

GI fatigue monitoring solutions for on-line monitoring of thermal loads on pipes, nozzles, heat exchangers or valves

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Application: Fatigue Monitoring, Long Term Operation, Stress and Fatigue Analysis

Associated Product(s): Q.Station, Q.series modules, FatONE fatigue software, GI web portal

Abstract

Gantner Instruments provides a fatigue monitoring solution to detect analyze thermal cyclic load conditions on power plant piping, vessels, or heat exchangers that causes fatigue to the equipment. Based on the robust local sensors or on existing plant instrumentation the FatONE software for stress and fatigue analysis and cycle counting is used. With the flexible Q.series with its decentralized signal conditioning and data acquisition modules, a very reliable and cost effective trend and condition monitoring solution is available and working also under harsh environmental conditions like in the containment of nuclear power plants.

The Problem

The design life of plant components e.g. pipes and heat exchangers is limited by a large number of different thermal transients and pressure loads causing material fatigue. For plant lifetime extension a detailed fatigue analysis based on the real loading conditions is required for further operation of the equipment.

The Solution

Thermal load data on piping systems, heat exchangers, pump or valve casings are detected with special local sensors or measured with the existing process instrumentation. The special local sensors consist of thermocouples assembled as a measurement section for installation at the outer surface of a pipe.



Figure 1 Measurement section with thermocouples to detect transients with higher gradients on piping systems

The data acquisition system based on Gantner Instruments Q.series is installed in several containments of nuclear power plants worldwide. The very robust and flexible electronic hardware

with its decentralized concept can be easily installed and adapted the plant's requirements.

The measurement data is stored directly on the system for temporary application and later data evaluation.

For on-line acquisition and analysis, the highly automated software FatONE is used with its fatigue evaluation approach for fatigue screening or cycle counting. Detection, classification and counting of thermal events like stratification and thermal shock or the fatigue trend with end of life prediction of monitored components are key features of these software.

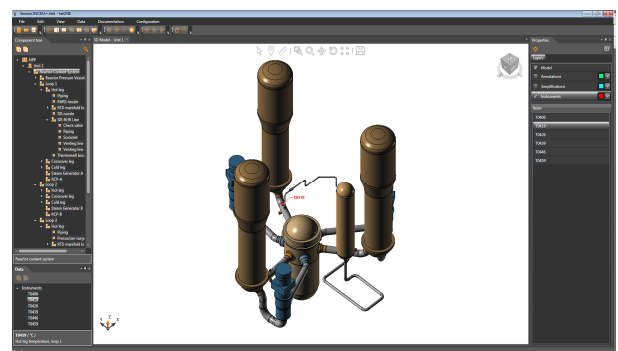


Figure 2 FatONE software with 3D plant model for on-line monitoring, data storage and stress & fatigue analysis

FatONE provides an interface to Gantner Instruments Q.station and to other plant systems like PI historian. The 3D plant model provides an overview about the fatigue status of all monitored components and indicates warning thresholds in case of dynamic or amount of detected transients.

System Features

- Cycle counting and transient detection based on existing process instrumentation
- Local measurement section with thermocouples to detect thermal stratification and plug flows with high gradients
- Robust and reliable sensor and electronic for installation within the containment of nuclear power plants
- Automated fatigue evaluation with qualified and code conforming approaches (KTA, NUREG, ASME, RCC-M)
- 3D plant model for comfortable visualization of load data and fatigue status of a large set of components
- On-line detection, classification and counting of thermal events like thermal stratification, thermo shock or pressure transients
- Other fatigue relevant events like leaking valves are detected in real time by analysis of position indicators and temperature measurements
- Quality of input data is analyzed by pattern recognition and faulty data is ejected for further processing
- Notification in case of threshold violation for thermal events (stratification or shock), amount of counted transients or fatigue usage factor
- Interface to plant process system e.g. PI historian for acquisition of operational data
- For monitoring of decentralized assets, the GI web portal is available as a local or public cloud service

The measurement sections are equipped with special clamping mechanism and support rings to

keep installation time low and to prevent the thermocouples from being damaged. The long term stability even under high radiation conditions is given by use of passive elements made of stainless steel.

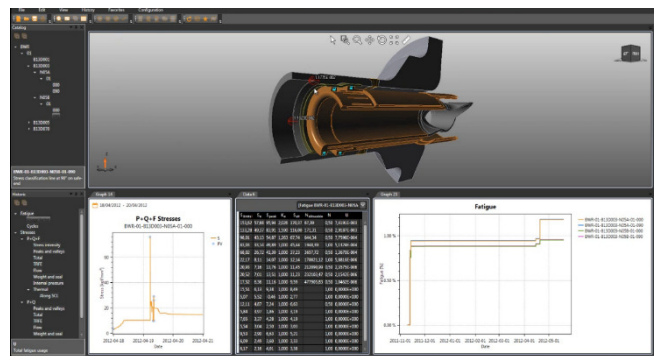
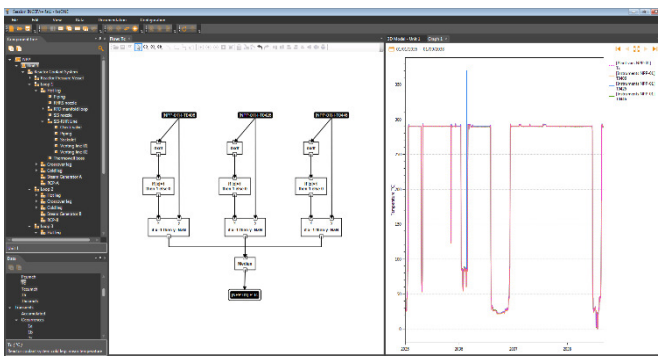
Further detailed stress and fatigue analysis can be done with special software like ANSYS or Code Aster. The detailed 3D plant model of FatONE helps to design the finite element model on short term to keep the costs for analysis low.

The Gantner Instruments hardware and the software FatONE ins used on over 10 pressurized and boiling water reactors of different vendors worldwide.

With the fatigue monitoring system for components in nuclear or conventional power plants, the fatigue status of a large fleet of different assets can be monitored. The complete system with its robust and reliable equipment can be installed in short time inside the containment even under harsh environmental conditions. With the help of the detailed fatigue relevant data, operating modes can be optimized and costly replacement of components for lifetime extension can be avoided.

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