Predictive Maintenance Software for the Motors Wear Condition Determination

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Abstract: *In this study, the vibration monitoring and analysis case studies were presented and examined. Failures formed on the machineries in the course of time were determined in its early stage by the spectral analysis. This article focuses in providing information about the motor wear maintenance system, by using vibration analysis. The software takes into account the information coming in real-time from different sensors and other information sources and tries to detect possible anomalies in the normal behaviour expected of the industrial components. The incipient detection of anomalies allows for an early diagnosis and the possibility to plan effective maintenance actions.*

Keywords: *defects, vibration measurements, predictive maintenance, software*

1. INTRODUCTION

This paper presents the architecture of a new predictive maintenance system. Its predictive maintenance strategy can be applied to any industrial system or equipment and its main goal is to find the most appropriate time to carry out the needed maintenance actions both from a component health condition and an incipient failure diagnosis perspectives.

Currently, preventive and predictive maintenance system supports enterprise management since it is highly effective, through the information it provides in decision making:

- evaluate the technical condition of operation by comparing the vital parameters (vibration, bearing wear, viscosity lubricants, their resonant frequencies, etc..) with the values recommended by the equipment manufacturer or national and international standards;
- identifying and locates faults, providing possibility to intervene only where needed, minimizing the duration of the system stop;
- specific analyzes allows avoiding structural resonances;
- analyzing the evolution of the measured parameters, we can estimate the optimal time to stop the machine, avoiding the risk of accidental shutdown, but capitalizing full production potential of the machine.

The software enables management and knowledge of all those categories of technical and economic information needed to conduct the optimum maintenance activity.

This method ensures the highest level of predictive maintenance. Implementation of predictive maintenance can drastically reduce maintenance costs and increase the quality and profitability.[1][2]

The engine used is a single-phase asynchronous motor type AL90S-MA-24-2. A small portion of single-phase motors are used in industry, the largest share of applications where used is the domestic or services sector. A high percentage of these engines are represented by the dominant phase capacitor motors due to the advantages it presents: High starting torque, high power factor, low noise operation and increased efficiency compared with other single-phase motors.

The characteristics of the engine are given in Table 1.

Table 1
Engine characteristics

Name	Value
Power (kW)	1.5
Speed (r / min)	2855
Nominal current (A)	6.9
η (%)	80
The total mass of active parts (kg)	13
Direct coupling (Ip / In)	6
GD^2 ($kgfm^2$)	0.012
Weight (kg)	13
Efficiency cos φ	0.8

It was conceived a latest generation research stand as a basis for the application study and development heady necessary for the calculation of vibration analysis

algorithms needed to achieve optimization of production and thus profitability / reliability.

Fig. 1. The experimental stand

The stand concept aims implementing the latest technology in the field of analysis and diagnosis of asynchronous machines through vibration analysis. The experimental stand built, shown in Figure 1, combines next-generation mechanical and electronic components, microprocessors, Ifm Electronic touchscreen display elements.

For testing, we used three sensors for measuring vibration and one Ifm MK5111.

2. METHODOLOGY

The parameters measured are vibration rear bearing, imbalance and vibration front bearing.[3]

The first and the third sensor track the back bearing level having the following characteristics: [4]

- Measure acceleration,, mg,
- Evaluation Signal peak (peak).
- Frequency domain analysis: 450-6000 Hz
- Measurement resolution: 1526 Hz

For this sensor we chose to use HFFT (Discrete Fast Fourier Transformation) method for measuring transient signals; HFFT is a FFT (Fast Fourier Transformation) analysis with filter and calculation, which separates the transient signals by the machine signal. Also, it was opted to use A-RMS (The Root-Mean Square Acceleration) which is the square root of the area under the curve in the frequency domain DSA. A-RMS value is usually used to express the total energy of a random vibration event and is a statistical value used in mechanical engineering design purposes and structural analysis.[5]

Sensor 2 monitors the unbalance and measures the movement mm/s. In order to calculate the linear spectrum are used two different methods of analysis.

- FFT: To assess the harmonics signals
- H-FFT: To evaluate signals such as edge-type elements of the bearing.

Establishing alert and danger alarms are essential to the safety and proper functioning of a machine. Alarm value is determined according to international standards and depending on the user experience.[6]

To specify the boundaries of the assessment, ISO 10816-1 and ISO 2372 classify machines into four classes according to type and rated as follows:

Class I: Individual parts of engines or machines, integrally connected to the entire car in its normal operating condition. (Motors up to 15 kW machines are typical examples of this category).

Class II: Medium machines (typically electric motors with power from 15 to 75 kW), no special foundations, internal combustion engines or machines (up to 300 kW) mounted on special foundations.

Class III machines engines and other machines with rotating masses mounted on rigid and heavy foundations which are relatively rigid in the direction of measurement vibration.

Class IV: Car engines and other machines with rotating masses mounted on foundations relatively weak in the direction of vibration measurement (eg, turbo-generators and gas turbines with outputs greater than 10 MW).

3. SOFTWARE FOR PREDICTIVE MAINTENANCE: OBJECTIVES AND ARCHITECTURE

Particularly for companies operating in continuous flow is vital that the equipment work with minimal risk of accidental shutdown. Currently, preventive and predictive maintenance system supports enterprise management since it is highly effective, through the information it provides in decision making:

- evaluate the technical condition of working by comparing the vital parameters (vibration, bearing wear, viscosity lubricants, their resonant frequencies, etc..) with the values recommended by the equipment manufacturer or national and international standards;
- allows the identification and fault location, providing possibility to intervene only where needed, minimizing the duration of the equipment stop;
- specific analyzes avoids structural resonances;
- analyzing the evolution of the measured parameters, can estimate the optimal time to stop the machine, avoiding the risk of accidental shutdown.

Accidental stop of the machines produce serious disturbance in the production flow, with significant costs. Therefore, the estimation of the safe working time of the equipment can be a powerful tool in the efficient planning of repairs. Achieving this goal is the basis for a predictive maintenance software program whose desired functionality is explained in this article.

The proposed software system consists of all the hard and software (software) intended, in principle, for the process data collection, transmission of the controls, and validation, processing, display of data. It provides:

- monitoring the mechanical elements (Figure 2);

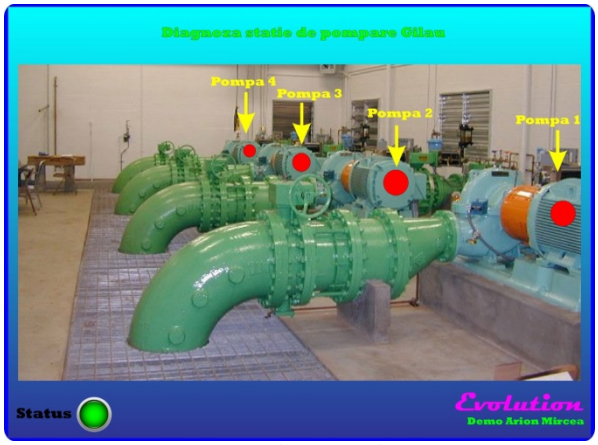

Fig. 2. Software interface

- staff information on the mechanical elements status;
- alarm for mechanical equipment failures, alarming is done by lighting the buttons according to the damage degree as well as through emails via SMS if the seriousness of the problem requires. (Figure 3)
- retaining a history of the events in a certain period of time, together with time of occurrence for post-crash analysis.

The software uses the VSE100 module by Ifm Electronic. VSE100 module will interface EVOLUTION Maintenance analysis, requiring OPC Server.

To achieve the above, the computer system includes the following main functions:

3.1. PURCHASE AND EXCHANGE OF INFORMATION

The function is used to provide the interface of the software system for operational management leadership of data acquisition equipment and external systems (Figure 2)

With this function is carried out:

- the collection and transmission of the information from / mechanical equipment;
- reception and sharing of data with other levels of operative management or other systems, including files (database files (display), reports, charts, diagrams etc.).
- updates the database;
- information validation.

The access over the settings is shown below:

There will be three levels of access over the settings as follows:

Level 3 - Primary user access, inexperienced operator - no password;

Level 2 - Advanced user access, experienced operator, will be able to extract all the necessary information, will be able to make changes, settings, possibility of writing the events (debugging, etc..)

Level 1 - Full Access, experienced operator will be able to extract all the necessary information, will be able to make changes, settings, possibility of writing the events (debugging, etc..). Also he can extract the history access data (time) regarding the interventions in the system.

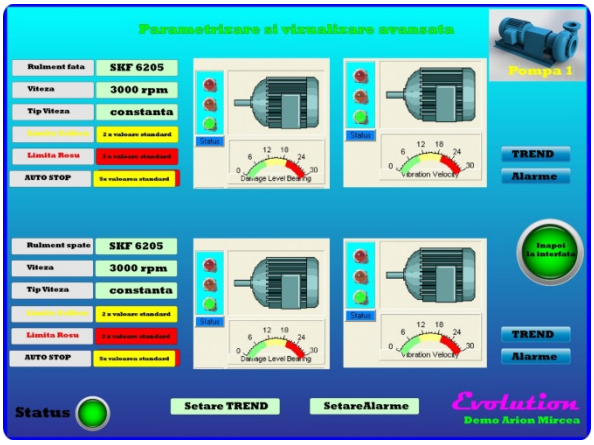

Figure 3. Monitoring the mechanical elements

3.2. DATA PROCESSING

This function provides real-time data from storage database, also the checking and accurate of the quality and the encoded information, for example: out of services problems, overflow limit, erroneous information etc.. (Figure 4).

Function include the following:

- analog data processing;
- data processing;
- writing data.

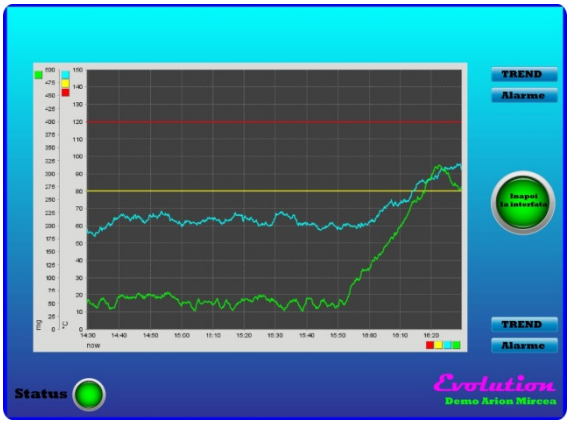

Figure 4. Output Data

3.3. STORAGE

Every 10 seconds it stores a snapshot (instantaneous reading) of some selected points or the entire database in a circular file that contains the last 10 snapshots.

3.4. HISTORICAL INFORMATION SYSTEM

The system maintains a history of changing the equipment status, providing the necessary information for a meaningful analysis of the events. All events are stored with their location in time and space, and are presented in chronological order, highlighting problem areas by visual signals.

3.5. USER INTERFACE

Man - machine interface allows viewing and navigating into the energy target areas of interest. Are viewed the mechanical elements, the analog display sizes, the events and the alarms. It also allows data entry into databases, printers extracting, applications inspection execution etc.. Presentation of the analog quantities can be done in the form: numerical, charts, analog devices.

3.6. ALARMING

The system recognizes the malfunction equipment state and sends optical and / or acoustic warning signs to the personnel (dispatcher) about the events (Figure 5, And Figure 6).

The detected alarms by the informatics systems are processed so that the important alarm conditions are transmitted in a clear, concise and time associated to people who need this information (Figure 6). They are treated in relation to their priority level.

Figure 5. History alarms

Messages from the sequential recording of the events are treated separately from those on normal status, they are not part of the treatment process alarms. Sequential recording messages are stored and reported separately.

Model report in case of incidents (Figure 5, Figure 6):

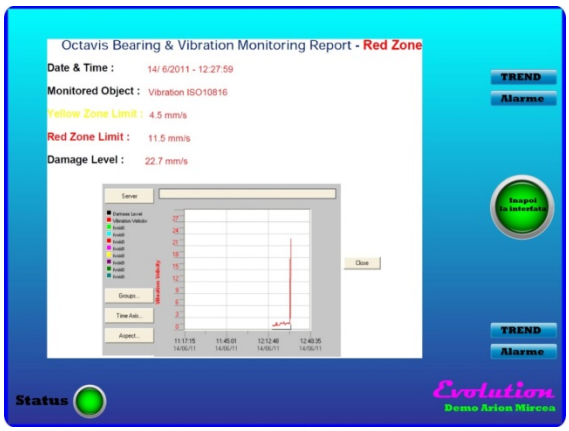

Figure 6. Method of incident report

Date: 27/09/2013

Time: 9:45 p.m.

Event: Vibration level exceeds the allowable vibration level.

Action: Local Alarm - sending mail to: mircea.arion @ ifm.com - SMS to Mircea Arion 0751989 464

Indications (database) - Emergency check of the engine compressor 46, front bearing

Level Alarm (1 of 3)

3.7. STATES MONITORING OF THE SOFTWARE SYSTEM

The function provides status supervision of various components and computer system as a whole. Supervision of the state will provide:

- Interventions plans - based on selection criteria of the equipment and / or planning of interventions performs planning them over a given period
- Unplanned interventions
- Repair programs
- Maintenance orders - unique maintenance activities execution IDs. You can determine the necessary raw materials, spare parts and workmanship actual costs
- Repairs release documentation
- Register orders workmanship reports
- Tracking maintenance interventions reports
- Repair plans

3.8. FEATURE

Depending on customer demands can be develop custom interfaces with the model application; can interface e.g. a pump station, a section of a plant, wind turbine, etc..

Also, it can be developed the reliable mode of component (estimated based on the history of the pieces that have been changed); if the defect was in the same area, changing the manufacturer or type of bearing, etc.. .

4. CONCLUSIONS

Since the early years of use of the maintenance system cost are reduced with 15%, reaching 25-30%. The direct consequence of reducing the number of accidental falls, reducing costs is favored by:

— Their management in real time;

— Implementation and tracking of expenditure budgets;

— Clear separation of internal and external costs;

— Optimizing the use of human and material resources, etc..

— Provides information about how long to work, this function provides an important history in the production optimization, according to this forecasts can be done for work, maintenance, supply.

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