International Journal of Engineering Research and Development
e-ISSN: 2278-067X, **p**-ISSN: 2278-800X, www.ijerd.com
Volume 5, Issue 11 (February 2013), PP. 09-15

Management of Maintenance by Vibratory Analysis Illustration in the Case of a Coolant Pump

Bensaci M[1], Chaib R[2], Benretem A[3], Verzea I[4]
[1]Université 20 Août 1955, Skikda, [2]Université Constantine1.
[3]Université Badji Mokhtar, Annaba, [4]Technical University Gh. Asachi Iasi, Romania

Summary:- With the opening of the markets, today, the problems of the company are to be competitive under the best conditions of production, quality, cost and the shortest times to satisfy its customers. Unfortunately, the industrial plants are disturbed by dysfunctions, which affect quoted conditions. A fact the unavailability of the machines comes to cut down the output heavily and thus to increase the cost price. It is one of the major plagues of industry. Our objective is to guarantee the availability of the machines, stake major of the production, by decreasing to the maximum the expenditure related to the purchases and operations of maintenance, while setting up an effective system of management of maintenance, using the vibratory signal. The use of the methods of signal processing emitted by the bodies of the machines, enable us to extract from information on the operating condition of these machines, and thus to envisage the early appearance of the dysfunctions, even an intervention advisedly, while following the evolution in the time of the symptoms of drift of state of the equipment: A better targeted maintenance, it is less unavailability; a controlled maintenance, they is less expenditure.

Key words: Availability, analyzes spectral, level total, conditional maintenance, precocity, failure.

I. INTRODUCTION

The costs of maintenance in a power station represent a particularly significant share of the life cycle cost. In addition, the optimization of these costs is a major stake in this competing and strategic sector of all the industrial sectors. The production of electricity represents the part upstream of this industry and with the opposite, the part downstream that is unavailability. Currently, of the methods and the means of maintenance are thus developed, to allow to evaluate and to reduce these costs **[1]** and thus to increase the availability of stations major stake the generating of the production, relatively much higher than the direct cost of maintenance. However as maintenance influences the two factors: a better targeted maintenance, it is less unavailability; a better controlled maintenance, they is less expenditure **[2].**

Until a recent date, the maintenance of the machines and the replacement of the parts subjected to wear could be considered in two manners: waiting of breakage (curative maintenance) or the replacement with regular intervals (systematic maintenance) **[3, 4, 5]**.Waiting of breakage is not economic any more and the systematic interventions are often useless, expensive in spare parts, labour and loss of production, without also counting that a lack of spare parts at one critical time can induce direct and indirect expenses significant. During disassembling and start-ups and the inevitable human errors (estimated of 10-15 %), these interventions can harm reliability **[3, 6]**.From now on, the monitoring and the diagnosis of the mechanical systems became one of the concerns major of the industrialists.

Among the various methods of diagnosis used, the vibratory analysis is most used in conditional maintenance, because of the increasing performances of the treatment of the signal. Those allow today, to improve the availability and the safety by early detection and the follow-up of degradation of the critical elements **[7]**: *The vibratory signal is the identity of the machine* **[8]**; it contains its kinematics signature, related to the operating conditions. This makes it possible to guarantee the availability of the machine, by decreasing to the maximum the expenditure related to the purchases and operations of maintenance.
This is why; this article aims at the detection and the diagnosis of the dysfunctions of the complex vital machines, such as the coolant pump in a power station. An intervention advisedly, while following the evolution in the time of the symptoms of drift of state of the equipment, is then possible: to make selective maintenance.

Technical 2-characteristics of the power station:

- Fuel : the fuel used for the boilers is the natural gas of flow necessary to ensure the full load of the two groups 160.000 Nm3/h.

- Vapor generator (boiler): has as a role to transform water into vapor with high pressure to feed it (AWG).
- Harness (KWU/RFA): the turbine transforms the thermal energy contained in the vapor coming from the boiler into a rotational movement of the tree, mechanical work obtained is used to actuate the alternator.
- Water of refrigeration : the hydrant located at sea at 900 m of the station of pumping and filtration. After crossing of the condenser, the water of refrigeration is rejected towards the channel, which ends in the sea.
- The station of water : is the whole of the equipment which preheats water and transfers it from the condenser to the boiler while passing by the food cover.
- Alternator : transform the mechanical energy into electric power.
- Auxiliaries common to both sections :
  - a station of production of hydrogen;
  - a gas pressure regulator station;
  - a station of discharge and transfers fuel;
- Station of demineralization : it completes the treatment of water before its use in the cycle water vapor.
- Station electrochloration: the chlorination of sea water makes it possible to protect the circuit from water against any clogging.
- Evacuation of energy : the produced electric power is evacuated via lines of 225 Kv.

2.1-order and control:

The power station is characterized by a high degree of automation and centralization of the orders, figure1. One counts forty closed loops by group of production, which allows an automatic piloting of the group.

- Analysis and alarm, monitoring systems :

- to allow a good control of the group of production of the operating parameters (temperature, pressure, level of water, vibrations.), various equipment of the group, is indicated, recorded permanently in control room and is announced in the event of going beyond of threshold.

- For a better analysis in the event of incident a consignor of state is installed. He makes it possible to record alarms in a chronological order.

2.2-room of centralized order

Each pair of sections is monitored and regulated since a control room. The control room includes/understands for each section:

- Two (02) desks of conduits,
- Two (02) vertical tables where are resembled the control units and the apparatuses of recording of most of the parameters.
- One (01) synoptic table schematizing the electric auxiliaries.

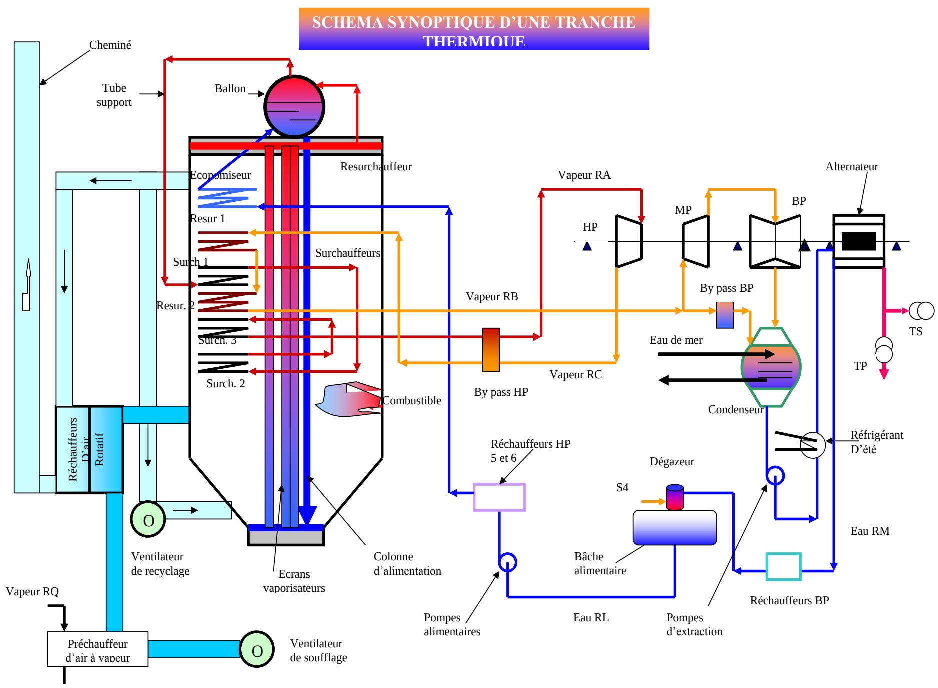

Figure 1: Synoptic diagram of a thermal section

II. DESCRIPTION OF THE MONITORING SYSTEM

In order to optimize the programmed actions of maintenance, while taking account of the reliability, we called upon maintenance based on reliability (MBF) **[9, 10]**. Among the constituent links the technological chain, since the extraction of sea water until the production of electricity while passing by the various operations and technological processes, and being given the evolution of the relations of cause for purpose binding the variables of the technological chain, a detailed attention is given to the coolant pump, strategic equipment in the production process of electricity.

In order to know the state of ` santé' pump, a system monitoring was adopted, using the software of analysis VIBROEXPERT Cm-400.This software is conceived to treat the data of vibrations, collected on the revolving machines and allows the comparison of the spectra as well as a better visualization of the dynamic signals. The preventive one applied to the coolant pump consists to supervise and analyze continuously the operating condition like its evolution in time and to decide the maintenance actions necessary.

The function ` santé' of a revolving machine is based on the installation of one or several indicators with preset thresholds not to exceed, indicators calculated starting from the vibratory signals of the supervised parts. Each going beyond generates an alarm whose analysis will start maintenance actions (figure2), **[5].** More precisely, the calculated indicators are defined to be sensitive to the early detection of the defects on the revolving parts. The vibrations emitted by these machines or certain bodies of these machines in their spectral or temporal forms, make it possible to extract from information making it possible to envisage the early detection of faulty operations, even the intervention necessary.

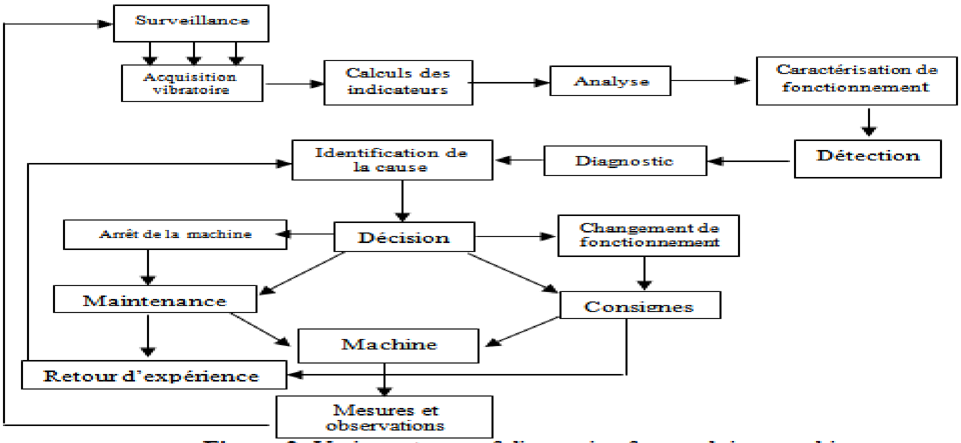

Figure 2: Various stages of diagnosis of a revolving machine

III. CHARACTERISTIC OF THE COOLANT PUMP

Technical 3.1-characteristics of the machine

- Driving drive has:
- Power:6kw
- Number of revolutions:1484 tr/min
  - Stages engine:02 bearings
  - Bearing with dimensions of coupling: 6322C
  - Frequencies characteristic of the bearing: 123Hz, 76Hz, 100Hz and 9, 55 HZ
  - Bearing with dimensions opposed of coupling:N321
  - Frequencies characteristic of the bearing:192Hz, 132Hz, 132Hz and 10,3HZ.

B Pump cooling NORIA 11:

- Frequency of passage of the blades: 175 Hz
- Values limit according to Normes 2, 5 mm/s
- Values limit according to Normes 2, 5 mm/s
- Values limit according to Normes 2, 5 mm/s

Figure 3 : Pump cooling NORIA 11

3.2 - The raised spectral ones of the defect

Measurements were taken on a coolant pump coupled with an engine of drive.

- The points of measurement are:PM1, PM2, PM3 and PM4 (see figure 4)
  - Date of catch of measurement: from the 21/01/03 to the 18/01/05
- Number of revolutions 1490 tr/min (25 Hz);
  - The directions of measurement are horizontal and vertical.
  - Measurement is in Acceleration geff by means of an accelerometer.

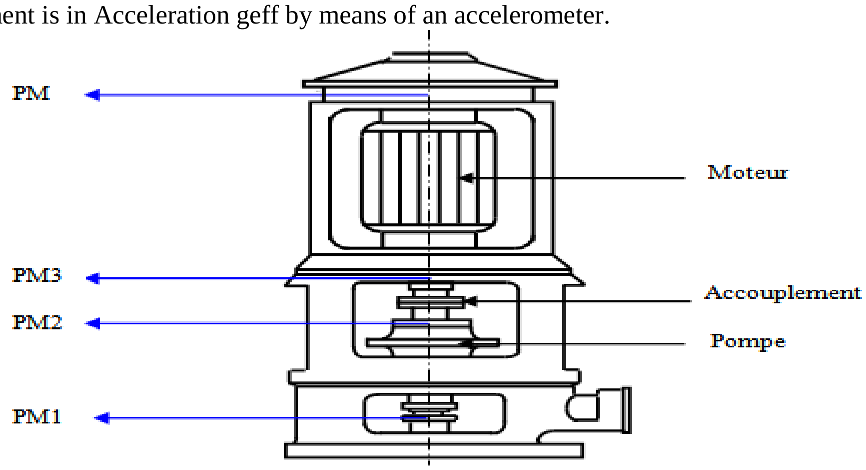

Figure4: Synoptic diagram of the machine pumps cooling and points of measurements

IV. ANALYZE TENDENCIES

The determination of the thresholds of intervention is certainly one of the operations most delicate and most significant for a good tracking. These preset thresholds can be fixed while being based on standards, statistics or histories of machines or by time still, according to the experiment of the manufacturer. The going beyond of threshold results practising a more complex analysis and in using the tools for diagnosis. It should be noticed that the choice of the threshold is fundamental (frequent and unjustified alarms or the breakdown can occur without preliminary alarm).

Diagrams of the figures (5.1), (5.2), (5.3), (5.4), (5.5), (5.6), (5.7), and (5.8) show 1' interest of the data storage and their representation in the form of diagram of evolution. The layout of the curve of tendency gives 1' evolution in the time of an indicator (total level acceleration, speed, displacement), which can bring invaluable elements to confirm or cancel assumptions on the nature of the defect. The diagrams as of the these figures concerning the evolution of the spectral indicator (total level acceleration) measured on stages 1, 2, 3 and 4 according to the corresponding direction, are respectively:

The figure (5.1) represents the evolution of the tendency as in point 1 in the horizontal direction for the date of the 12/10/03 and raises a brutal increase of the total level acceleration, which reaches the value 5,128 geff, exceeding the threshold of danger.

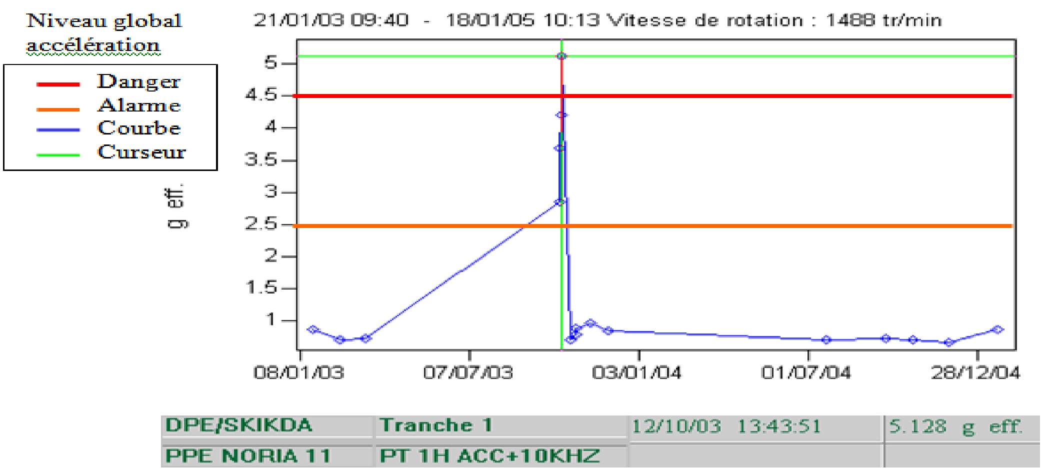

Figure 5.1: Evolution of the tendency of the horizontal point 1H

The diagram of figure 5.2 represents the evolution of the tendency as in point 1 in the vertical direction for the same date, a significant increase in the total level acceleration, which reaches the value 4,409 geff, exceeding the alarm.

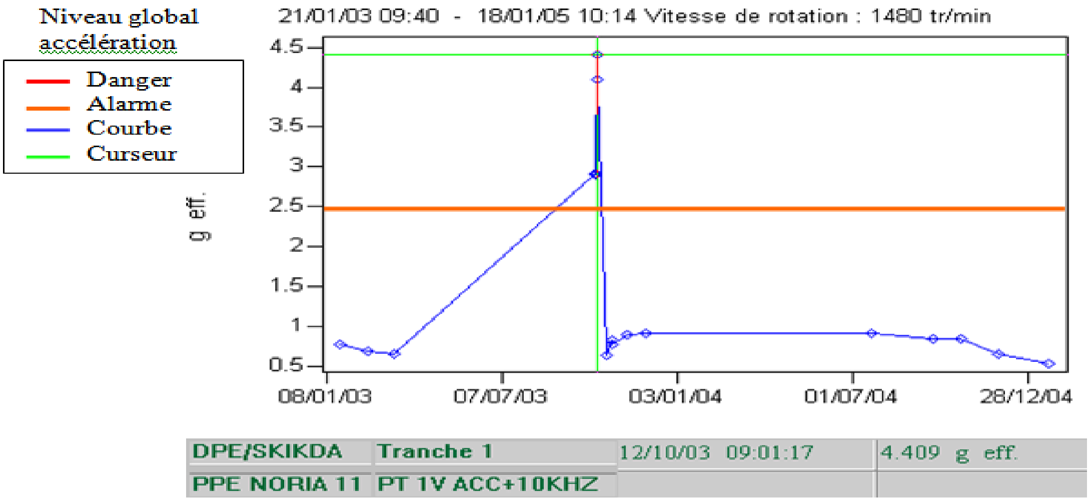

Figure5.2: Evolution of the tendency of the point 1V

threshold. For the point of measurement PM2, according to the two directions (Horizontal and Vertical), one also notices that there is a significant increase for the two tendencies (Figures 5.3, 5.4), for values of 3,376 geff and 3,814 geff exceed the threshold of alert.

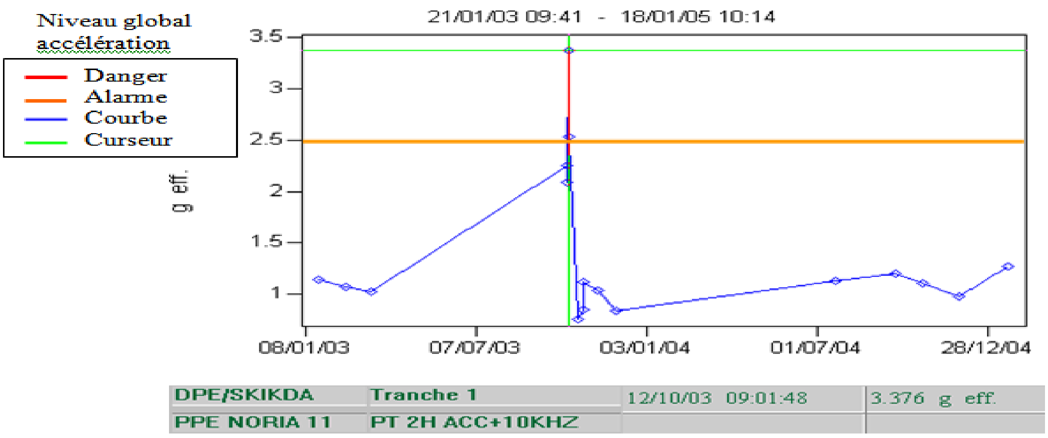

Figure5.3: Evolution of the tendency of the point 2H

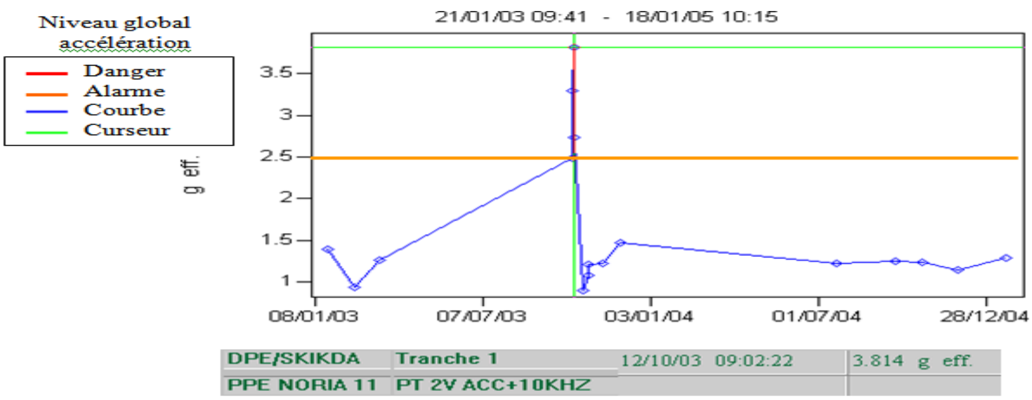

Figure 5.4: Evolution of the tendency of the point 2V

D' after the results of the points of 1H measurements, 1V and 2H, 2V, one notices goings beyond of alarm threshold of the total level which is respectively 5,128 geff, 4,409 geff, 3.376 geff and 3,814 geff. That

resulted in a going beyond of the threshold of judgement suggested by the in-house standards (the threshold of alarm is of 2, 5 geff and the alarm threshold is of 4, 5 geff), even a problem to be identified.
To identify the type of defect and as the analysis total level does not make it possible to qualify the defect, therefore it became necessary to pass to the spectral analysis (figure 5.5, 5.6, 5.7 and 5.8) in order to make a diagnosis and to identify the defect. These figures illustrate well the spectra of the defect on the level of stages 1 and 2 of the pump.

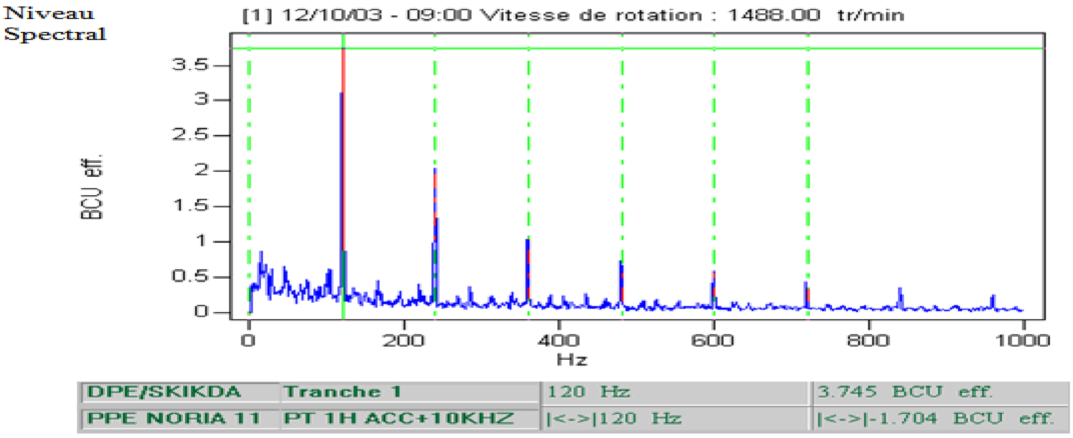

Figure 5.5: spectrum for the point 1H

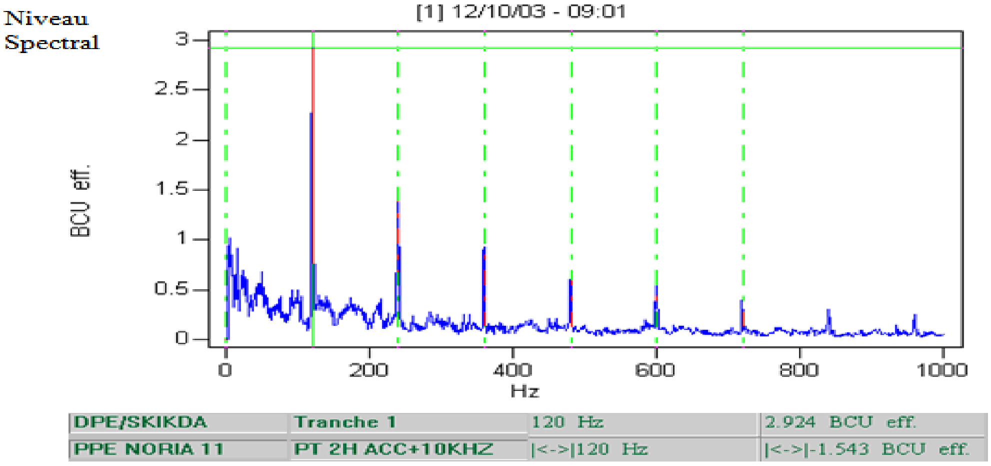

Figure 5.7: spectrum for the point 2H

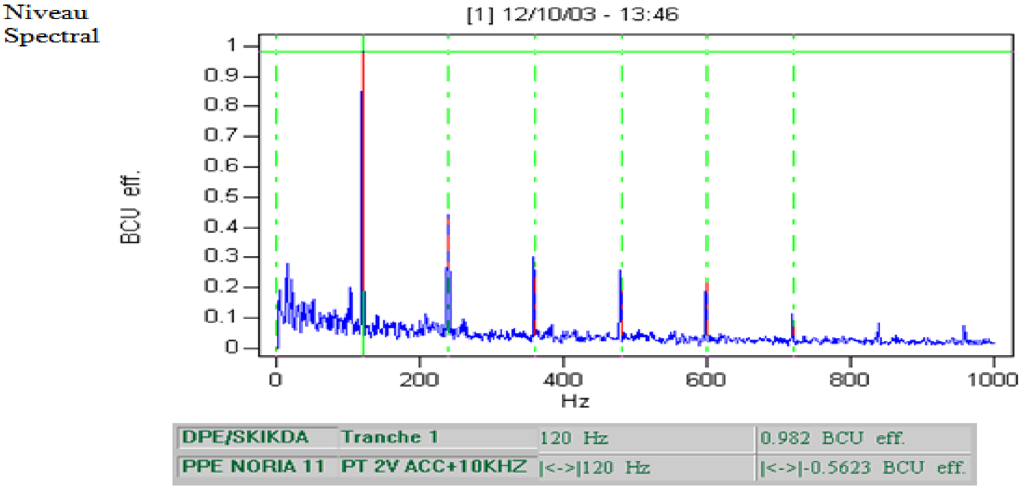

Figure 5.8: spectrum for the point 2V

4. Report: The spectral analysis forms BCUeff of it, enables us to make the following observations. One notices in the spectra of the figures (5.5, 5.6, 5.7 and 5.8) that there is an anomaly translated by an increase in amplitude of the fundamental frequency, which is 120 Hz like its harmonics. This last component corresponds to the frequency of the internal ring of the bearing 6313 N which is closer to value 123 Hz (frequency characteristic of the bearing) with an amplitude of 3,745 BCUeff, 1,9 BCUeff, 2,924 BCUeff, and 0,982 BCUeff. The alarm threshold is 2, 5 BCUeff.The spectral analysis confirms the defect: is a defect of bearing of the internal ring.

V. CONCLUSION

The change of the bearing of the pump, after the defect announced on 12/10/03, stabilized the shape of the curve of tendency of point PM1 (figures 5.1) and of point PM2.From this period, experimental measurements and the comparison between the peaks of the spectra and the alarm thresholds total level acceleration (figures 5.2, and 5.3), did not express any value of amplitude exceeding the threshold values. The examination of all these figures shows the essential role that the treatment of the signal in the identification of the defect plays.

This example illustrates the fact well that 1' analyzes spectral is a reliable technique of investigation which requires on behalf of the operator a knowledge of the precise kinematics of the machine and vibratory images of the defects suitable for affect the machine and consequently to make selective maintenance, to see targeting the defective component. A better targeted maintenance, it is less unavailability; a better controlled maintenance, they are less expenditure.

BIBLIOGRAPHIES

[1]. R. Chaib, A. Benretem, S. Teyar and I Verzea, Management of maintenance by vibratory analysis box: has planetary reducer, World Journal of Engineering.Vol.4, N.1 (2007), pp 22-27.Sun Publishing Light, Canada. ISSN: 1708-5284.

[2]. A. Despujols, Method of optimization of the strategies of maintenance, Technique of the engineer, MT 9 050, 2005.

[3]. A.Tomache, Communication EMS-ERCE, Symposium on the plant maintenance, Aeid-iap.Algiers, 21-23, January 2001.

[4]. S.Elfezazi et al..Towards a tool, based on the functional analysis, for the placement of the indicators of measurement of performance of the function maintenance.French review of industrial management.Vol.22, N3/2003.

[5]. R. Chaïb, M. Benidir, N Boulkroune and I.Verzea, To determine the priority of the actions of maintenance, Formalization of a method of hierarchisation of the actions realized starting from the analysis of the dysfunctions of the belt conveyors of 4 cement factories, 18th Forum (inter)national of maintenance 2006, Exhibition site, Paris, November 7-8 and 9.

[6]. A.Boulonger, C. Pachaud, vibratory Diagnosis in preventive maintenance, Dunod, Paris 1988.

[7]. Mr. Bensaci, vibratory analysis, invaluable tool for the detection of the defects of bearing, thesis of magister of the university August 20, 1955, Skikda 2007.

[8]. M.Glade, I.Yves longère, P.Lyonnet, Impact of the use of a system monitoring of the failures on the costs of exploitation and maintenance of mechanics of helicopter. French review of industrial management. N Special Maintenance, Mars2003.

[9]. I.Versea, M.Cabriel, D.Richet, total MBF, a strategic stage towards the TPM, French Review of industrial management, flight 18, N2, Paris 1999.

[10]. J.P.Mouse, methods and tools of maintenance, to make reliable at lower cost, N519 maintenance, April 1999.