Title: A SYSTEM AND A METHOD FOR TRACKING PLANT-WIDE FAULT

Abstract: The invention provides a system for tracking faults in a plant. The system of the invention comprises detection means for detecting the faults in the plant. The detection is done continuously over a period of time suitably through corresponding measurements of the parameters of the process and of the fault related thereto. The system also comprises computation means for calculating at least one Key Performance Index (KPI). The KPI that has been calculated is traceable over the period of time and in relation to the faults. Decision support means is provided to support and/or perform diagnosis based on the at least one KPI to reduce or eliminate the faults from the plant. The invention also provides a method for tracking the faults in a plant by a system of the invention.
A SYSTEM AND A METHOD FOR TRACKING PLANT-WIDE FAULT

FIELD OF THE INVENTION

The invention relates to faults in a process plant, and more particularly to a system and a method for tracking plant-wide faults in a process plant.

BACKGROUND

Generally, process plants experience disturbances emanating due to the faults occurring during the process. Such disturbances could be intermittent, progressive, continuous or persistent. The faults in relation to causing disturbances include nonlinearities in valve, aggressive tuning, faults in sensors etc.

Currently, there exist different techniques like Plant-wide disturbance analysis (PDA) to detect faults in the plant, and these techniques / applications detect faults in the plant at a particular instance of time. It can be understood that appropriate remedial measures can be determined only after giving due consideration to all or most of the information relating to the faults. Presently, in the existing approach, certain critical information such as propagation of the fault, entry of new faults, nature of the fault (whether transient or persistent), etc., are not made available, which renders the detection of fault and determining remedial measure therefor unreliable and inaccurate.

Hence there is a need for an invention that provides a solution that detects the faults more accurately and that could be better employed for monitoring control performance and thereby provide appropriate remedial measures for improving the performance.

OBJECTS OF THE INVENTION

It is an object of the invention to provide a system for tracking faults in a plant, continuously over a period of time.

It is another object of the invention to provide a system for tracking faults in a plant more reliably and accurately.
It is yet another object of the invention to provide a system for tracking faults where the propagation of the fault, entry of new faults, nature of the fault (whether transient or persistent) can be determined.

Further object of the invention is to provide a method for tracking faults in a plant by a system of the invention.

SUMMARY OF THE INVENTION

Accordingly the present invention relates to a system for tracking faults in a plant. The system of the invention comprises detection means for detecting the faults in the plant. The detection is done continuously over a period of time suitably through corresponding measurements of the parameters of the process and of the fault related thereto. The system also comprises computation means for calculating at least one Key Performance Index (KPI). The KPI that is calculated is traceable over the period of time and in relation to the faults. Decision support means is provided to support and / or perform diagnosis based on the at least one KPI to reduce or eliminate the faults from the plant.

Accordingly the present invention also relates to a method for tracking the faults in a plant by a system in accordance with the invention. The method of the invention comprises the steps of detecting the faults in the plant continuously over a period of time suitably through corresponding measurements, and calculating at least one Key Performance Index (KPI). The KPI is traceable over a period of time and in relation to the faults. The method also includes providing support and / or performing diagnosis based on the at least one KPI to reduce or eliminate the faults from the plant.

BRIEF DESCRIPTION OF THE DRAWINGS:

With reference to the accompanying drawings in which:

Fig. 1 shows a system for tracking faults in a plant, in accordance with the invention; and
Fig. 2 shows a system for tracking faults in a plant, in accordance with an exemplary embodiment of the invention.

**DETAILED DESCRIPTION**

For better understanding the invention is further described with reference to non-exhaustive exemplary embodiments as shown in Figs. 1 and 2.

Fig. 1 illustrates the system (100) for tracking faults in a plant. The system (100) involves a plant (101) that encounters faults (say A, B, C and D). The parameters of the process of the plant (101) are measured by suitable measuring means. The faults in the plant are detected by a detection means (102). These fault measurements are represented by the references XI to Xn. The measuring means referred herein before include tools or applications like Plant wide Disturbance Analysis (PDA). PDA may be employed to detect the presence of oscillation clusters, and the measurements regarding the same are determined at a given instance of time.

A computation means (103) is provided for calculating Key Performance Index (KPI) in respect of the detected faults. KPIs are calculated in a manner that can be tracked over a period of time. This enables the system to clearly identify the control loops that are affected by the detected faults, propagation of the fault to other control loops, appearance or occurrence of any new faults, characteristic nature of the fault (whether transient or persistent), etc, and can become part of classifying the said faults partly or holistically. This becomes viable with the tracking of the fault over a period of time, in accordance with the invention.

A decision support means (104) is provided to support and / or perform diagnosis based on the KPI(s) to reduce or eliminate the faults from the plant. This refers to working towards reducing or eliminating the faults from the plant. In the course of providing support and / or performing diagnosis, one or more of classifying the said faults, prioritizing the said faults, reducing or eliminating the said faults or the like, are involved. This aids in appropriate and effective tracking of the faults in the plant and of reducing or eliminating the faults thereof.
In Fig. 2, the system (200) of the invention is shown with reference to an exemplary embodiment, in accordance with the invention. Here, the plant (201) encounters the faults, and the faults are detected by the detection means (202). The faults herein, for the purpose of this exemplary embodiment are associated with the oscillations and of the disturbances. Accordingly, the detection means (202) detects the oscillations (202a) and clusters the oscillations (202b). Also, the detection means (202) as a Spectral Principal Component Analysis (SPCA) unit (202a') that receives the operating data from the plant (200) and reduces the dimensionality through singular value decomposition technique or the like. The results are then used for clustering the loops with similar spectral disturbance signatures obtained by SPCA clustering.

The computation means (203) calculates the KPIs in respect of the oscillations (203a) and of the disturbances (203a'). These KPIs are traceable over a period of time in respect of the faults. The KPIs from the previous time periods for corresponding previous or past clusters are obtained from the storage unit (204) and serves as an additional input that enables to establish the changes in the numbers / characteristics of the current or present clusters as against the previous or past clusters or vice versa. The KPIs so calculated are traced over a period of time or over different periods of time, by the KPI tracing unit (205). These KPIs being tracked are further used by the decision support means (206) to support or perform diagnosis to reduce or eliminate the fault from the system.

The KPI as described above herein, for oscillation cluster, may be exemplarily calculated through statistical method as follows:

\[
KPI = \frac{\text{abs}(P_i - P_j)}{\max(D_i, D_j)}
\]

Where

\(P_i\) is the mean oscillation period of cluster \(i\);
\(P_j\) is the mean oscillation period of cluster \(j\);
\(D_i\) is the standard deviation of oscillation periods of cluster \(i\); and
\(D_j\) is the standard deviation of oscillation periods of cluster \(j\).
Here, the cluster i and cluster j have the same cluster identity if the KPI < 1.

Similarly, for disturbance cluster, the KPIs are tracked by carrying out SPCA analysis on the plant dataset containing data from the loops for which the clusters are being compared.

The invention is further extensible coextensively to monitoring and of tracking the faults through the progression of diagnosis of the faults in the plants. This serves as a tracking of the faults and its effect during the process of reducing or eliminating such faults.

Only certain features of the invention have been specifically illustrated and described herein, and many modifications and changes will occur to those skilled in the art. The invention is not restricted by the preferred embodiment described herein in the description. It is to be noted that the invention is explained by way of exemplary embodiment and is neither exhaustive nor limiting. Certain aspects of the invention that have not been elaborated herein in the description are well understood by one skilled in the art. Also, the terms relating to singular form used herein in the description also include its plurality and vice versa, wherever applicable. Any relevant modification or variation, which is not described specifically in the specification are in fact to be construed of being well within the scope of the invention. The appended claims are intended to cover all such modifications and changes which fall within the spirit of the invention.

Thus, it will be appreciated by those skilled in the art that the present invention can be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The presently disclosed embodiments are therefore considered in all respects to be illustrative and not restricted. The scope of the invention is indicated by the appended claims rather than the foregoing description and all changes that come within the meaning and range and equivalence thereof are intended to be embraced therein.
WE CLAIM:

1. A system for tracking faults in a plant, the said system comprising:
   detection means for detecting the faults in the said plant continuously over a period of time
   suitably through corresponding measurements thereof; wherein the said system comprises
   computation means for calculating at least one Key Performance Index (KPI), the said KPI being
   traceable over the said period of time and in relation to the said faults; and
   decision support means for providing support and / or perform diagnosis based on the said at
   least one KPI.

2. The system as claimed in claim 1, further comprising measurement means to measure at
   least one parameter in the plant in relation to the process thereof.

3. The system as claimed in claim 1, wherein the said decision support means is provided
   for performing one or more of classifying the said faults, prioritizing the said faults, reducing or
   eliminating the said faults or the like.

4. A method for tracking the faults in a plant by a system as claimed in any one of the
   preceding claims, the said method comprising:
   detecting the said faults in the said plant continuously over a period of time suitably through
   corresponding measurements thereof;
   calculating at least one Key Performance Index (KPI), the said KPI being traceable over the said
   period of time and in relation to the said faults ; and
   providing support and / or performing diagnosis based on the said at least one KPI to reduce or
   eliminate the said faults from the said plant.

5. The method as claimed in clam 4, further comprising measuring at least one parameter of
   the process of the said plant, and of the relating fault thereof, suitably by a measuring means.

6. The method as claimed in claim 4, further comprising monitoring the said faults and of its
   characteristics through the corresponding said KPIs.
7. The method as claimed in claim 4, wherein providing support and/or performing diagnosis include one or more of classifying the said faults, prioritizing the said faults, reducing or eliminating the said faults or the like.

8. The method as claimed in claim 4 or 7, further comprising monitoring the said diagnosis and of the corresponding progression thereof, and/or performing further diagnosis therefor.

9. The method as claimed in any one of the claims 4 to 8, wherein the said fault is intermittent or continuous or progressive or persistent or propagative or localizable or of suitable combination thereof.

10. The method as claimed in claim 4, wherein the said KPI(s) for oscillation or disturbance or the like are calculated continuously over a period of time through statistical method.
Fig. 1
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. G05B19/418... P.B. 5818 Patentlaan 2
N L - 2280 H V Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016 B a i s o Poy, Alex

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
G05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of Box C.  [X] See patent family annex.

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Date of the actual completion of the international search  11 November 2013
Date of mailing of the international search report  18/11/2013

Name and mailing address of the ISA/
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Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer  Barri Poy, Alex
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