CEAST

progress in testing

MODULAR HDT VICAT

MODULAR HDT VICAT
code 7342.000, 7343.000

Introduction and Test Philosophy

The effect of temperature on the mechanical properties of plastic materials has a fundamental role in the design of components, and especially in the selection of materials. Unlike metals and ceramics, plastics are extremely sensitive to changes in temperature, even if these changes occur within a few degrees of room temperature. Crystallinity has a number of important effects upon the thermal properties of a polymer, and the melting point of crystal phases dramatically changes its mechanical properties. Amorphous plastics, however, have a gradual softening range. Molecular orientation also has a significant effect, since orientation tends to decrease dimensional stability at higher temperatures. Many other aspects, such as cross-linking, particle or fibre reinforcement, and also blending and co-polymerisation, all have a considerable effect on the polymer's thermo-mechanical properties.
For these reasons the selection of plastics for applications under different temperatures is a complex task. The material must be able to support a certain stress under operating conditions without loosing its strength and without critical distortion.
The effect of temperature on geometrical stability and mechanical properties in general can be studied following different procedures and methods:
- at constant temperature, to determine the creep behaviour;
- with a ramp of temperature, a quicker method to determine a critical temperature corresponding to a standard mechanical deformation.

The second approach was standardized creating two main testing standards:
- Heat Deflection Temperature (HDT), where a bar is loaded in a 3-point bending test and the temperature raised in a ramp until the deflection reaches a critical value;
- Vicat Softening Temperature (VST), where a small specimen is loaded by an indenter and the temperature raised until the penetration reaches a critical value.

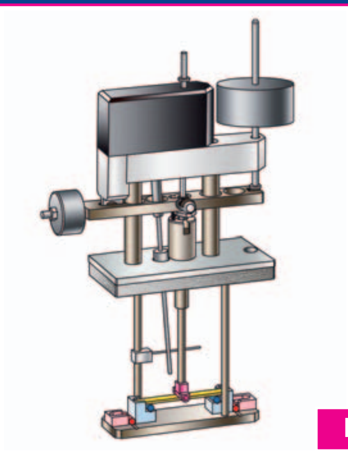


Fig. 1

HDT (Fig. 1)

The bar can be loaded in the flatwise or edgewise position, and the load is applied to obtain a standardized maximum surface stress in the material. ISO and ASTM describe methods with one defined heating rate (120 °C/h) but three possible stresses. The load to be applied depends on the geometry of each specimen. The test ends when a standardized deflection is reached, the value depending on the specimen size. This test is also suitable for reinforced and non-uniform materials, and gives a useful indication of the thermal stability of the material in terms of bulk mechanical properties.

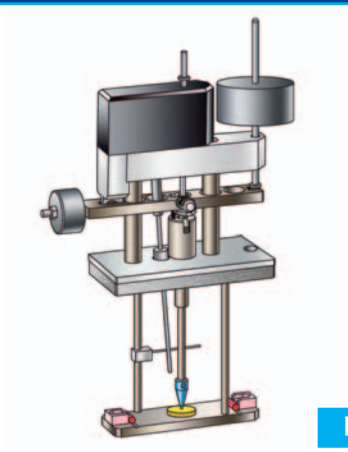


Fig. 2

VICAT (VST) (Fig. 2)

The specimen is loaded through a flat-ended needle. ISO and ASTM describe methods with two possible heating rates (50 or 120 °C/h) and two possible loads (10 or 50 N). The test ends when penetration of 1 mm is reached. This test is more suitable for homogeneous materials, and provides a useful indication of the thermal stability of the material, especially in terms of surface mechanical properties.

Standards

Our instruments are designed and built to meet the following standards:

"HDT" TEST

ASTM D 648 - ISO 75 - DIN 53461 - BSI 2782 - Met 121 C - NT T 51-005 and others equivalent.

"VICAT" (VST) TEST

ASTM D 1525 - ISO 306 - DIN 53460 - BSI 2782 - Met. 120 C - NT T 51-021 and others equivalent.

MODULAR HDT VICAT APPARATUS

This instrument consists of many elements coupled together:
- a dedicated thermostatic bath with testing stations;
- a system to apply the load to the specimen at each station;
- a measuring system to detect displacement, connected to the electronics and eventually to the software for test management and data storage.

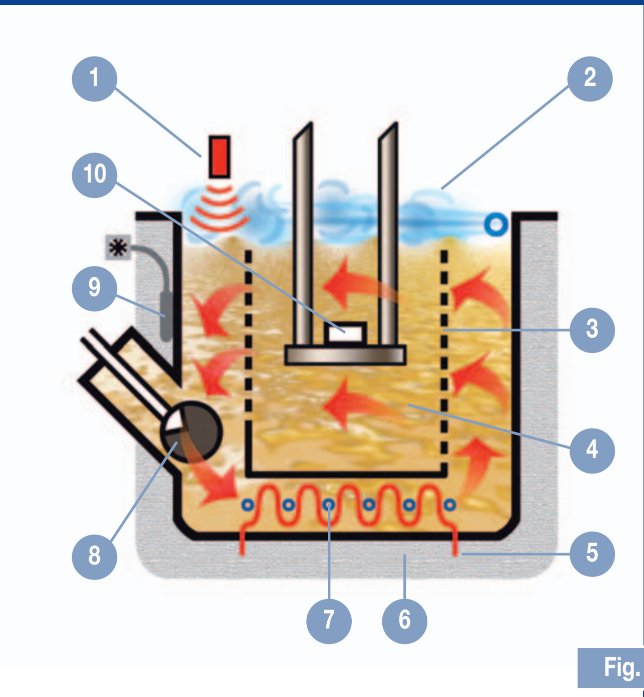


Fig. 3

1	Oil level ultrasonic detector	6	Thermal insulation
2	Nitrogen covering	7	Water cooling coil
3	Basket bounding the test area	8	Oil pump
4	Oil flow having uniform speed and temperature	9	Safety thermostat
5	Heating resistors	10	Specimen

Thermostatic Unit (Fig. 3)

This consists of a stainless steel conditioning cell with proper insulation, which incorporates the heating and after-test cooling system. It is equipped with safety devices to check the temperature and oil levels. The uniformity of thermal distribution is guaranteed by a properly dimensioned circulating pump located in the middle of the bath. A series of sensors measure the working temperature and efficiently compensate for deviations through a PID system, keeping an optimal distribution and executing a correct ramp of temperature according to the testing method. A system for delivering a blanket of inert gas can be activated to prevent degradation and fire hazards related to the thermostatic fluid at the highest working temperatures.

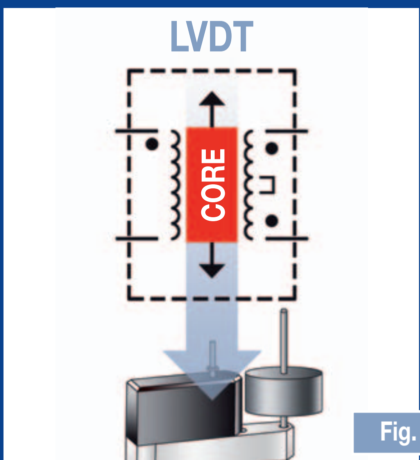


Fig. 4

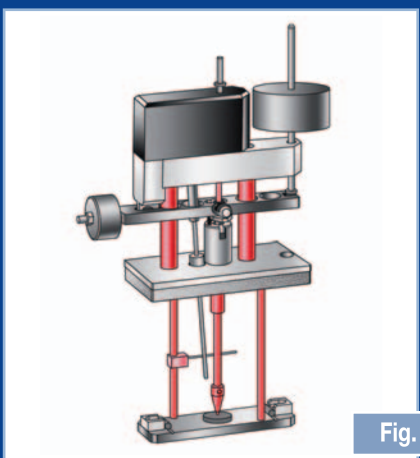


Fig. 5

System for Load Application

Based on a well-integrated pneumatic system, this system is useful in avoiding the sudden application of the loads to the specimens. It reduces the labour for the operator and eliminates possible influence on the measurements.

Measuring System (Fig. 4 - Fig. 5)

The system for detecting and measuring the displacement of the testing heads (hence the deformation of the specimens) is based on high-resolution LVDTs (Linear Variable Displacement Transducers). Their superior stroke length (10 mm), along with a high resolution (0.001 mm) makes it possible to also run high deformation and creep tests. The thermal frame dilatation effects are software compensated thanks to the calibration done with a reference quartz sample.

Test Masses

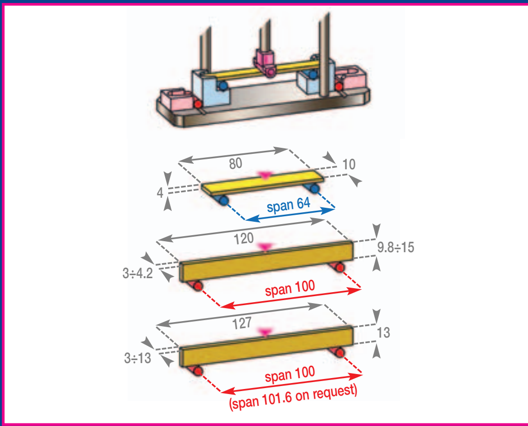
To generate the required load, a binary set of masses allows the operator to adjust the applied mass by 1 gram. All possible combinations can be obtained according to the various test methods and specimen sizes.

Electronics and Touch-screen Interface

The instrument is completed with an advanced touch-screen for parameter setting and data reading. The electronics are based on PC-embedded hardware.

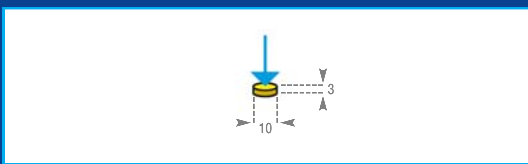
External Frame of the Instrument

The external frame is made of thermoformed POM, providing optimal thermal insulation and vibration damping, making the measurements more stable and repeatable.



HDT Tests Execution

Dimensions and positioning of specimens (bars)
Flatwise
ISO 75-2 (80x10x4 mm, span 64 mm)
Applicable stresses: 0.45 – 1.80 – 8 MPa
Edgewise
ISO 75-2: 120x(9.8÷15)x(3÷4.2) mm, span 100 mm
Applicable stresses: 0.45 – 1.80 – 8 MPa
ASTM D 648: 127x13x(3÷13) mm, span 100 mm (Method B)
Optional span 101.6 mm (Method A)
Applicable stresses: 0.455 – 1.82 MPa

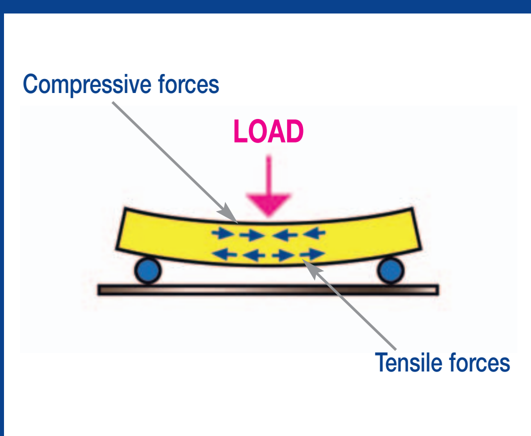


VICAT (VST) Tests Execution

ISO 306, ASTM D 1525
(minimum 10x10 mm or diameter 10 mm, thickness 3 to 6.5 mm)

Tests Execution and Number of Operating Testing Stations

The modular system allows the use of 2 to 6 stations that can be set up independently combining, for example, HDT and VST measurements in one instrument run.



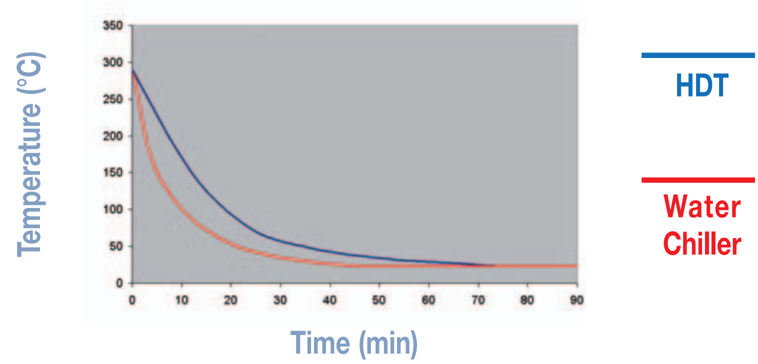
Flexural creep

Creep is the permanent deformation resulting from prolonged application of stress below the elastic limit. This is typically observed with polymers, because of their viscous-elastic nature, and this characteristic is critical for design and material selection. The most common test is a three-point bending performed by applying the load and keeping the temperature constant over time. The method is described by ASTM D2990. It is possible to run this type of creep test using CEAST's HDT/Vicat instruments and calculate the flexural-creep modulus Et [MPa] by using the following equation:

$$E_t = \frac{L^3 \cdot F}{4b \cdot h^3 \cdot s_t}$$

See also the brochure for our VisualIMPACT software.

Cooling HDT and Water Chiller



Using the new separate water chiller for HDT and Vicat instruments it is possible to save water! The separate water chiller is a closed circuit refrigeration system that quickly cools the HDT and Vicat instruments without consuming any fresh water. The chiller is equipped with a water reservoir of 65 litres. The temperature of the reservoir can be chosen by the operator according to the individual requirements. The chiller uses a nominal refrigerating power of 4.77 kW.

TECHNICAL CHARACTERISTICS

Model	Modular HDT Vicat 6	Modular HDT Vicat Auto
Code	7342.000	7343.000
Number of stations	Up to 6 (2 included)	
Test capabilities	HDT, VICAT, CREEP (HDT and VICAT tests at the same time)	
Electronic control	DSP board for process control - PXA board for interface control	
Instrument interface	6.4" VGA colour display, 640 x 480 dots with touch-screen	
Temperature range	20 ÷ 300 °C	
Temperature resolution	0.1 °C	
Thermal distribution	± 0.5 at 300 °C	
Thermal stability	± 0.5 at 300 °C	
Temperature slope	120 ± 10 °C/h (12 ± 1 °C/6 min) and 50 ± 5 °C/h (5 ± 0.5 °C/6 min) Operator may select any other rate between 50 and 120 °C/h	
Main temperature sensor	PT100 probe, steel shell, diameter 3 mm	
Stations temperature sensor	PT100 probe, steel shell, diameter 3 mm	
Safety thermostat	Yes	
Deflection/penetration measurement	LVDT sensor	
Deflection/penetration stroke	10 mm	
Deflection/penetration resolution	0.001 mm	
Automatic compensation for thermal expansion	Yes, for each station	
Automatic compensation accuracy	± 0.02 mm	
Deflection/penetration transducer zeroing	Automatic	
Cooling system at test end	Automatic	
Cooling time from 200 to 50 °C	20 min approx.	
Separate water chiller (code 6975.000)	Optional	
Stations lifting	Pneumatic (manual control, simultaneous lifting of all stations)	Pneumatic (automatic control, simultaneous lifting of all stations)
Weights lifting	Manual (independent for each station)	Automatic (simultaneous for all stations)
Nitrogen blanket	Manual on-off valve	Automatic control
Nitrogen bottle and connections	Optional	
Oil capacity	15 liters approx.	
Oil level check	Manual	Automatic
Oil level alarm	No	Yes
HDT Test		
Binary masses	Optional code 7330.010 (13 masses for tests from 67 to 5186 grams)	
HDT testing head complete with traceable certificate	Optional code 6505.078	
HDT tool for HDT head positioning	Optional code 7330.055	
HDT support distance (span)	64 and 100 mm	
Automatic calculation and list of masses to apply to reach defined stress according to norms	ISO 75-2: 0.45 – 1.80 – 8 MPa ASTM D 648: 0.455 – 1.82 MPa	
VICAT Test		
VICAT masses	Optional code 7330.011 (3 masses for 10 and 50 N tests)	
VICAT heads	Optional code 6505.077	
Data Acquisition and Software		
USB port for test printout	Yes	
LAN serial port for connection with PC	Yes	
Software	Optional (VisualTHERM - CeastVIEW platform)	

Dimensions WxDxH	1150 x 560 x 650 mm
Weight	200 kg approx.

Paint	grey RAL 7035, fuchsia RAL 4006
Power supply	230V 50 Hz (60 Hz on request)
Compressed air supply	5 bar

VisualTHERM Software code 0710.500

Software for all HDT and Vicat Instruments

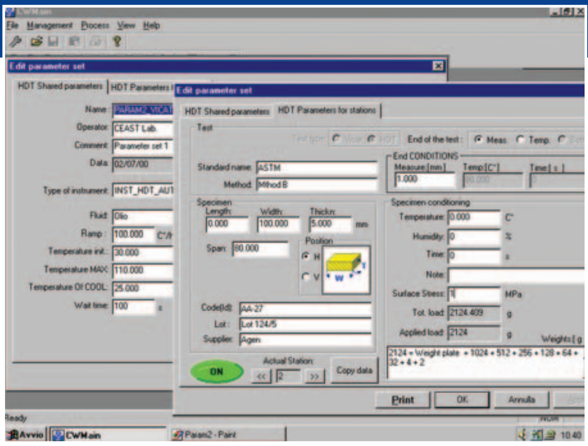


Fig. 6 Parameters Management

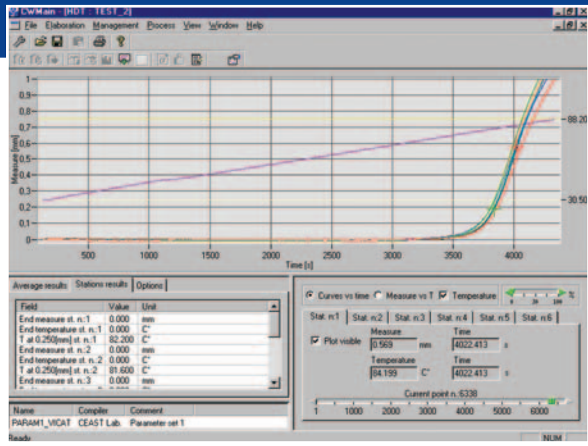


Fig. 7 Presentation of Results

The VisualTHERM software is a user-friendly interface for instrument setup, test management and data storage for all CEAST HDT and Vicat instruments. Connecting the instrument to a PC through a LAN port, the user can check the status of the instrument, write and store parameter sets, and run the data acquisition. The calibration of the measuring stations is also software-assisted. During parameter setup (Fig. 6), the software calculates and shows the sequence of weights to be applied in order to obtain the desired stress on the specimen.

In case of ‘AUTO’ instruments, the stations are automatically lowered and lifted, and the weights applied after a user-defined delay. Time-displacement and temperature-displacement curves are shown for each station (Fig. 7), and a database is created with multiple advanced options for sorting and browsing.
VisualTHERM is part of the CeastVIEW software family, developed by our engineers.
Additional optional modules are available (see dedicated leaflet for VisualTHERM).

NEW FEATURES

The last release includes new and important features to make the use of software more and more flexible and friendly. The parameters management has been completely revised in order to remove any constrain in the use and to give to the user the maximum freedom in modifications. The parameters input, now based on international standards, is completely assisted and guided. All the standardized values, as the deflection or the load, are automatically set according to the selected standard. Furthermore a powerful filtering feature is provided to make easy the search of test parameters and test results. To carry out tests with different materials or according to different standards, the new VisualTherm version allows to freely define specimens groups and automatically calculate, display and print out the results of each group separately. Many well-known function as “cut and paste” and “print preview” has been implemented to increase the usability. To avoid any loss of data, now the daily backup can be automatically stored on a server connected to the Local Area Network.

"Due to the continuous development policy of CEAST's Research and Development Department, changes may be introduced without notice"

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