Symbols and Numbers
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Monitoring- and Analysis-Software
FATIMO

Remaining Lifetime of Pipelines due to Material Fatigue

Alternating pressure loads on pipelines limit their lifetime. Based on the history of measured pressure values the monitoring software FATIMO determines the already reached degree of fatigue damage and predicts the remaining lifetime.

The development of the software emphasized the following special items:

- Reevaluation of cyclic load impact by TÜV SÜD according to AD–Merkblatt S2
- Evaluation and analysis on personal computers
- Periodic evaluations at intervals of arbitrary length
- Exclusion of time intervals comprising missing or erroneous measurements
- Cause studies by means of visualized data
- Safe storing of results
- Insight into the complete history and reproducibility of results

The offered methods to identify causes of damage and to exclude erroneous measurement values may increase the remaining life time by a factor 2 to 3.

Reevaluation of Cyclic Load Impact by TÜV SÜD according to AD–Merkblatt S2

Since pipelines are exposed to strongly varying and many small but frequent load cycles, an evaluation according to AD2000–Merkblatt S2 (English title "Analysis for Cyclic Loading") is requested (see also EN 13445–3). In these regulations is defined how the load cycle spectrum has to be evaluated.

Furthermore FATIMO is able to include the following amplifying effects to meet the standards of TÜV SÜD:

- Unroundness of the pipe
- Influence of mean stress
- Roughness of surface
- Higher safety factors

The stress loads can be calculated and evaluated along the longitudinal as well as the circumferential weld seam.

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Evaluation and analysis on personal computers

FATIMO can be delivered for the operation systems Windows, Mac OS X and Linux. It needs not to be directly connected to a process control system. Instead, it enables a subsequent evaluation and analysis of archived data, which might be even slightly compressed.

Periodic evaluations at intervals of arbitrary length

Due to the long lifetime of pipelines, the current degree of fatigue damage is typically determined at periodic time intervals and reported to the approving authority.

Because of the enormous amount of data, each subsequent evaluation is based on the results of the previous ones. FATIMO ensures that the produced results are always exactly the same – independent of how many and how long time intervals have been used.

Excluding erroneous measurement values

Not in all cases the recorded pressure values represent the real events. Maintenance work and faulty measurement sensors or communication devices sometimes cause wrong recorded values. Very often these erroneous values are at the boundaries of the measurement range and result in extremely high damage rates.

In order to avoid these wrong contributions to the total fatigue value, FATIMO allows to exclude time intervals from the evaluation. For the purpose of documentation the result data keep the original input data marked with user defined tags.

Cause Studies by means of visualized data

Diagrams show

- the trend of pressure and stress values
- the accumulated distribution of damages by rated load cycles
- the trend of the fatigue value

Single pressure and stress values in the trend curve as well as load cycles in damage distribution can be selected with the mouse. Thereafter the relation between trend curve and load cycle is highlighted. So the reasons for the determined damages can be analyzed.

It can be figured out, to what extent pressure amplitudes have an impact on the fatigue value, and which time intervals contain extraordinarily heavy load cycles. In this way it can be determined which operations or events (e.g. maintenance) contributed most or which damages were causes by certain operations.

Time periods without plausible measurement values can be quickly identified in the graphical display of the pressure sequence.

Safe storing of results

Fatigue monitoring takes place within very long periods of time. It easily happens that data from the past cannot be found anymore, because they became too many and were not needed in the meantime. Possibly they cannot be read anymore due to an unusual data format.

FATIMO saves all important results in a 7 bit ASCII code. Only user comments are added UTF–8 coded. The data in the files are arranged in a visually comprehensible way. Furthermore they can be read and depicted as a csv file from any spread sheet program.

New results are appended at the end of existing data files. This avoids an accidental erasure and guarantees the continued existence of all data.

Insight into the complete history and reproducibility of results

The underlying pressure series are compressed and stored in such a way that all detected load cycles survive and the rough trend in time can still be recognized. Therefore, the data can be analyzed even later and all results remain comprehensible although the amount of data shrinks considerably.

The compressed data series yields exactly the same results as the original input series. If necessary a new evaluation with modified criteria can be performed.

Applied Algorithms

In a first step the measured pressure values are converted to material stress. By means of a rainflow algorithm, the load cycles within the time series are detected and individually rated as per AD2000 Merkblatt S2. Summing up the ratings results in the total fatigue value.

The rainflow algorithm yields a residual sequence with not fully closed load cycles. Therefore the damage produced by the residuum is not contained in the total fatigue value yet. Since the amplitudes within the residual sequence are particularly high, these load alternations are evaluated in a separate step and added to a final fatigue value.

In a subsequent evaluation the last residuum is placed in front of the new input sequence. Thus a smooth transition between the evaluated sections is accomplished. Most notably the algorithm always generates the same reproducible result.

The interested user can learn the steps of calculation from the shown graphical output.

Required Adaptations

FATIMO must be configured so that the process of evaluation meets the requirements of the approving authority. The configuration is carried out by the producer of the software and will be protected against manipulations by a secret key.

In order to enable future changes of the configuration independent from the software producer, the key is disclosed to the approving authorities.

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If the requirements are uncertain, we are pleased to analyze the pressure alternations in the pipeline and bring an elaborated proposal into agreement with the approving authorities.

By default the input data are expected in a simple two column csv format (date and value). On request we can easily adapt the software to the customer's data format.