High Temperature Testing (III)

Thermo-Mechanical-Fatigue (TMF) Testing

During the operation of high temperature components beside a transient in mechanical loading, also the temperature can vary. The variation of the temperature normally results in additional loadings on the component. The analysis of the interaction of superimposed mechanical and thermal loading and the effect of temperature dependent material properties must be known in materials modelling tasks. Therefore Form+Test Seidner&Co GmbH (FTS) Test systems is providing adequate experimental equipment for cyclic thermomechanical fatigue test procedure according to ISO12111 or ASTM E2368.

Machine concepts

a. Electromechanical drives for low test frequencies
b. Hydraulic test machines for highest test frequencies

Temperature control

To apply the temperature on the specimen, a three zone furnace is used. The guaranteed maximum operating temperature can be maintained continuously, without any life-consumption of the furnace. If, in the unlikely event of a heating element damage, maybe caused by test sample failure, the elements can easily be changed as well as the measurement thermocouples of the furnace, which saves costs and time. FTS provides a temperature profile of the load train upon request, which is generated on the customers system at pre-acceptance tests

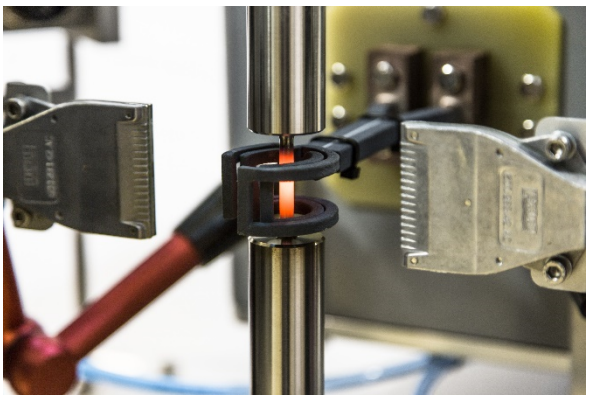
a. Temperature between RT and 1300°C in flexible inductive heating systems
b. For slower thermomechanical cycles, radiation heating furnaces up to 1600°C

Inductive heating system

For highest temperature transients, FTDS includes an induction heating system into the test rig. The system can be adapted to the specimen geometry, material properties and demands on temperature gradients. The specimen will be cooled by pressured air or inert gas. The control of the temperature can be done with contacting thermocouples or non-contacting pyrometer and is included in the ***DIGIMAXX®*** controllers.

Set-up of TMF tests with induction heating

- Adaption of inductors to special demand on material and specimen geometry
- Output power variable
- Operation in non-conductive atmospheres



High accurate heating of specimens

Calibration

The machine will be calibrated according to DIN EN ISO 7500-1 for test machines, not less than class 1 accuracy. Load cells and length measurement devices will be calibrated according to DIN EN ISO 376 and ISO 9513 respectively. All calibration certificates are corresponding to the German Accreditation Agency and can be issued after installation on site. FTS holds own calibration capabilities and an own calibration lab, as well as a close cooperation with considerable calibration offices. FTS can organise all relevant processes to guarantee an optimal documentation.

Measurement and control software

For controlling adequate high resolution 64 bit ***DIGIMAXX***® digital controllers are available, which can be modular extended for multi-axis tests (e.g. Tension+Torsion). The data logging can be done simultaneously on all channels. Including linked external measurement devices, all channels can be used in control mode. With the corresponding PROTEUS$^{PRO\ A}$ Software fully flexible test sequences can be set-up from the classical in- and our of phase TMF tests to complex component like cycles.

Additional test procedures and accessories and support

To enrich the test procedures different accessories are available to support the standard tests

a. Creep crack propagation measurement according to ASTM E1457-15 or ASTM E647-15 using
   Potential Drop probe
b. Equipment and adapters for various fracture mechanics tests.
c. Environmental chambers for testing in certain fluid atmospheres such as inert gas, corrosive media at medium temperatures or supercritical steam
d. Continuous strain measurement with contacting extensometer
e. Continuous strain measurement using non-contacting optical devices

Potential Drop Probe

Crack propagation can be monitored via the electrical potential. For this purpose FTS can integrate a potential drop probe, which has been tested in various long term projects. The dop probe is delivered with a digital data recording software, where the data can be used in user-defined formulas to evaluate the results- The results can be used in control mode along with FTS DIGIMAXX® controllers. The specific application is considered for the initial set-up of the system. For an optimal usage of the system an individual application training is offered.

DC PD, example

- Available with DC and AC detection
- With extension of scanning channels via Multiplexer
- Digital data recording and evaluation

Climate Chamber

For intermediate test temperatures or in combination with corrosion tests, FTS is able to supply adequate test chambers. The Temperatures can be set up to 350 °C. The chambers can include a front window and several feed-through for mechanical load train components and electrical wiring of measurement devices.

Example picture of climate chamber

Data Climate Chamber

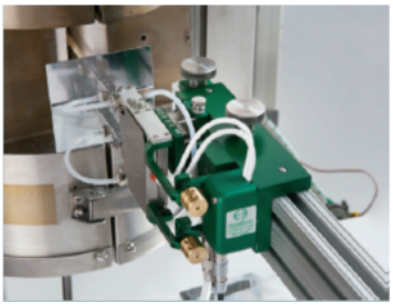
- Dimensions (W x D x H) : user-defined
- Max. Temperature available: 200°C
- Max. operating pressure 1.5 MPa
- Feed-Through for pull rods and Electrical feeders

Strain measurement

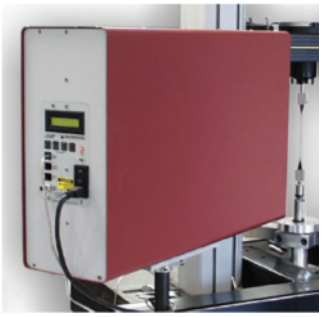
In LCF tests, the strain must be measured accurately to be able to feed the control loop. FTS provides adequate contacting extensometers with ceramic parts for highest temperatures and reliable elongations measurement. Based on the strain rate, the extensometer concepts show differently. For deliberate materials also non-contacting concepts are available

- Max. Temperature available: 1100°C
- For test frequencies up to 100 Hz
- For corrosive environments
- For biaxial testing
- For fracture mechanics approaches

For long term slow strain rate tests



For cyclic materials testing, example



Non-contacting extensometer, example,