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Design of Modern Central Intelligent Fault Diagnosis Power Plant System in Abadan Utility Plant 1

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Abstract: Due to the condition monitoring and fault diagnosis of gas turbines power plant utilities several systems developed in last 50 years. Under web condition monitoring systems are developing in recent years. Intelligent fault diagnosis and condition monitoring system VCM investigated in this paper and operate successfully on four main gas turbine generator in Abadan main power plant utility. this system also working under the web condition and divided in two main hardware and soft ware's parts. Hardwar's facilities consist of sensors, signal conditioners and A/D card and so on. On the other hand software facilities consist of detecting, storing and analyzing data. The readers who directly contact with condition monitoring systems could have better understanding on the software facilities and principal of these kind of systems and also others could have improve their general knowledge about modern intelligence fault diagnosis and condition monitoring systems in most critical equipment like gas turbine power plant utilities.

Key words: Sensor · Signal conditioner · A/D card · Condition monitoring system · Intelligent fault diagnosis · Gas turbines · Time wave form (TWF) · Fast Fourier transform *(*FFT).

INTRODUCTION

VCM intelligence under web condition monitoring and fault diagnosis is a system that has the capability of detecting and measuring the different vibration data and graphs and equipped with alert and danger systems of gas turbine or any other most critical equipment. besides this system can compare the different vibration data and graphs characteristics with basic vibration behaviors, shape of data and graphs in fault diagnosis documentation and predict or guess the real fault of machine. these kind of capabilities was not provide by previous condition monitoring systems then VCM consider as a modern intelligent fault diagnosis system in condition monitoring system of most critical equipment world. this system can present the on line monitoring of different vibration data like overalls, time wave form (TWF), fast Fourier transform *(*FFT) and so on beside this the expert vibration analyst can cooperate the vibration analysis process with on line advisor system in web also the fast evaluation of machine condition proposed by intelligence monitoring system can help the process members in critical conditions like alert and danger situation to choosing the optimum decision in minimum critical times.[1]

Experimental Details: The VCM software consists of three main parts. First condition monitoring after that signal processing and finally vibration analysis are these three main parts. All of the advisors could simply connected to internet and printing the server IP (the mentioned gas turbine generator) and evaluating the machine condition in critical alert or danger times with a user name and password. The server could input all necessary machine characteristics like RPM, critical speeds, name of the machine, position of vibration points, type of sensor and sensors characteristics and so on in software system. This kind of information is essential for

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any further data processing and should be accurately provided by related groups. Also server could introduce maximum three vibration sensor for each vibration points in horizontal, vertical and axial direction. The sensor characteristics consist of type of sensor, its sensitivity, frequency band limits and the number of connection for A/D card and so on should accurately provide by related groups (special electronic tools and equipment installation). [2] the close monitoring gaps also could be adjusted in this part and strongly suggested to be appropriately close as well as possible due to the criticality of these kind of equipment (gas turbines power plant).VCM software use a system include combination of both saving files and data base. in this system firstly data collected by sensors after that processing happen on these kind of data. the processed data saving in data base but unfortunately the raw data collected by sensors did not saving in data base. these kind of data usually is in the form of voltage numbers and provide pure and extremely useful information specially in shaft center line monitoring analysis. Therefore the raw data saved in the main hard by specific format for further applications. The data that based on initial analysis of all signals transfer to fault diagnosis center by replication service. Raw data transfer to a Zip file by data saving management soft ware's in a specific period of time that I mentioned before. These Zip files transfer to fault diagnosis center from main utility plant by a specific FTP protocol. Condition monitoring part consists of three main indicating facilities linear trend graph, bar chart and schematic diagrams. Sensors data provide initial information like overall vibrations for further analysis also the mentioned graphs provided the latest trending information that will extremely useful in process of vibration analysis. The overall vibration data in both mm/s RMS and micrometer peak to peak (p-p) for different vibration points could be monitored during operation time (shown in figure 1). Also phase values could be trend by any type of diagrams mentioned before and provide us valuable information in rotor motion analysis or vibration modal analysis in critical period of time [3].

In signal processing part, several analysis and diagrams provided by VCM such as time wave form (TWF), fast Fourier transform (FFT), shaft orbit, Envelope, Cepstrum, Waterfall FFT and so on. all of these graphs are widely useful in vibration analysis world. Also Transient analysis could provide by VCM for startup, turn off or shutdown times as coast down and run up diagrams that extremely useful in critical conditions [4].

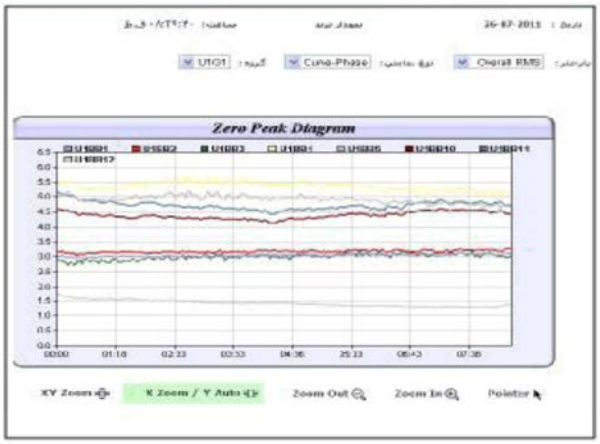

Fig. 1: Typical vibration data trends. (26thJune 2011- Abadan utility plant 1)

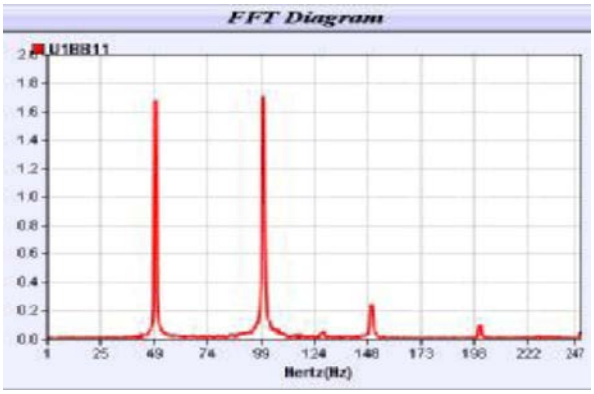

Fig. 2: Typical FFT turbine side(26th June 2011- Abadan utility plant 1)

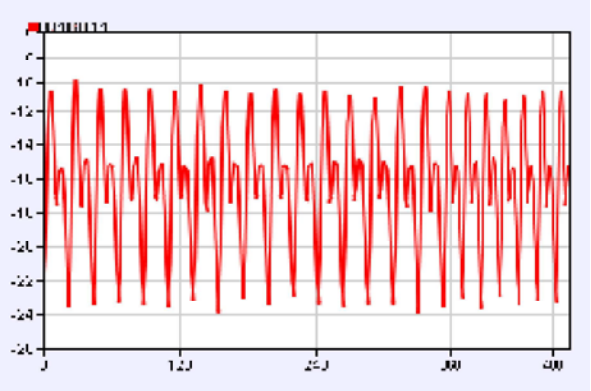

Fig. 3: Typical TWF turbine side (26th June 2011- Abadan utility plant 1)

Transient analysis is related to times that machine operating with fluctuating RPM like startup, turn off or shutdown times. these kind of data and graphs could potentially provide extremely valuable information about machines condition. The first step in Transient analysis is

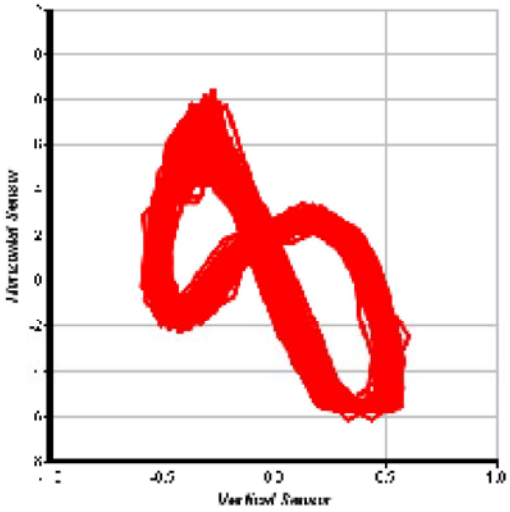

Fig. 4: Typical shaft orbit generator side(26th June 2011- Abadan utility plant 1).

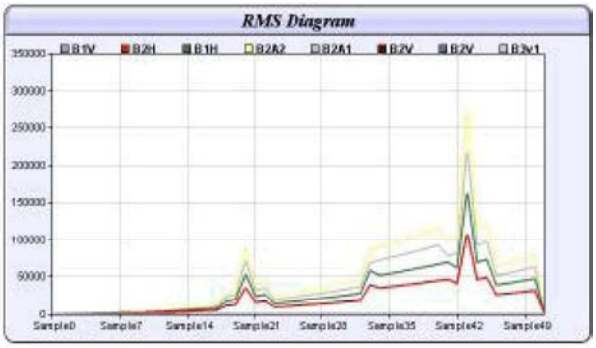

Fig. 5: Transient condition trending diagram start up turbine side (26th June 2011- Abadan utility plant 1).

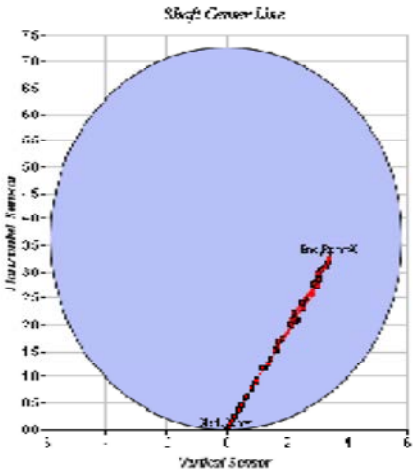

Fig. 6: Transient condition shaft center line position turbine side (26th June 2011- Abadan utility plant 1).

how to detect the vibration signals but it should be considering that the RPM is fluctuating. In VCM system it provided by combination of two software and hardware parts that mentioned before. VCM equipped with TWF, overall vibration trends, bode plot, polar plot and average shaft centerline plot and waterfall diagram in transient condition. VCM have the capability of drawing orbit in 0.5X, 1X, 2X and 3X by pioneer filtering facilities. in the vibration analysis part the pattern faults indicates and the software asking the current shape or diagram is close to what are the following matters or pattern this technique will help the fault diagnosis process to increase its reliability and capabilities and cause increasing its accuracy [5].

RESULT AND DISCUSSION

Fault diagnosis and vibration analysis in VCM consist of two parts. The main part consists of an intelligent neural network system and the second part consists of a set of typical fault diagnosis questions. These kinds of facilities equipped with typical main vibration analysis references data bases. Due to the extremely high qualified neural network systems in Fault diagnosis and vibration analysis of most critical equipment, we used a back propagation intelligent three laminate feed forward neural network system in this project. the input of this system is the increasing in overall vibration or some specific frequency amplitude or some phase value fluctuation on the other hand

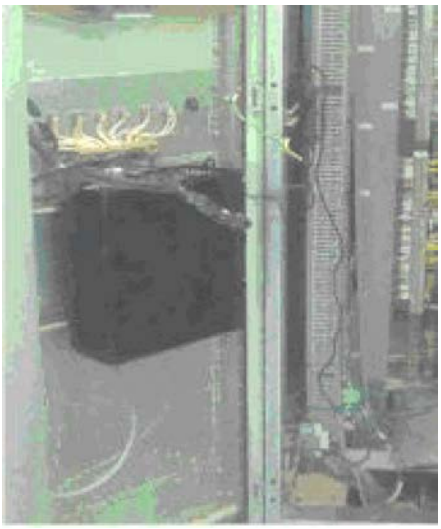

Fig. 7: Signal conditioning box in Abadan utility plant 1 substation

Table 1: Typical vibration analysis and fault diagnosis results testing information for VCM Abadan utility plant 1

Vibration points	U1B1	U1B1-2	U1B2	U1B3	U1B3-2	U1B4	U1B4-2	U1B5
unbalance	0	0	0	0	0	0	0	0
misalignment	0	0	0	0	0	65.64	99	0
Bent shaft	0	10.32	0	0	3.36	40.56	0	0
wear	0	87.8	85.2	0	99.9	0	0	0
Rotary looseness	0	88.2	89.2	0	84.3	76.2	83.1	0
Journals looseness	0	0	0	0	0	82.9	93.4	0
Oil whirl	0	61.8	59.4	0	75.4	0	0	0
High frequency faults	0	2.6	0	0	0	0	13	0
Critical speeds	0	88.7	95.2	0	93.2	88.3	96.4	0
Shaft crack	62	61.4	65	68	61.3	66.9	64	63.7
Rotor eccentricity	63	66	60	64	67	62	69	60
Rotor damage	64.5	67	69	61	60.8	66.3	65	64
Hydraulic unbalance	62	63	64	66	62	64	69	60
Electromagnetic problems	61	62.3	64.1	67.7	60.9	66	62	64

the output will be the possibility of some common faults in vibration analysis world like, unbalance, misalignment, bent shaft, rotor rob, looseness, wear, shaft crack, oil whirl and so on [6] Besides some typical question also asked from process operators these kinds of activities will increasing the accuracy and reliability of this method especially in shaft orbit analyzing of main gas turbine rotor. The question that asked to increasing the accuracy and reliability of the VCM is generally about both vibration and process parameter. VCM will controlling all of the related alarms every minute. and will sending email and SMS to utility managements automatically if any alert or danger appear on the system. Because of the fact that the utility managements always trying to minimized the condition monitoring costs we had to adapt our hardware facilities with current vibration sensors of these gas turbines. [7]The VCM is completely independent from previous classical condition monitoring system of this power plant and just use the raw signals and information (by using an isolator system) from the sensor connections and a kind of parallel condition monitoring system to increase safety and reliability. Isolators usually installing in main board control room substations in a box inside signal panels called signal conditioning. Hardware facilites also equipped with some filtering systems to avoid aliasing phenomena and eliminate any noise from signals before analyzing as well as possible [8].

The VCM indicate the results by percentage for all common faults in most critical equipment. A typical vibration analysis and fault diagnosis down by VCM shown in table 1 in some testing results information condition for Abadan utility plant 1 [9]. Just imagine that table 1 was the results in real condition analyzed by VCM by taking a glance we could guess that the main problem of gas turbine should be wear or something like this. we should change the analogue signals to digital form to create saving capability in computer systems.[10]We used a main terminal board ADAM-3968, analogue-to-digital converter card PCI-1747U and related cable PCL-10168 (68 Pin SCSI-II Cable) in this project. Analogue-to-digital converter card PCI-1747U installed in mother board in main server computer equipped with 32 input analogue channels [11]. This computer also equipped with GSM modem for SMS activities in alarm and danger conditions. The overall amplitude of each signal control in danger and alarm signals amplitude analogue control main board and in alert or danger condition the related LED red light lamp will on in this main board and siren system will active in danger condition and announce related alarm. [12] Each plant equipped with a siren system and each sensor equipped with an alert and danger LED lamp indicator. Measuring the frequencies done by a AVR microcontroller equipped and adopted with a key phasor accurately [13].

CONCLUSION

In this article modern Central intelligent faults diagnosis power plant system VCM capabilities discussed in details. by installation of these kind of condition monitoring systems the costs and problems of expert vibration analyst advisors will reduce considerably and these kind of specialists could explain their opinions through internet by accessing accurate and complete vibration information like overall vibration data, graphs, phase values and trends. On the other hand process

members can evaluate the general condition of their machine and possible machinery faults in critical times that they have to make critical decisions. These kind of intelligent systems are effective both economically and technically for most critical equipment like main gas turbines but the similar intelligence data collector for ordinary condition monitoring activities in industrial sites and non on line applications is not recommended.

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