

Providing Unique Materials Testing Capabilities

Versatile Testing Machine Combines High-Speed Positioning with Temperature and Humidity Control

Universal testing machines have served as an essential tool in materials testing labs for years. Typically, these machines can be configured to apply tension, compression, and bending loads. Some models are available that achieve high speeds and provide temperature control. Common materials like synthetic and natural polymers have viscoelastic properties that are dependant on loading rates and temperature. However, these materials also may be affected by the level of absorbed moisture.

With this need in mind, Pico Systems, Inc. (PSI) designed and now operates a universal testing machine that delivers high speeds combined with temperature *and* humidity control. Also, custom software and controls enable operators to configure the test parameters and define the actual strain curve to be applied. The PSI machine makes it possible to study materials that have a high temperature and moisture dependency or are exposed to a variety of stresses and conditions in the factory or in the field.

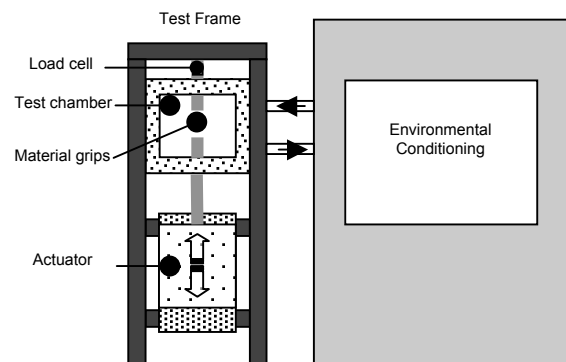


Figure 1. Representation of the PSI equipment. Strains are applied by the actuator while the environmental unit maintains the conditioned air in the test chamber.

Features

Unlike most materials testers, the PSI machine controls the temperature and humidity in the test area. Temperatures ranging from -20 to 150°C can be maintained in the glovebox enclosure. Humidity levels can be controlled between 5 and 95% RH. At temperatures approaching the boiling point, maintaining the desired humidity level becomes difficult. For these situations, methods have been developed in-house to encase specimens and limit the evaporation of moisture out of the material.

In addition to controlling environmental conditions, the PSI machine has the ability to produce complex strain curves at high speeds. The restrictions of traditional ramping and sinusoidal movements are removed. User-defined trajectories can be entered, and the apparatus will follow the desired strain curve within the limits of the actuator. This actuator can achieve speeds up to 2 m/s and precise positioning with 5 μ m resolution. Although the actuator was designed to produce static loads of approximately 300 lbs, the forces may peak at much higher levels during high-speed impacts.

The software applications for operating the equipment were developed by PSI and can be customized for each project. With this software, new types of tests can be designed to suit customer needs. The applications provide interfaces to define test parameters and strain waveforms. While running tests, the software also handles the data acquisition and signal conditioning. With the current configuration, force data can be captured at rates up to 250 kHz, which generally provides more than enough data even for the fastest strain rates. After running each test, the software can automatically process the data and present the results in a variety of ways. Additional analysis can be performed such as curve fitting, modulus calculations, and time

constant measurements. Continuing modifications and enhancements will be made to the software according to specific test requirements.

Applications

The PSI system offers advantages over a traditional universal test machine. The highly customizable equipment and software can be used to expand on traditional methods and conceive new tests as in the following uses:

- **Data collection for time-temperature superposition.** Increasing strain rates shortens the test duration, and material response can be measured over more time decades while avoiding experiments that last hours or days.
- **Short duration stress relaxation.** Specimens may be loaded in tens of milliseconds and held for seconds.
- **Observation of changing failure modes.** High-speed cameras can be used to observe the propagation of failure during rapid tensile tests as in Figure 2.
- **Image processing of visual data.** PSI can automate video analysis to calculate Poisson's ratios and measure other material features.
- **Dynamic mechanical analysis (DMA) while controlling temperature and humidity.** Measuring the response to a sinusoidal strain enables calculation of modulus and tan delta. This test is useful, for instance, when the glass transition of a material is affected by moisture.
- **Simulation of loading encountered in manufacturing or field use.** As an example, forming and packaging processes have been simulated by rapid compressions followed by brief periods of relaxation at various strain levels. For these studies, PSI has designed fixtures or used the actual tooling from the manufacturing line.

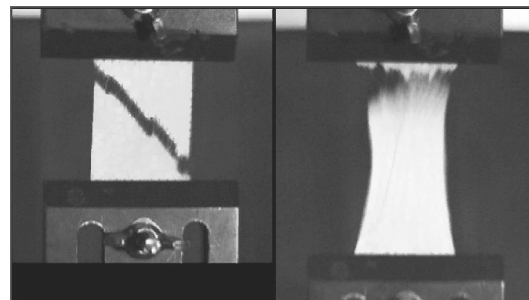


Figure 2. Comparison of failure modes for identical specimens at ambient (left) and 90% humidity (right) under tension at 1.25 m/s.

In summary, Pico Systems brings together an effective combination of capabilities. With their custom test machine, materials can be studied under high rates inside a temperature and humidity controlled environment. Using the software developed for the machine, loading trajectories can be defined and the actuator commanded to apply these waveforms to material specimens. Lastly, PSI emphasizes the value of communication and collaboration with customers from project conception to delivery of final results and carefully written reports. PSI strives to craft the best possible solution for each customer's materials testing needs.

Pico Systems, Inc. is a custom solutions provider specializing in high-speed controls and data acquisition, as well as programming for laboratory and manufacturing equipment.

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