APPLICATION

Thermo-Mechanical Fatigue Testing - TMF

TMF is a major cause of component failure in industrial machinery and structures exposed to temperature conditions and mechanical loads that change over time.

TMF affects a range of components, including train wheels and brakes, aircraft and ship engines, components used in gas turbines for power generation and compressors for gas and oil pipelines.

International Standards

ASTM E2368-04
Standard Practice for Strain Controlled TMF-Testing

• This practice covers the determination of thermo mechanical fatigue (TMF) properties of materials under uniaxially loaded strain-controlled conditions. A “thermo mechanical” fatigue cycle is here defined as a condition where uniform temperature and strain fields over the specimen gage section are simultaneously varied and independently controlled. This practice is intended to address TMF testing performed in support of such activities as materials research and development, mechanical design, process and quality control, product performance, and failure analysis. While this practice is specific to strain-controlled testing, many sections will provide useful information for force-controlled or stress-controlled TMF testing.

• This practice allows for any maximum and minimum values of temperature and mechanical strain, and temperature-mechanical strain phasing, with the restriction being that such parameters remain cyclically constant throughout the duration of the test. No restrictions are placed on environmental factors such as pressure, humidity, environmental medium, and others, provided that they are controlled throughout the test, do not cause loss of or change in specimen dimensions in time, and are detailed in the data report.

• The use of this practice is limited to specimens and does not cover testing of full-scale components, structures, or consumer products.

European Standard

The International Organisation for Standardization (ISO) set up a working group to draft a TMF testing standard. Progress towards achieving a balanced document has been hampered because of the lack of pre-normative R&D. The aim of this study is to coordinate EU input to the ISO working group and to provide the technical basis that will enable researchers to define all test-related aspects of the draft standard.
Typical System Configuration of a TMF - Testing System

In a TMF test the stress and strain applied to a specimen are varied independently of the temperature.

Two main types of tests are usually conducted

- **In-Phase TMF**
  The maximum value of temperature and the maximum value of mechanical strain occur at the same time.

- **Out-of-Phase TMF**
  The maximum value of temperature leads the maximum value of mechanical strain by a time value.

Typical System Components

- High stiffness load frame (Series LFV or Series LFMZ)
- Alignment fixture
- Force transducer
- Extensometer
- Water Cooled High Temperature Grips
- Heating Device (induction heating system, radiant or forced air heating)
- Temperature Measurement (Pyrometer or Thermocouple)
- Digital Closed Loop Controller (Series PCS8000)
- TMF-Testing Software (DION7)
- (compensation for thermal strain)

Optional Components

- Alignment fixture
- Vacuum Chamber