

Investment Casting Wax *Technology*

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Agenda

Raw Materials

Testing of Physical Properties

Raw Materials

Paraffin Waxes

Microcrystalline Waxes

Resins

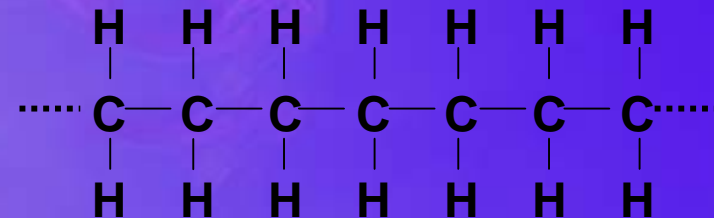
Hard Waxes

Polymers

Fillers

Paraffin Wax

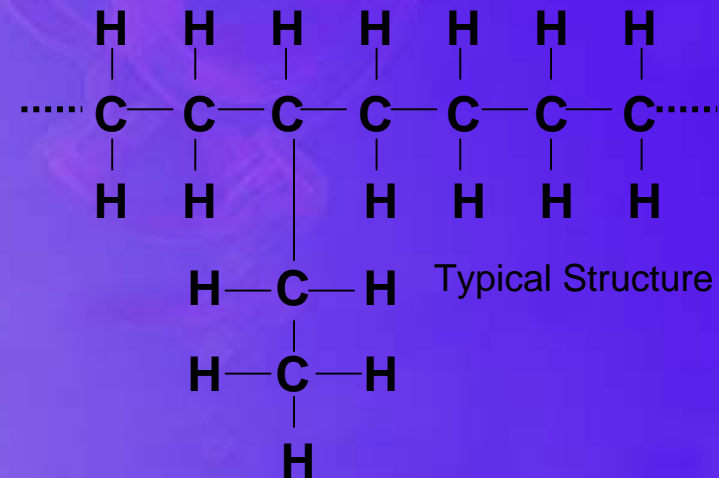
- Hydrocarbon based petrochemical
- Its structure comprises of short straight chain molecules 20 – 36 carbon atoms in length
- Its molecular weight is 300 – 500 depending on the grade
- Its typical melting range is between 32°C – 66°C
- Its typical hardness is between 12 – 25 10thmm



Typical Structure

Microcrystalline Wax

- Hydrocarbon based petrochemical
- Its structure comprises of branched hydrocarbon molecules 31 – 50 carbon atoms in size
- Its molecular weight is 450 – 700 depending on the grade
- Its typical melting range is between 60°C - 93°C
- Its typical hardness is between 2 – 75 10thmm



Resins

- There are three main types of resin used in investment casting waxes
- Each have their own unique advantages

Hydrocarbon Resins

Synthetic Resins

Natural Resins

Hydrocarbon Resin

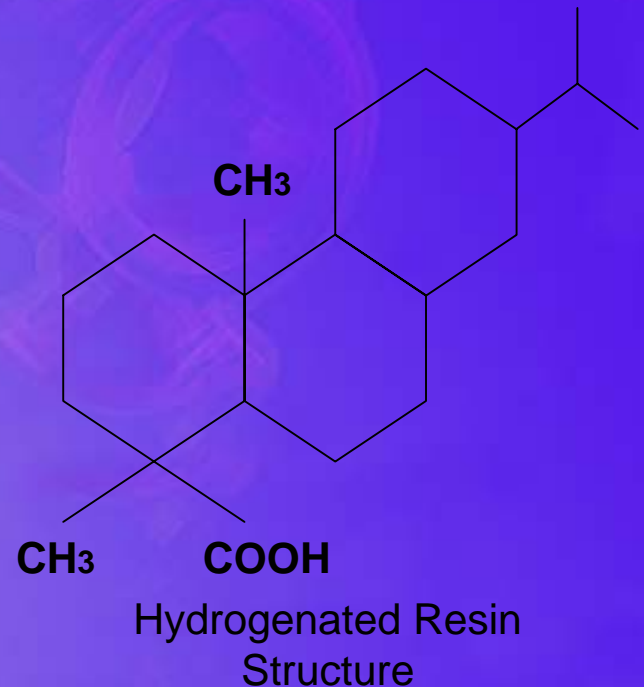
- Petrochemical
- Complex straight and branched chain and ring structures
- Molecular weights range from 390 – 1615
- Softening points range from 18°C – 178°C
- Examples of Hydrocarbon resins
 - Hydrogenated
 - Pure Monomer
 - Aliphatic
 - Aromatic

Synthetic Resin

- Organic compounds
- Complex straight and branched chains and ring structures
- Molecular weights range from 350 – 1750
- Softening points range from 25°C – 190 °C
- Examples of synthetic resins
 - Modified Resin
 - Polymerized Resin
 - Resin Esters

Natural Resin

- Complex mixture of organic compounds
- Complex straight and branched chains and ring structures
- Molecular range from 250 – 1575
- Softening points range from 80°C – 180°C
- Examples of natural resins
 - Modified resin
 - Hydrogenated resin esters
 - Polymerized resin esters
 - Acid-modified resin esters



Hard Waxes

- Can be natural esters or modified hydrocarbon compounds
- Typical hardness $<1.0 \text{ 10}^{\text{th}}_{\text{mm}}$
- Congealing point range from $65^{\circ}\text{C} - 120^{\circ}\text{C}$
- Mechanically they are brittle compounds
- They all exhibit low viscosities

Polymers

- Main use is ethylene vinyl acetate (EVA)
- Sometimes use other polymer compounds
- Molecular weights range from 50 – 2500
- Melting ranges are between 50°C - 200°C
- Mechanically they usually exhibit high ductility
- Typical hardness ranges from 5 – 50 10th_{mm}

Filler Materials

- Type of filler material used in investment casting wax
 - XLPS and XLMA
 - Terephthalic Acid
 - Bisphenol A
 - H₂O
- Fillers are used to enhance the properties of the wax to provide
 - Decreased cavitation on thick sections of patterns
 - Increased fluidity to aid injection moulding
 - Improve the surface finish of the solidified wax
- All the filler materials used in modern investment casting waxes are inert and do not chemically react with any constituents of the wax blend

Testing Physical Properties

Congealing Point

Melting Point

Viscosity (Thickness)

Ash Content (% of Non-Combustibles)

Penetration (Hardness)

Mechanical Strength

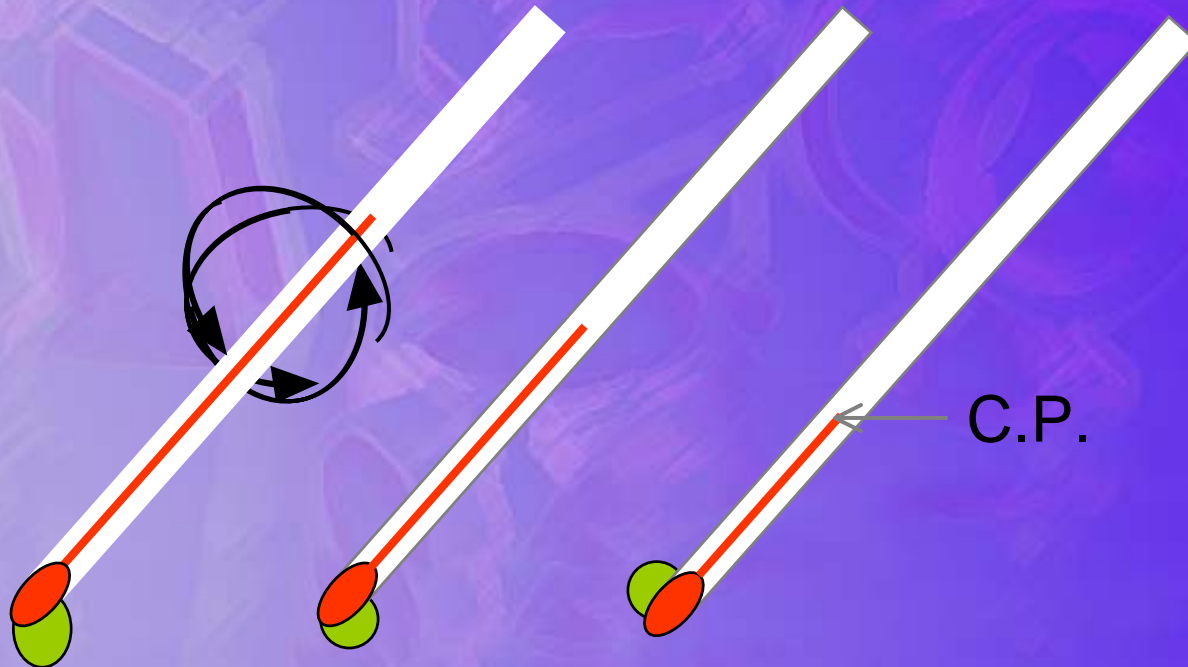
Contraction Rate

Expansion Rate

Rheological Properties

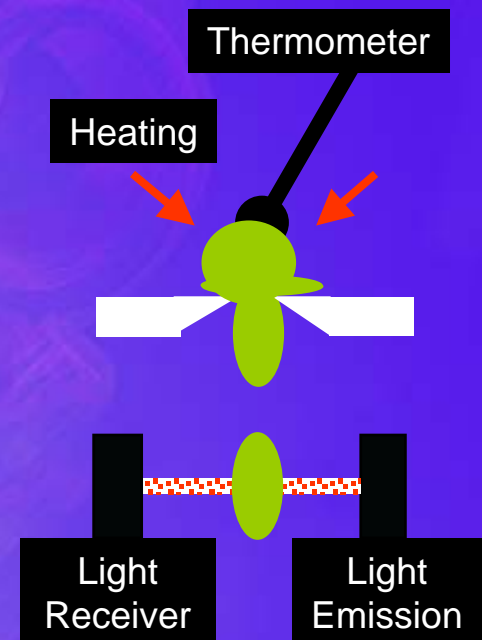
Congealing Point Test Method

- The congealing point is the temperature at which a small ball of wax will cease to flow under the affect of gravity
- The temperature ($^{\circ}\text{C}$) at which this occurs is called the C.P



Melting Point

- The melting point is determined by gently heating a known, solidified volume of wax until it 'drops' out of the bottom of a special crucible
- A light beam detects the melted wax and the temperature is recorded by a data logger

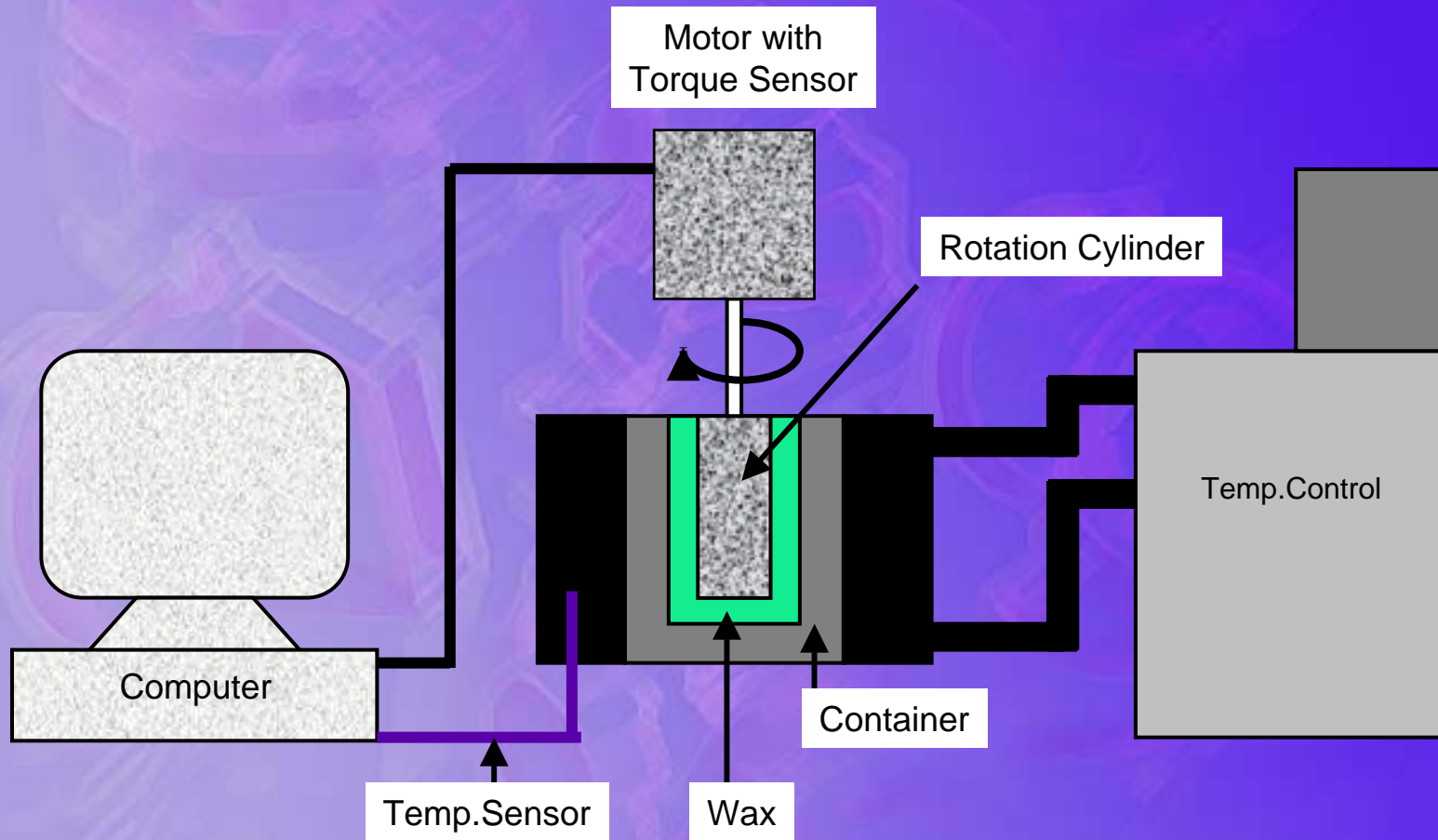


Viscosity

(Thickness or Fluidity vs. Temperature)

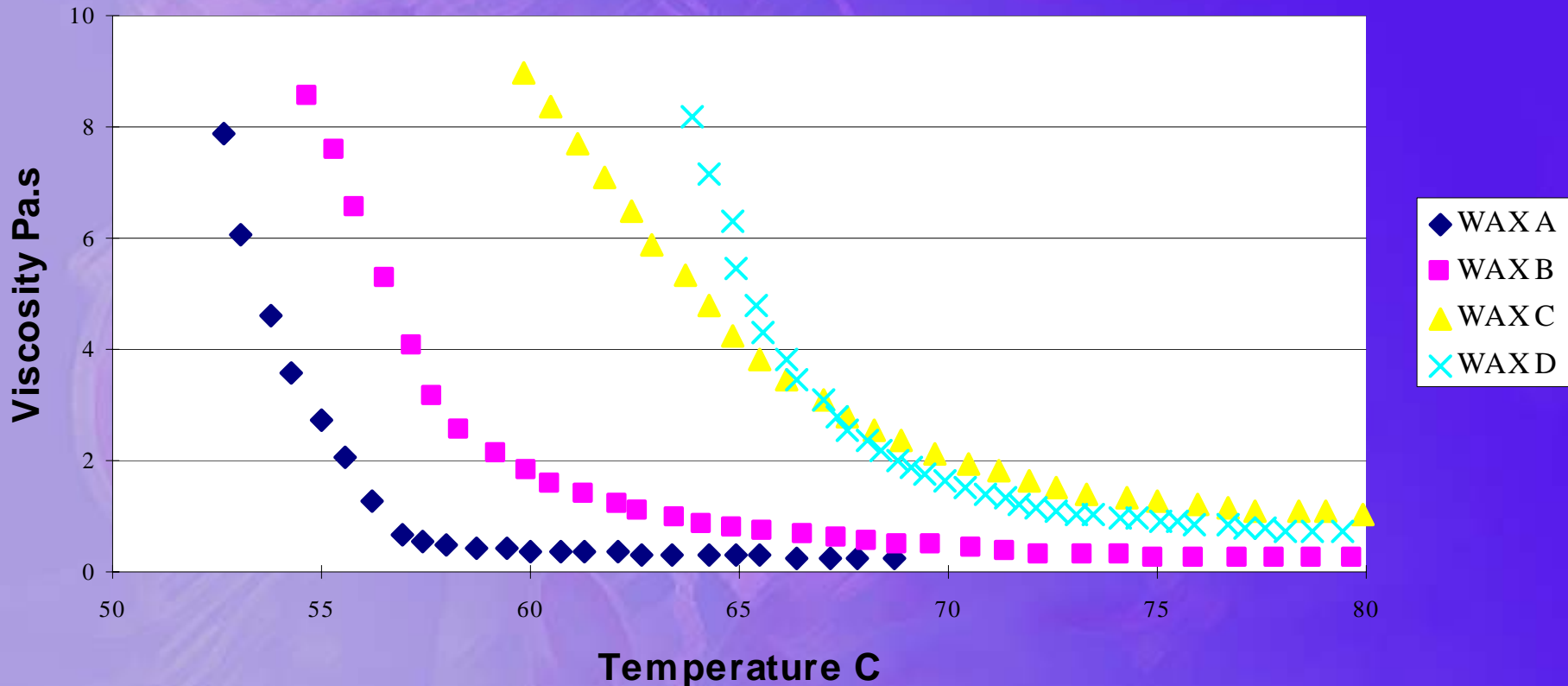
- The wax is poured into the container at 80°C and allowed to stabilize
- The temperature is then lowered with the motor applying a known rate of velocity
- The torque sensor processes how much force is needed to keep the motor at the same known velocity
- As the wax cools the forces needed to keep a constant velocity increases and a computer processes the collected information and displays it as a graph

Viscosity Machine Diagram



Viscosity Output Graph

Thickness or Fluidity (Pa.s) vs. Temperature (°C)



Ash Content

- The ash content is described as the percentage of non-combustible compounds left after complete combustion in air
- The ash is determined by
 - Burning a known weight of wax with a Bunsen burner
 - Firing of the left over carbon deposits in a furnace at 1000°C
 - Weighting the crucible and calculating the percentage
- Blaysons waxes have a maximum ash value of 0.05%
- A wax with a high ash content will cause visual defects on the finished parts

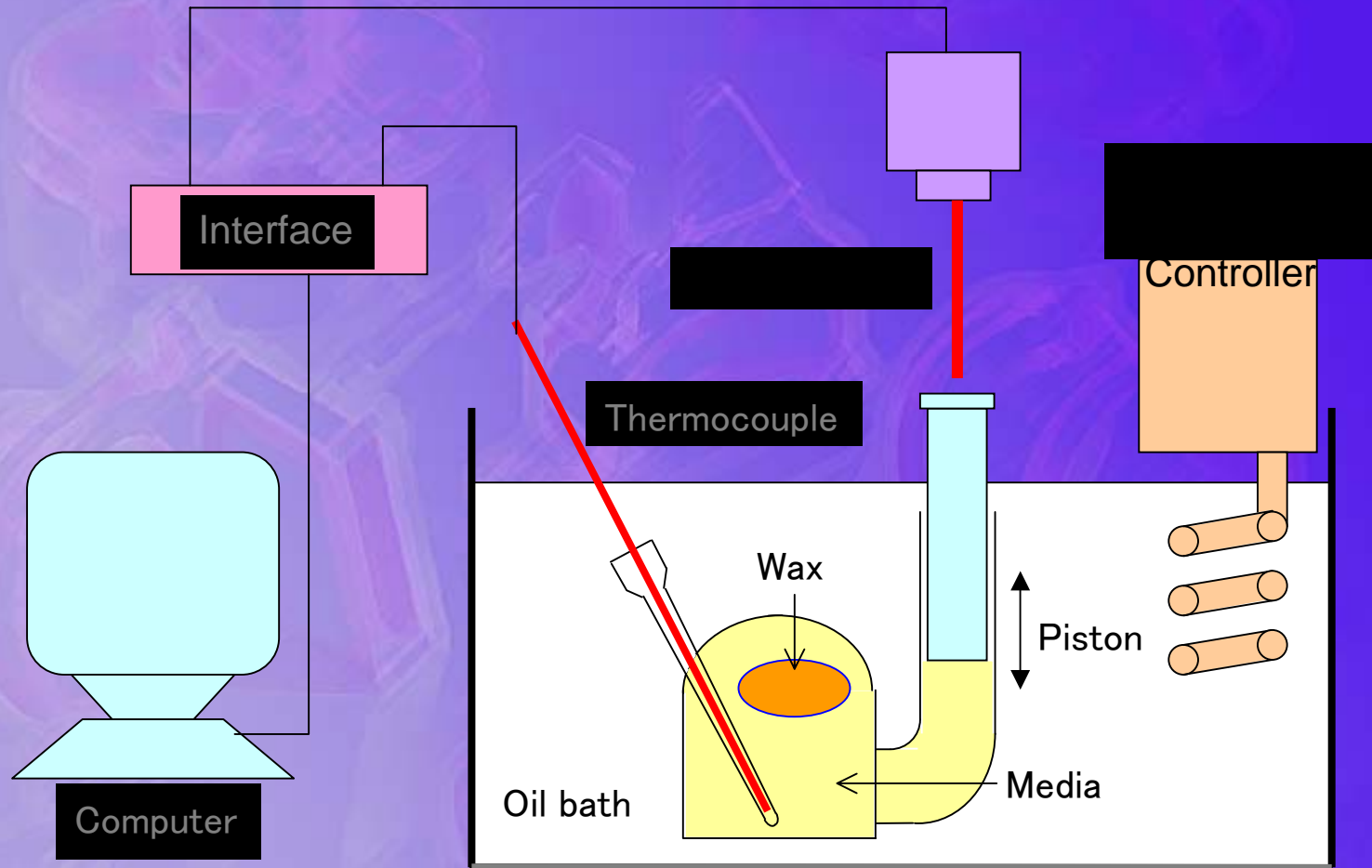
Penetration (Hardness)

- The penetration give us with a rough guide to the 'stiffness' of the wax
- The penetration is carried out at 25°C (a water bath is used to condition the sample for two hours)
- Once the sample has been conditioned a weight of 200g is applied to a vertical needle (of known calibration) for 5 seconds
- The result is the attained in the unit of $10^{\text{th}}_{\text{mm}}$

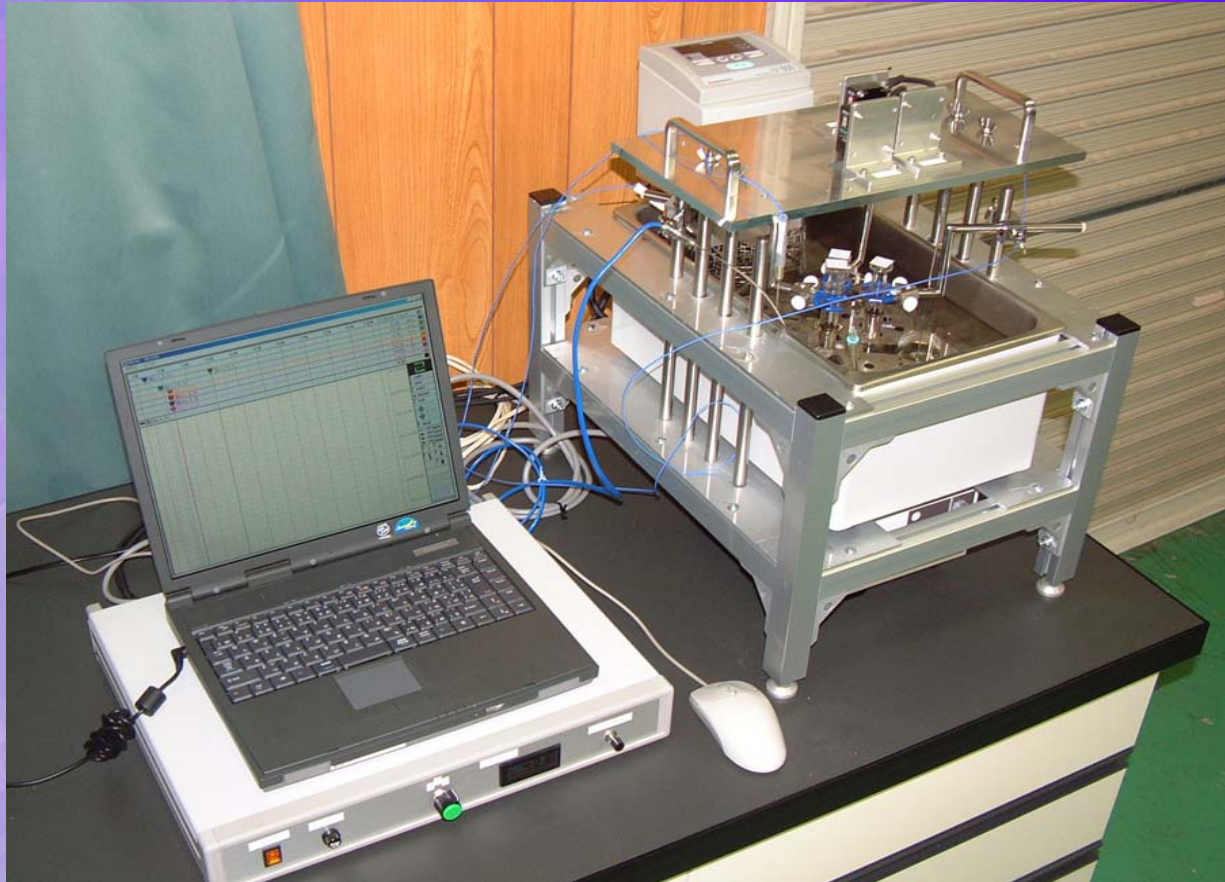
Mechanical strength

- Blaysons use the standard three-point-bend-test method to determine the load bearing ability of a wax
- The samples are conditioned at 23 C for two hours prior to testing

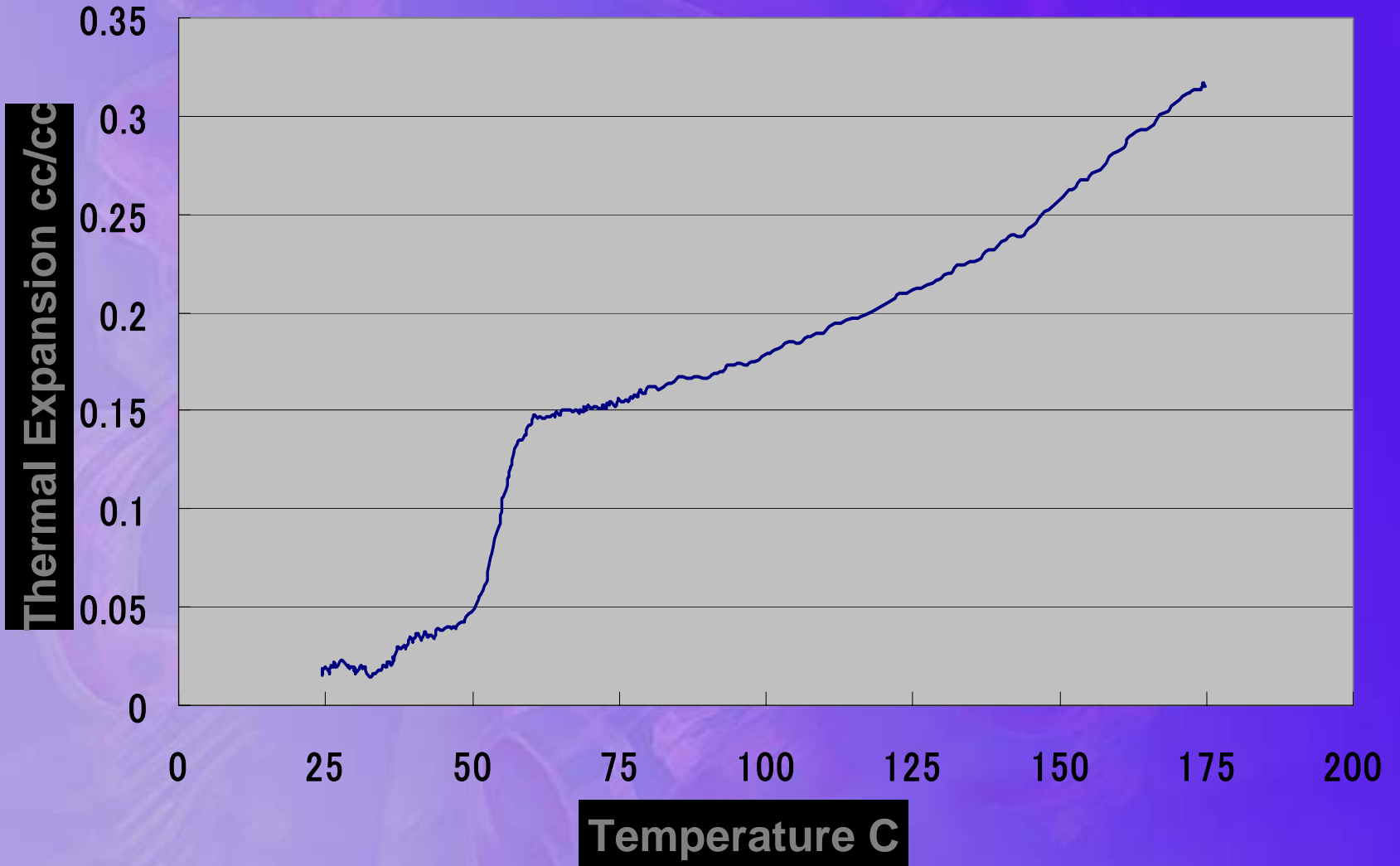
Schematic - Measuring Equipment for Volumetric Thermal Expansion of Wax



Measuring Equipment for Volumetric Thermal Expansion of Wax



Thermal Expansion of Paraffin Wax 135



In conclusion

Points to consider on the sale of wax

- Price
- Wax type: Filled (Patterns) or Non-Filled (Runners)
- C.P. range
- Melting range
- Hardness
- Type of parts produced
- Volume of production
- Injection machine type
- Injection cycle times
- Shelling materials and methods
- Size of shells and assemblies