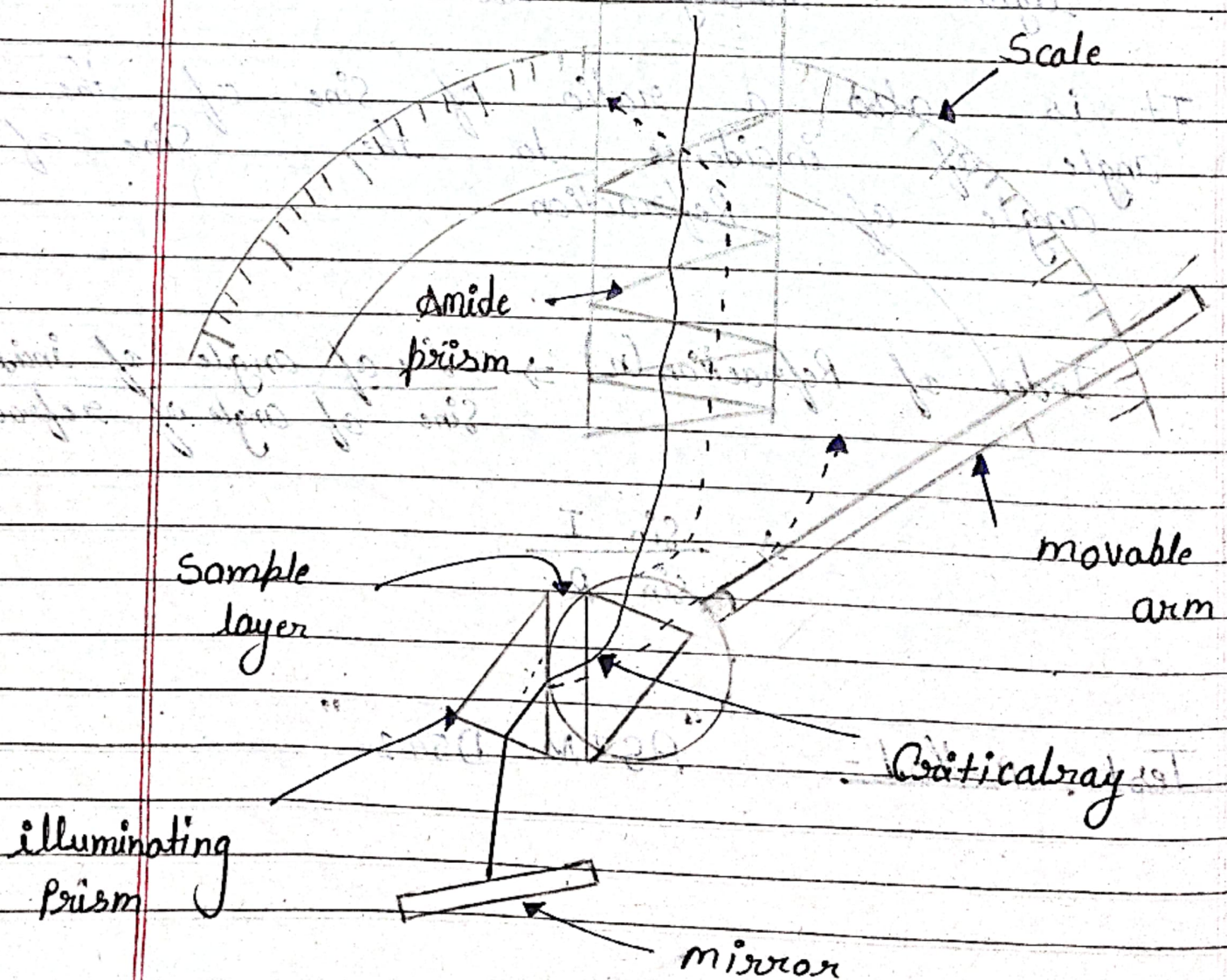
Test Specimen and Conditioning :-

Test Specimen Shape and size is same as prism face.

Test Specimen Conditioned at the temperature of $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ R.H.

Equipment :-

- Abbe Refractometer



Procedure :-

Refractometric method

A source of diffuse light is placed, so that good illumination is obtained along the plane of the surface of contact between the specimen and the refractometer prism.

A small drop of a suitable contacting liquid is placed on the polished surface of the specimen.

The specimen is placed in firm contact with the surface of the specimen prism and with the polished edge of the specimen towards the source of light. The index of

The index of refraction is determined by moving the index arm of the refractometer so that the field seen through the eye piece is half dark.

The index arm is then adjusted in such a way that the dark light position of the field coincide at the intersection of the cross hair.

The value of the refractive index directly recorded at this point.

Result $\Rightarrow$

Index of refraction (n) $\Rightarrow$

$$\frac{\text{Actual Thickness of the Specimen}}{\text{Apparent Thickness of the Specimen}}$$

Factors affecting -

- Temperature
- medium used
- wave length of light

Topic - Luminous Transmittance and Haze

• Luminous Transmittance -

Luminous transmittance is defined as the Ratio of transmitted light to incident light.

$$\text{Luminous Transmittance} \Rightarrow \frac{\text{Transmitted light}}{\text{Incident light}}$$

Expressed in "%"

• Haze - A Cloudy or milky appearance in plastics is known as haze.

• Haze $\Rightarrow$
$$\frac{\text{Diffuse Transmittance}}{\text{Total Transmittance}}$$

It is expressed in "%"

• Test method $\rightarrow$ "ASTM D1003"

Test specimen and Conditioning -

Test specimen should be in the form of Disc of 50 mm Diameter.

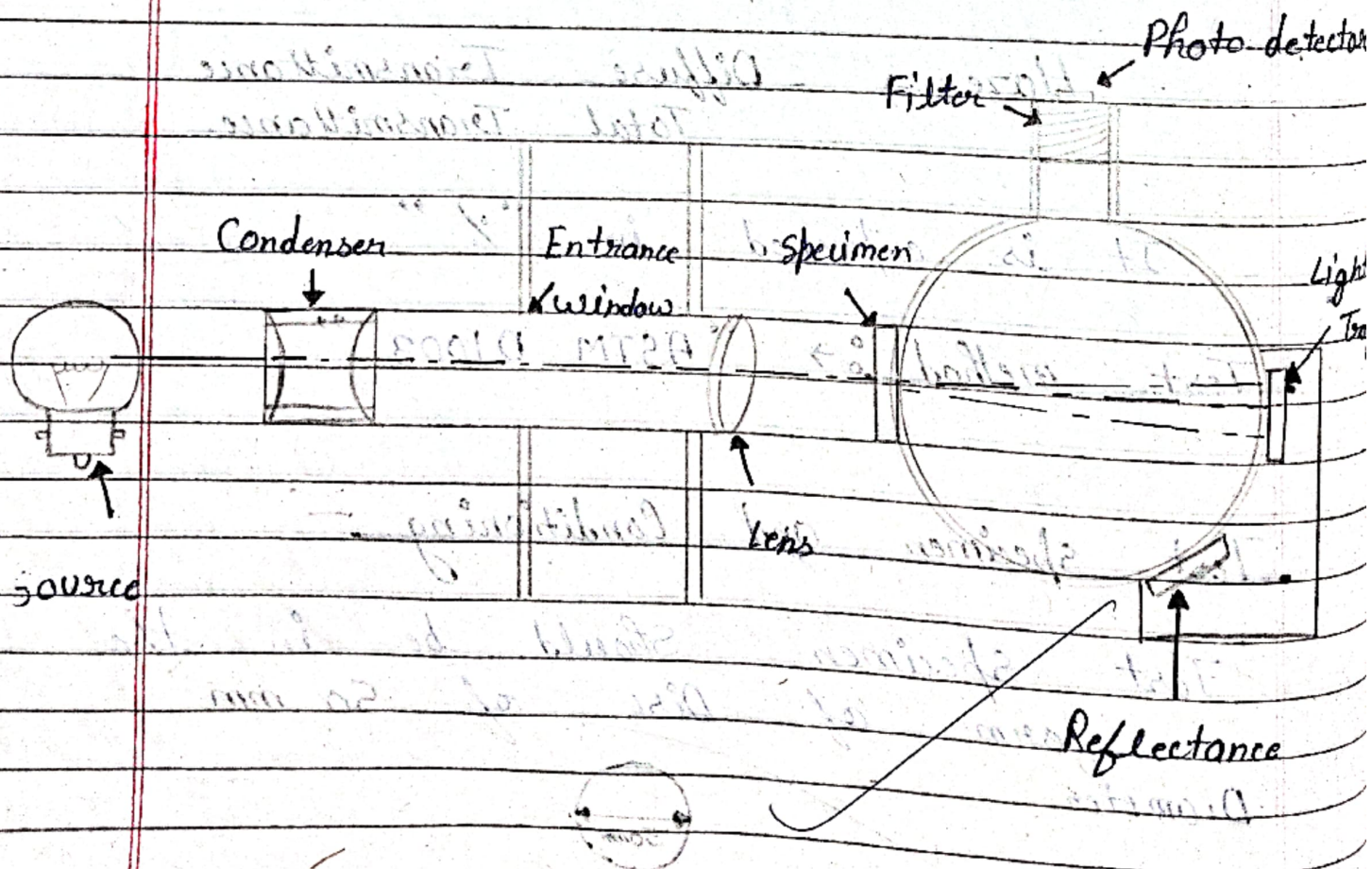


The test specimen conditioned at
The Temperature of $23 \pm 2^\circ\text{C}$
and $50 \pm 5\%$ R.H for not
less than 40 hours.

Equipment $\Rightarrow$

- light source
- lens
- Photo detector
- Integrating sphere $\rightarrow$ to collect the transmitted light

Procedure $\Rightarrow$



- The Sample is placed between the specimen holder at the lance
- Light from the light source is allowed to fall over the sample
- The test is conducted by four different reading and measuring the photocell output as follows-

$T_1 \rightarrow$ Specimen, Light Trap out, Reflectance

$T_2 \rightarrow$ Specimen, Reflectance, Light Trap out

$T_3 \rightarrow$ Light Trap out, Specimen, Reflectance

$T_4 \rightarrow$ Specimen, Light Trap out, Reflectance

Short-Cut to learn

$T_1 \rightarrow 123$

$T_2 \rightarrow 132$

$T_3 \rightarrow 213$

$T_4 \rightarrow 123$

Where -

1 $\rightarrow$ Specimen

2 $\rightarrow$ Light Trap out

3 $\rightarrow$ Reflectance

Result $\therefore \rightarrow$

Total Transmittance $T_t \Rightarrow T_2 / T_1$

Diffuse Transmittance (T_D) $\Rightarrow$

$$\left[T_4 - T_3 \left(T_2 / T_1 \right) \right] / T_1$$

Haze Percentage $\Rightarrow$

$$T_d / T_t \times 100$$

Factors Affecting $\Rightarrow$

- moulding Defect
- Additives
- Type of material

Topic - Clarity

Clarity Refer to the Property of transmitting light which has Scattering when passing through the object.

If the transmitted light deviates less than 2.5° from the incident angle, the material is said to be Clear.

Test method $\rightarrow$ "ASTM D1746"

Test Specimen and Conditioning $\rightarrow$

Specimen may be in the form of film or sheet.

The test specimen Conditioned at $23 \pm 2^\circ\text{C}$ Temperature and $50 \pm 5\%$ R.H for not less than 40 hours.

Equipments $\rightarrow$

- Sensing Unit
- Photo metric Unit
- light Source
- Focusing lance
- Specimen holder
- Test Chamber

Procedure :-

- The optical alignment of photometric unit is checked.
- Center is controlled by micro adjusting assembly
- Which is standardized a reading of 100 relative to air.
- The beam is completely blocked with a piece of black paper.
- And knob is set to zero.
- Sample is placed in sample holder.
- The position is re-adjust so maximum value is obtained.
- If slit optics are used the specimen may be rotated on its own axis.
- Maximum value of transmitted light recorded.

Result :-

The Reading at different position is taken and result is noted and take average.

Topic: Color

Color is a property of an object that results from the particular wavelength of light which they reflect on give out, producing a sensation in the eye.

Test method :→ ASTM D2244

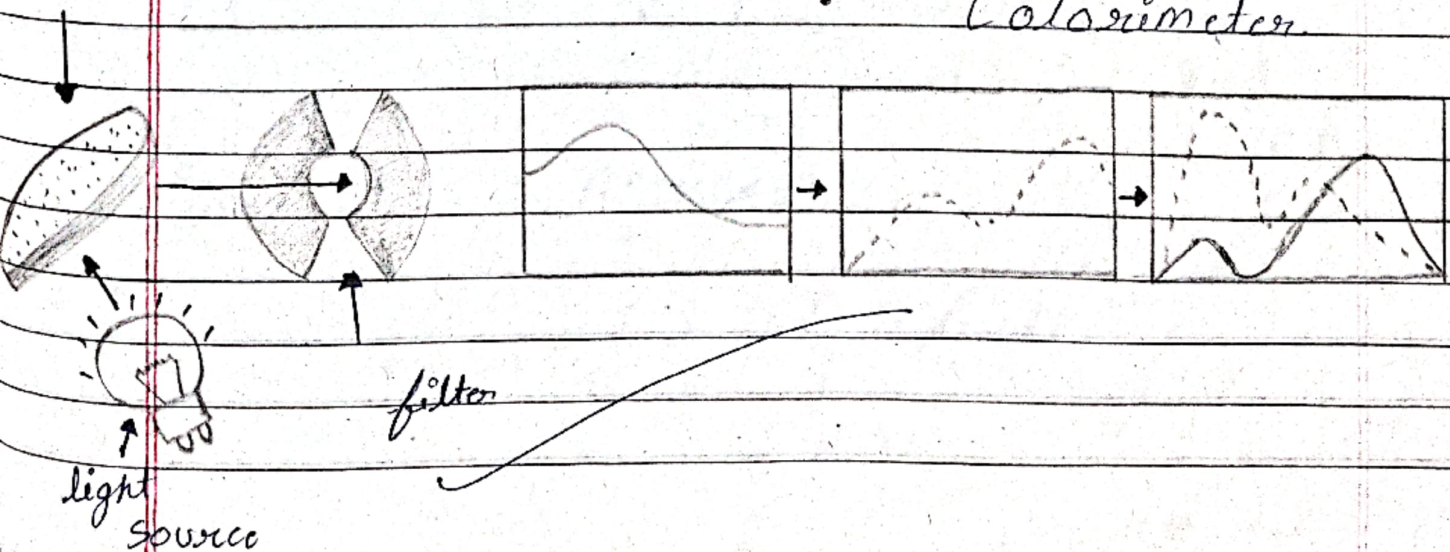
Specimen and Conditioning :→

The test specimen is taken from representative material.

The test specimen conditioned at $23 \pm 2^\circ\text{C}$ Temperature and $50 \pm 5\%$ RH for not less than 40 hr.

Equipments :→

- Spectrophotometer
- Colorimeter



Spectrum Color	Wavelength (nm)
Red	750 - 610
Orange	610 - 590
Yellow	590 - 575
Yellow Green	575 - 555
Green	555 - 510
Blue - Green	510 - 480
Blue	480 - 450
Violet	450 - 400

Procedure :-

Spectrophotometer

Colorimeter.

Factors affecting :-

- Angle of illumination
- Type of material
- Particle size

Topic - Photo Elastic Properties

Photo elastic properties of transparent material are useful in stress analysis and determine orientation in moulded parts.

Test specimen and Conditioning :-

The test specimen can be a sheet or moulded part.

The specimen is conditioned at $23 \pm 2^\circ \text{C}$ Temperature and $50 \pm 5\%$ R.H. for not less than 40 hours.

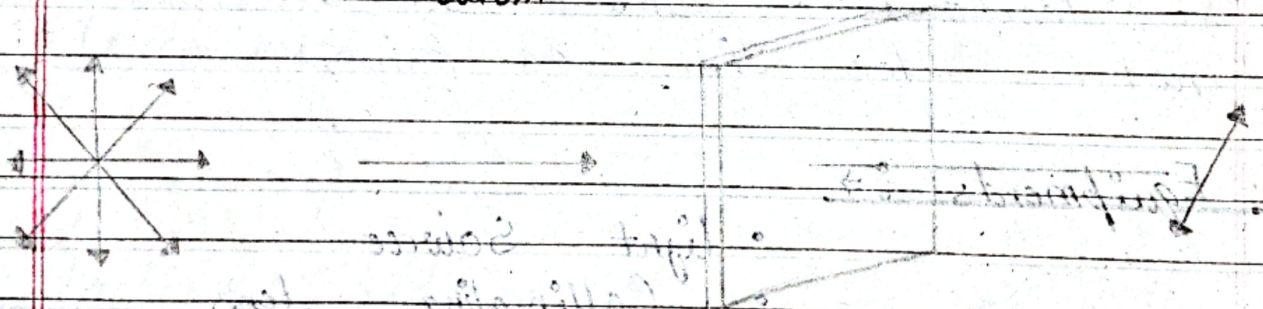
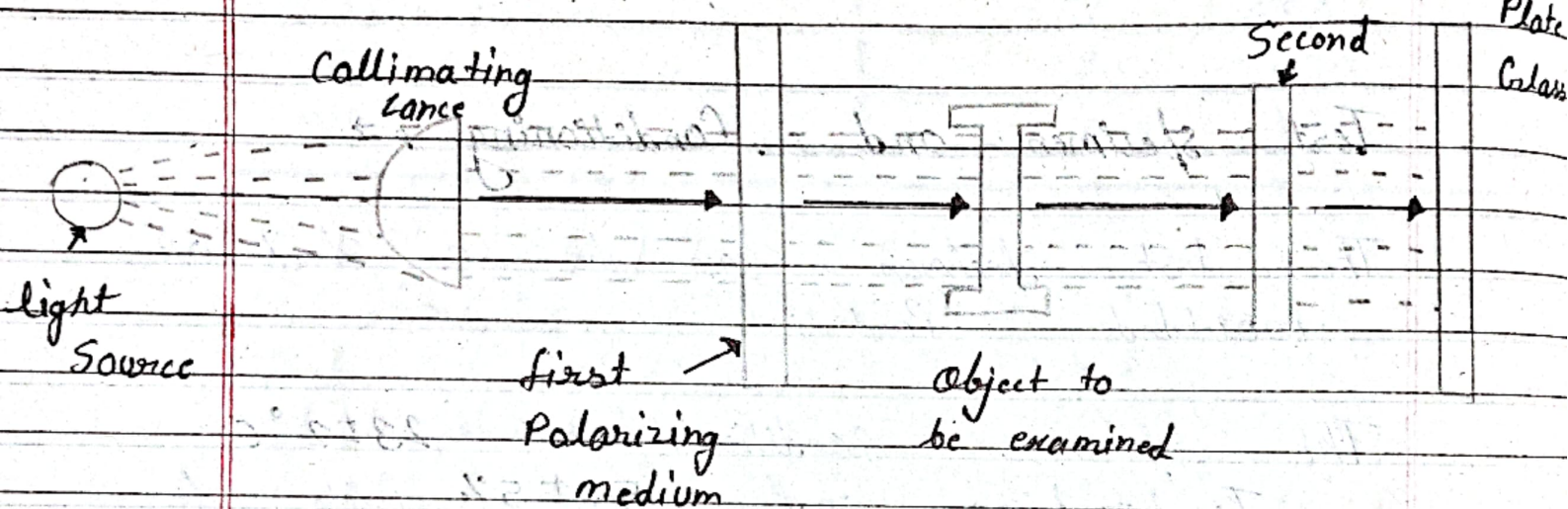
Equipments :-

- Light Source
- Collimating lens
- Polarizing medium
- Specimen
- Ground Plate of Glass

Test Method :- ASTM D4093

Procedure

The object to be examined is placed in the center of the Polarizing medium and viewed from the opposite side of the light source.



The numbers of Fringes formed due to polarized light is preferred for stress analysis.

Higher order of Fringes represent high stress level and low order of Fringes represent low stress.

Several techniques are used with stress the basic photo elastic concept.

Thermo photo elasticity measurement of the thermal stress by photo-elastic means.

Scattered light photo elasticity -

Analysis of rheology of Plastic by Photo Elasticity.

Factors Affecting :-

- moulding Design
- mould size

"UNIT - II"

Topic - Stain Resistance of Plastic

Ability of Plastic material to resist staining when in contact with chemicals or staining reagent such as Acetone, Tea, Coffee etc.

Test method :- "ASTM D1712"

Test specimen and Conditioning :-

Test specimen 100 ± 25 mm in length and 13 ± 6 mm in width.

The Test specimen Conditioned at $23 \pm 2^\circ\text{C}$ Temperature and $50 \pm 5\%$ R.H for not less than 40 hours.

Equipments :-

- 250 ml glass beaker
- Glass Cover

Procedure :-

- Pre - Conditioned specimen are immersed in beaker containing saturated staining reagent such as Acetone, Tea, Coffee etc.

- The beaker is covered with watch glass for required test duration.
- Specimen is removed, wiped, dried and examined for discoloration of the immersed section for comparison with the non-immersed product.

Result :->

Test result is expressed in terms of discoloration, physical change and relative degree of staining.

Factors Affecting :->

- Temperature
- Humidity
- Surface finishing
- Stress condition

Topic - Immersion Test.

This test is particularly useful for quality control test for PVC Pipes, fitting and other PVC moulded parts.

Because PVC Compound is easily attacked by anhydrous acetone which cause swelling.

Test method : $\rightarrow$ "ASTM D.2152"

Test specimen and Conditioning : $\rightarrow$

Test specimen : light is not less than 13 mm.

The test specimen shall be conditioned at $50 \pm 3^{\circ}\text{C}$ Temperature for 24 hours in Oven.

Equipment : $\rightarrow$ • Analytical weighing balance
• micrometer

Procedure :-

- Place cut piece of test specimen in AR grade acetone.
- Test piece is placed in immersed Condition for 20 minutes.
- After 20 minutes Sample is removed and observed for attacking of acetone on the sample.

Result :-

Result can be expressed in terms of lifting, raising or removal of material from out side, inside or mid wall of specimen.

Factors Affecting :-

- Thickness of specimen
- Test Condition
- Time

Pr
2/1/24

Topic - Environmental stress - Cracking Resistance "ESCR"

Environmental stress - Cracking Resistance (ESCR) is a material's ability to resist cracking caused by environmental factors and stress.

ESCR describes the tendency of Polyethylene product to prematurely fail in the presence of detergents, water, sunlight, oil or other active environments.

Test method : $\rightarrow$ "ASTM D1693"

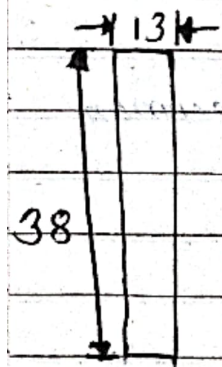
Test specimen and Conditioning : $\rightarrow$

The test specimen of size 3.8×13 mm is used for ESCR test.

test specimen Conditioned at $23 \pm 2^\circ\text{C}$ Temperature and $50 \pm 5\%$ R.H for not less than 40 hours.

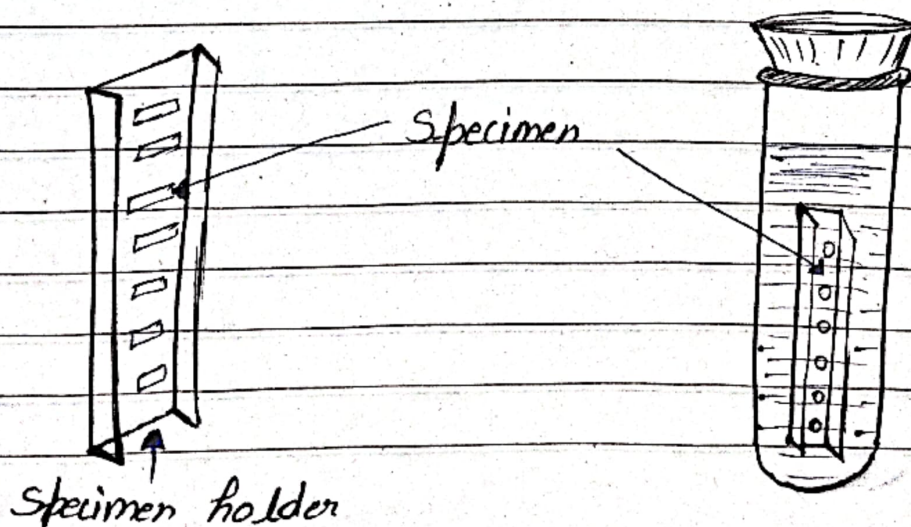
Equipments : $\rightarrow$ Jig, Test tube, Specimen holder

Reagent : $\rightarrow$ CO 630 (Igepal)



Procedure :-

- The rectangular test specimen is cut very precisely.
- The nicked specimens are bent through 180° .
- Ten sample are mounted on one holder.
- The holder is inserted in the test tube.
- Then test tube is filled with fresh reagent to submerge the sample.
- The test tube closed with help of cork and placed in constant temp. Bath. $50 \pm 0.5^\circ\text{C}$ or $100 \pm 0.5^\circ\text{C}$.
- The test sample are removed after a specified time and observed crazing.

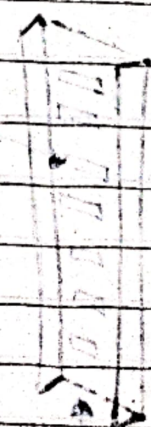


Result :->

The F_{50} value (failure 50%) has to be determined and reported in graph.

Factor affecting :->

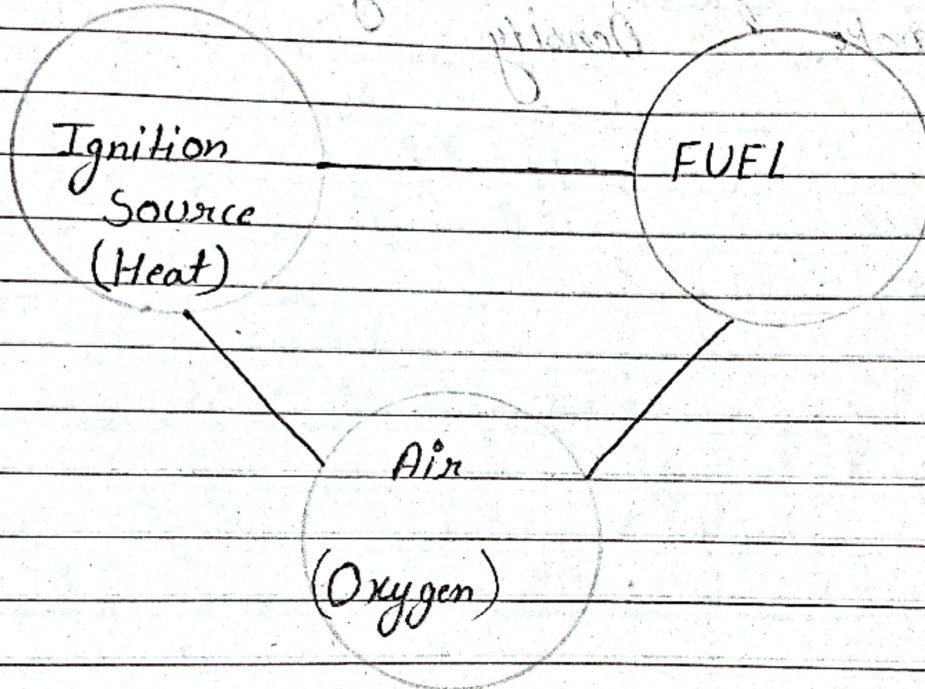
- Internal Stress
- Solvent
- Temperature
- Time



Topic - Flammability

Mostly Plastic are Carbon based materials and they burn and give smoke or gases.

For Combustion three components are necessary "Fuel, Oxygen, Ignition"



Primary Thermal
 ↓
 Primary Chemical
 ↓
 Polymer Decomposition
 ↓
 Ignition
 ↓
 Combustion
 ↓
 Flame Propagation.

Flammability of Plastics

following test are used to determine the flammability characteristics:

- UL 94
- Limiting Oxygen Index (LOI)
- Rate of Burning (ROB)
- Smoke Density

Topic - Underwriters Laboratory 94 [UL 94]

The ignition resistance of a plastic is rated according to Underwriters Laboratory Standard 94.

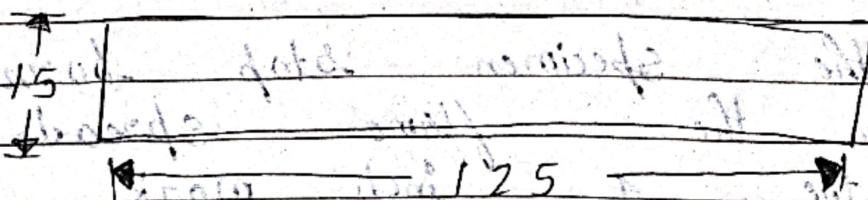
UL Testing is a method of classifying a material's tendency to either extinguish or spread a flame once it has been ignited.

Test method : → TEC 60695

Test specimen and Conditioning : →

The test specimen of rectangular shape with the dimension of 125 × 15 mm

Test specimen conditioned at $23 \pm 2^\circ\text{C}$ temp. and $50 \pm 5\%$ RH for not less than 40 hours.



Equipment → Laboratory burner
Burner mounting fixture
Stop watch
Gas supply
Test Chamber
Conditioning oven
Cotton micrometer.

Procedure → "Horizontal Testing"

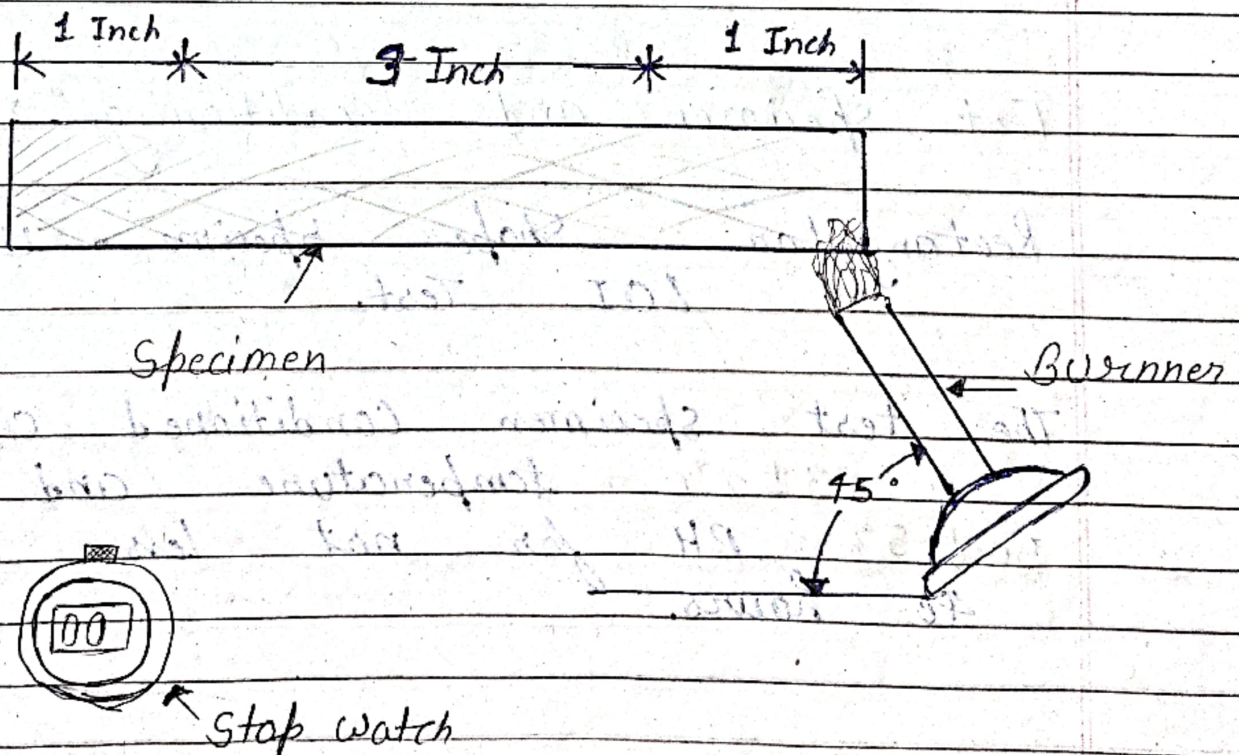
- Specimen is supported in Horizontal Position and fix the burner in 45° Angle.
- A flame is applied to the end of the specimen for 30 sec or until flame reach one inch mark.
- If the specimen continues to burn after the removal of flame
- The time for the specimen to burn between the 1 inch and 4 inch mark are recorded.
- If the specimen stop burning before the flame spreads to the 4 inch mark

→ The time of Combustion and length damaged between two marks is recorded

• Minimum 3 Specimens are tested for each Thickness.

Factors Affecting :-

- Thickness
- Flame length
- Temperature and Humidity
- Burner Angle.



Topic: Limiting Oxygen Index (LOI)

The limiting Oxygen Index is measures the percentage of oxygen present to support Combustion of the Plastic.

Air contain approximately 21% oxygen

Any material with an LOI is less than 21% is probably support burning in open air.

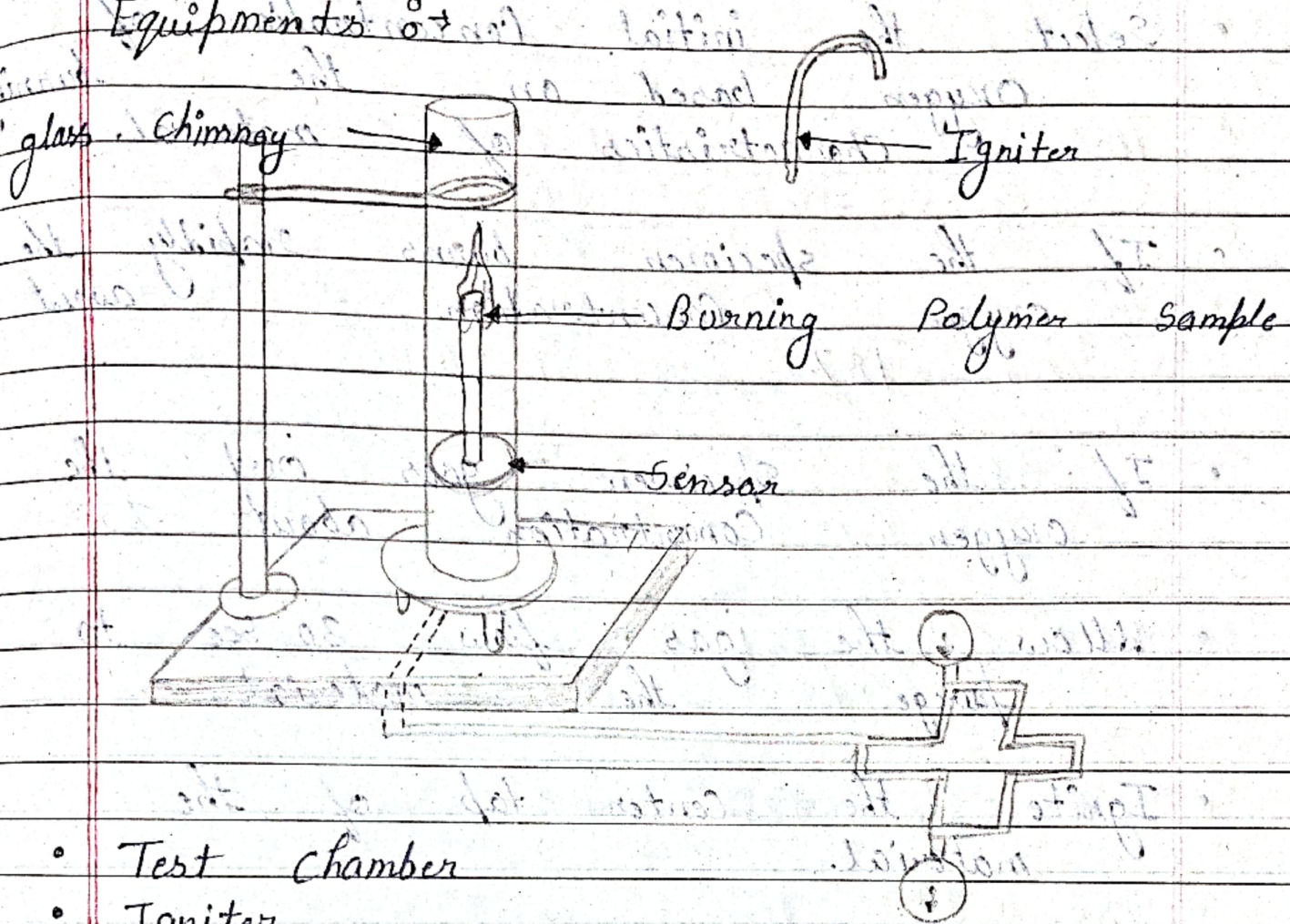
Test method $\rightarrow$ ASTM D2863

Test specimen and Conditioning $\rightarrow$

Rectangular Shape Specimen used in LOI Test.

The test specimen Conditioned at $23 \pm 2^\circ\text{C}$ temperature and $50 \pm 5\%$ RH for not less than 40 hours.

Equipments :-



- Test Chamber
- Igniter
- Sample
- Specimen holder
- gas supply
- gauge
- Timer.

Procedure :-

- Clamp the specimen vertically in the center of test chamber.

- Select the initial concentration of oxygen based on the burning characteristics of material.
- If the specimen burns rapidly the oxygen concentration about 18%.
- If the specimen goes out the oxygen concentration about 25%.
- Allow the gas flow 30 sec to purge the material.
- Ignite the center top of the material.

Result $\Rightarrow$ Calculate the oxygen index n of the different material for each test as follows.

$$n\% \Rightarrow \frac{100 \times O_2}{(O_2 + N_2)} \quad \text{mm}^3/\text{sec}$$

Factors affecting n :

Topic - Smoke Density

Smoke Density is measured by two Different Techniques.

- i) The Smoke generated is collected in a closed system and then Smoke Density is measured.
- ii) The Smoke is measured as it escapes from the test chamber.

Test method: $\Rightarrow$ "ASTM D.2843"

Test specimen and Conditioning $\Rightarrow$

The test specimens are conditioned at $23 \pm 2^\circ\text{C}$ temperature and $50 \pm 5\%$ RH for not less than 40 hours.

Equipments $\Rightarrow$

- Test Chamber
- Specimen holder
- Ignition system
- Timer
- Photometric System

Procedure :-

- Turn on photometric system, exit sign and exhaust Blower.
- Turn on the Propane (40 Psi) and light up the burner.
- Adjust the lamp to zero % light absorption.
- Hold the test specimen in specimen holder stand.
- Set the timer to zero.
- Turn off the exhaust blower and close the test chamber.
- Put the burner under the specimen.
- Start the timer.
- Record the percent light absorbed at 15 sec interval for 4 minutes.

Result :-

The light absorption data are plotted with respect to time in Chart.

Topic - Out Door Weathering Test

In Out Door weathering Test we observe the degradation of a polymer sample ~~in~~ by sunlight and rain in a specific location.

And under specific Condition like size, Orientation and ~~exposure~~ exposure Time.

Test method :- "ASTM D1435"

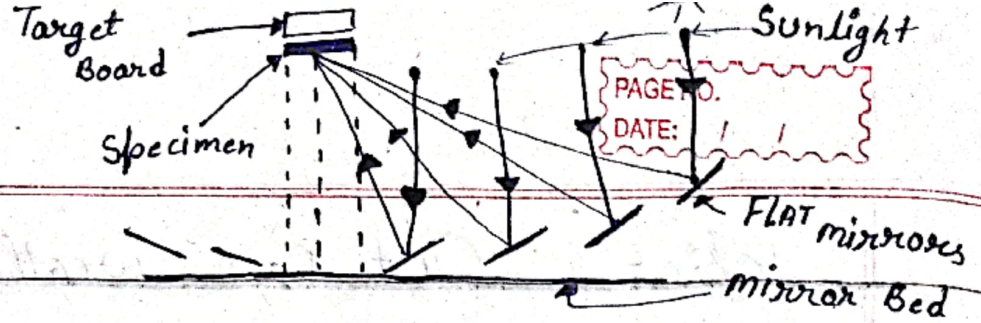
Test specimen and Conditioning :-

The test specimen in the form of Square and rectangular shape

The test specimen should be Conditioned at $23 \pm 2^\circ\text{C}$ and Temperature and $50 \pm 5\%$ RH for not less than 40 hours.

Equipments :-

- Specimen Rack (Hori., 45° , 90°)
- specimen holder
- frame holder



Procedure :-

- Two set of sample are taken
- One set is marked as Control and another is placed for weathering test
- The physical and other properties are examined
- The Specimen is placed directly on Specimen holder
- The test specimen position is recorded in term of Solar energy, Date and time
- Duration of exposure is define in term of exposure time, Solar radiation, UV Rays etc.
- After exposure sample are Removed and the required properties are determined to evaluate the effect of solar radiation and rain to check the weathering test.

Result :-

The Result is expressed in term of physical change in specimen.

Topic - Accelerated weathering using artificial UV light source

In Accelerated weathering test we use "fluorescent UV lamp" to evaluate the weather resistance of plastic material and products artificially.

Test method $\rightarrow$ ASTM D5208

Test specimen $\rightarrow$

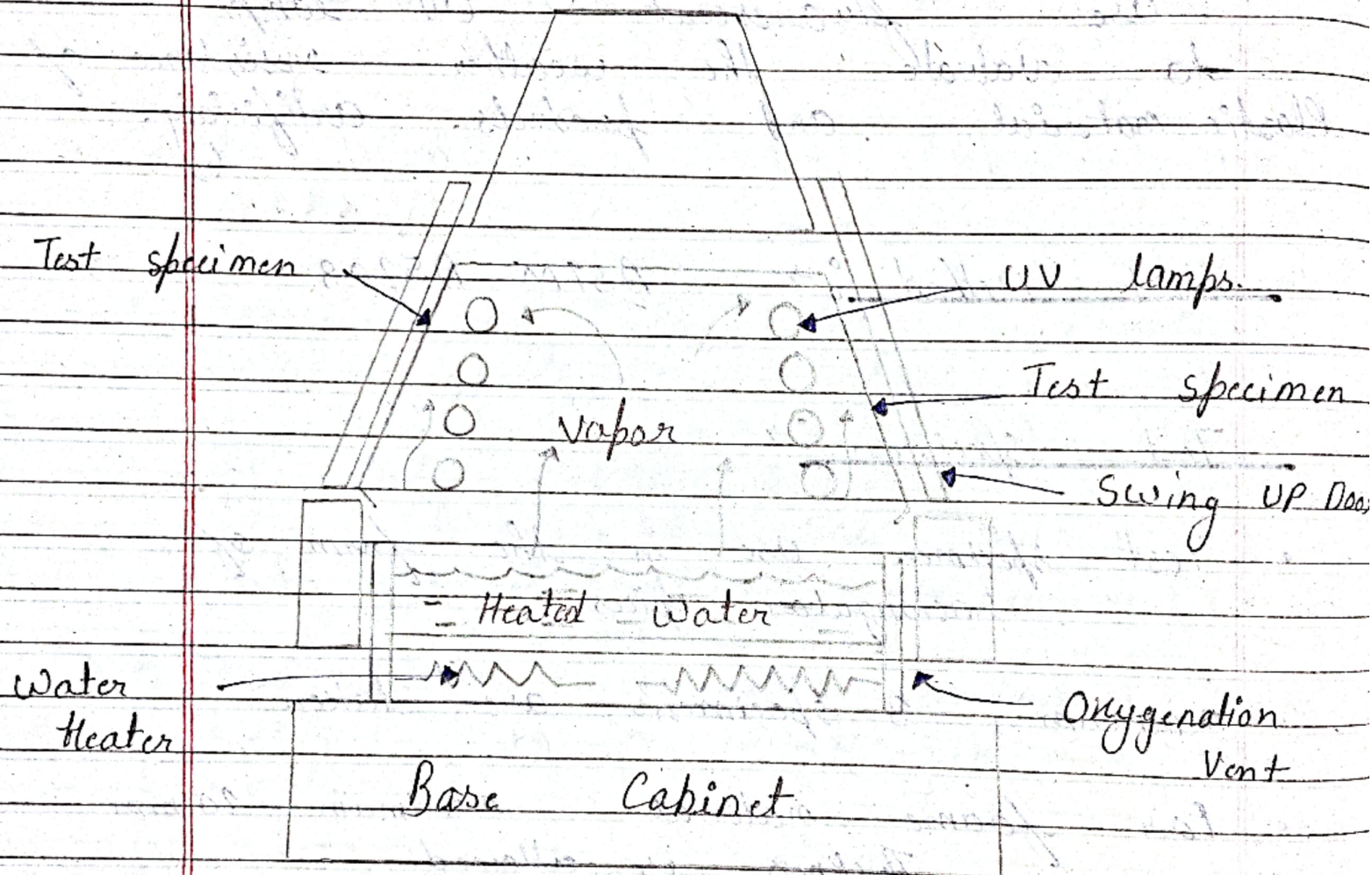
- Test specimen use in the form of rectangular pieces
- minimum 3 specimens are taken
- For foame material maximum 20 mm thickness is allowed.

The Test specimen should be conditioned in $23 \pm 2^\circ\text{C}$ Temperature and $50 \pm 5\%$ RH for not less than 40 hours.

Equipments :-

- Fluorescent UV Lamp
- Weather - o - meter

Procedure :-



- Samples are divided in two groups. One is marked as the test sample and the other as the control sample.
- Examine the physical properties before the test.

- Fix the test specimens on backing panels and place on the rack.
- Set the test conditioning and cycle as per test requirement.
- Reposition the test specimen in every third day.
- Periodic evaluation of test and control material is necessary to determine the change in physical properties.

Result : →

Result expressed in the term of
" KJ/m^2 "

Bio - degradability Testing

Biological and microbiological attack on Plastic is measured in term of Biodegradation of Plastic

Biodegradation Process starts when the Plastic material come in contact of Sewage Sludge or micro-organisms.

Bio-degradation Test divided in Two Parts

i) Short Term Bio-degradation Test

ii) Long Term Bio-degradation Test

i) Short Term Bio-degradation Test -

It is mainly two types.

- Aerobic biodegradation under sewage sludge
- Anaerobic biodegradation under landfill

Aerobic biodegradation under sewage sludge.

This test provides the degree of biodegradability and estimate time period for which plastic will remain in aerobic environment.

Test method - "ASTM D5271"

Test specimen and Conditioning -

The test specimen may be in the form of film or pieces.

The test specimen are conditioned at $23 \pm 2^\circ\text{C}$ temperature and $50 \pm 5\%$ RH for not less than 40 hours.

Equipments $\rightarrow$

- Weighing balance
- Flexible tube
- pH meter
- Pressurized air system

Reagents :-

- Test medium (magnesium sulphate, Calcium chloride, ferric chloride, Phosphate Buffer solution)
- Barium hydroxide medium used for CO_2 trapping.
- Analytical grade Cellulose

Procedure :-

- Pour distilled water 2470 ml add 3ml each of ammonium sulfate, magnesium sulfate and Calcium chloride
- Add 6ml of Phosphate buffer
- Add 12 ml of ferric chloride and activated sludge (30 ml) to each of the Four Erlenmeyer Flask.
- Put the Erlenmeyer Flask to CO_2 free air for 24 hrs.

- Add the specimen in two Erlenmeyer flask, third flask is kept blank and put Cellulose (reference material) in fourth flask.

- Start the test by bubbling CO_2 free air in $\text{Ba}(\text{OH})_2$ solution.

Following reaction start in flask



- Every two to three days after remove the CO_2 absorber which is placed near to flask for Titration.

- Incubation time of 45 days may be expanded if biodegradation still being.

Result is:

% Biodegradation $\Rightarrow$

Amt. of gaseous Carbon Produced - Amt. of Carbon added in test Compound

Anaerobic biodegradation under land fill

This test method is used to determine Anaerobic biodegradation of Plastic material under accelerated land-fill conditions.

Test method $\rightarrow$ ASTM D 5526

Test specimen and conditioning $\rightarrow$

The test specimen may be in the form of Pellet or film

The test specimen are conditioned at $23 \pm 2^{\circ}\text{C}$ temperature and $50 \pm 5\%$ RH for not less than 40 hours.

Equipment $\rightarrow$

- Weighing balance
- PH meter
- Gas analytic Analytical Device.

Procedure :-

Test specimen is cut in small pieces.

Put the specimen in airtight vessel and add inoculum which is same bacteria that found in landfill.

Test vessels placed in incubator for 15 days.

At the end of the test, the amount of methane and CO_2 is measured.

This information is used to calculate the % of biodegradation.

Factors Affecting :-

- Temperature
- Thickness
- Time

ii) Long Term Biodegradable Test divided in two parts.

i) Resistance to fungi

ii) Resistance to Bacteria

Resistance to Bacteria

This test use to determine the effect ~~and resistance~~ of Bacteria on Plastic.

And Resistance of Plastic to Bacterial attack.

Test method :- ASTM G22

Test specimen and Conditioning :-

Test specimen of any size and shape and injection moulded parts can be used.

The test specimen are Conditioned at $23 \pm 2^\circ\text{C}$ temperature and $50 \pm 5\%$ RH for not less than 40 hours.

Reagents :-

Distilled water and
melted minerals salt agar.

Procedure :-

The test specimen are exposed to
bacteria and then allowed to
incubate at 38°C and 85% RH.

Incubate the test specimen for 21
day

After 21 day check the bacterial
growth on Plastic Product

Factor Affecting :-

- Additives
- UV Radiation
- Temperature

UNIT - IV

Product Testing

Why we need Testing -

- For Quality Control
- To Prove a design Concept.
- To meet Standards and Specifications
- To Verify manufacturing Process.
- To evaluate Competitors Products.
- To establish a history for new material.
- Safety.

Topic - Testing of UPVC Pipes

Test method - IS 4985 : 2000

Test for UPVC Pipe -

Dimension

Visual Appearance

Density

VST

Hydrostatic Pressure Test

Reversion

Dimension Measurement - Outside Diameter

This test used to determine the dimension of pipe from outside.

equipment - Vernier Caliper

Specimen - UPVC Pipe

Procedure - with the help of Vernier Caliper we measure pipe from 6 different places.

Dimension measurement - wall thickness

To determine the wall thickness of pipe we measured 5 samples of pipe by micrometer.

Visual Appearance -

Visual appearance test is use to determine the physical properties like Color, Gloss and finishing of Product.

Density -

Density of Plastic product Tested by weighing the Plastic in air and the liquid

Equipment - Specific gravity tester

Vicat Softening Point (VSP/VST) -

In Vicat softening Point Test we put the test specimen in Silicon bath and check when the Indentor penetrates specimen (1 mm)

Hydrostatic Pressure test -

In this test we determine how much pressure required to break the pipe.

Reversion Test -

Reversion Test measures the linear shrinkage of Pipe when heated above its softening point.

Topic - Water Tank Testing

Test method :- IS 12701 : 1996

Test for water Tank :-

Dimension

Gross Capacity

Wall Thickness

weathering Test (out door)

Dimension :-

Water tank Dimensions like Height and Diameter measured by measuring Tape.

Gross Capacity :-

The Capacity of the tank is

The gross Capacity of a Tank refers to how much water the tank can hold when it is completely full.

Wall Thickness :-

The wall Thickness of water tank is measured by Vernier Calipers or micrometer.

minimum 5 Pieces of Sample are measured. and then take average.

Weathering Test :-

Weathering Test is used to determine the effect of UV Rays and Rain on water tank.

Visual appearance Test :-

Visual appearance Test use to determine the physical Properties like - Color, Gloss, finishing and optical Properties.

Topic - Women Sack Testing

Test method - IS 14887: 2000

Test for Woven Sack :-

Dimension
Fabric Strength
Seam Strength
Drop test

Dimension —

Measuring Tape is used to measure the Dimension of woven sack.

#	Fabric	Strength
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Fabric strength is tested on UTM machine and sample cut from the sack.

Specimen Dimension L - 300 mm
W - 50 mm

Test speed - 100mm/min.

Seam Strength -

A cut specimen from seam is tested in tensile testing machine until breakdown.

Drop Test -

A filled sack is dropped vertically from a height of 1.5 m

Topic - Plastic Film testing.

Testing IS 2598 : 1987

Test for Plastic Film

- Tensile Test
- Dart Impact Test
- Burst Test
- Glass Test
- Visual Test
- Weathering Test

Tensile Test -

Tensile Test measures force that is required to break the material.

In Tensile Test we clamp the specimen in WTM machine then stretch the Specimen until break.

Dart Impact Test -

In Dart Impact Test we determine the impact Resistance of the film.

For Determining Impact Resistance we Drop the Dart on Plastic film.

Burst Test -

In This Test we are applying air Pressure on film sample to Determine the Burst Test.

It is expressed in Kg/cm^2

Gloss Test -

Gloss is measured by determining the amount of light which is reflected from the object (film) surface.

Visual Appearance Test -

The Visual Appearance Test is used to determine the physical Properties like - Color and optical Properties.

Weathering Test -

Weathering Test is Used to Determine the effect of weather conditions on Plastic Film.

PLASTIC TESTING - II

UNIT - 1

Dielectric Strength	ASTM D 149
Dielectric Constant	ASTM D 150
Surface and volume Resistance	ASTM D 2305
Dissipation Factor	ASTM D 150
Arc Resistance	ASTM D 495
Specular Gloss	ASTM D 523
Refractive Index	ASTM D 542
Luminous Transmittance and Haze	ASTM D1003
Clarity	ASTM D 1746
Color	ASTM D 2244
Photoelastic Properties	ASTM D 4093

UNIT - 2

Stain Resistance of Plastic	ASTM D1712
Immersion Test	ASTM D 2152
ESCR	ASTM D1693
UL 94	IEC 60695
LOI	ASTM D 2863
Smoke Density	ASTM D 2843

UNIT-3 Out Door Weathering	ASTM D1435
Accelerated weathering	ASTM D5208
Aerobic Biodegradation	ASTM D 5271
Anaerobic Biodegradation	ASTM D 5526
Resistance to Bacteria	ASTM G 22