METRIC BASED PERFORMANCE MONITORING METHOD AND SYSTEM

FIELD

The present invention relates to performance monitoring systems, and particularly systems designed for use in process plants.

BACKGROUND OF THE INVENTION

Process plants such as chemical and petrochemical plants comprise hundreds of thousands of interrelated components ranging from individual devices, such as control valves, to complex plant equipment such as multi-stage compressors and heat exchangers, for example. Each of these components must operate continuously in a safe, efficient and effective mode in order for the entire plant to operate within predetermined levels of safety, quality and production.

Accordingly, hundreds of such devices, loops and equipment are required to effectively control the plant, and in turn, these assets must be constantly monitored for their optimal operations.

Countless prior art performance monitoring systems have been devised as attempted solutions, but all have had serious shortcomings and/or created problems themselves. For example, those based only on Key Performance Indicators (KPIs) do not produce an integrated presentation of the necessary information since they concentrate only on the process control loop level. Similarly, other systems focus on higher, supervising levels, but only by measuring against past performance and projected targets. These systems are not seamlessly integrated into the operation and maintenance layers, as does the present invention whereby an integrated and comprehensive view is provided of the total plant performance at the device level, control loop level and equipment level.

Moreover, while there have been prior loop and device performance monitoring systems, such prior systems have required highly skilled operators to interpret the results,

and the results do not directly tie to the KPIs currently in use as does the system of the present invention. Other prior attempts have suffered from converting data overload problems for the operators into information overload problems, whereas the system of the present invention normalizes the complex results into only 3 states such as, for example, "Excellent", "Good/Deteriorating" and "Bad". Further, these can be colour coded so that highly skilled operators are not required, and errors of interpretation are avoided.

By way of example, a typical scenario is illustrated in Fig. 1 wherein a production run is started at 40 and the production 42 continues, while quality checks 44 are performed, until the product is detected to be offspec as indicated at 46. The operator then begins a trouble shooting program 48 in an effort to determine the cause of the problem. As illustrated by way of example, the problem may involve the PID (Proportional - Integrated – Derivative) tuning 50, or the APC (Advanced Process Control) 52 may have become inactive, or a breakdown 52 may have occurred. Only after this determination is made can the problem be corrected, which may involve unacceptable downtime and/or loss of product before production may be resumed.

Contrary to this conventional approach, the performance monitoring control system of the present invention compares all of the sensed conditions, at three different levels as will be more fully explained hereinafter, and produces an integrated, overall and deterministic presentation to the operators. In addition, the complete presentation may be broken down into information segments of particular concern to different classes of plant personnel such as, for example, maintenance, operations, and management.

Other problems of prior art systems include such disadvantages as being limited to the diagnostics of the component supplier, or discounting the current health of the existing equipment and relying only on periodic maintenance, or an over reliance on RBI (Risk – Based Inspection) and RCM (Reliability Centered Maintenance) analysis rather than immediate identification a problem or potential problem before it occurs. These and other problems of prior art systems are solved by the present invention, along with

providing other substantial advantages as will become clear from the following description of one preferred embodiment of the present invention.

SUMMARY

The present invention comprises a system and method for monitoring the performance of a plant including performing diagnostics at more than one level of the plant, converting results of the diagnostics into KPIs, comparing the KPIs against predetermined benchmarks and providing integrated information as to the acceptability level of the plants' performance.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a flow diagram illustrating a typical prior art system;

Fig. 2 is a block diagram illustrating the system of the present invention;

Figs. 3-5 are illustrative examples of the displays of information which may be provided by the present invention to different types of personnel involved in the plant operation;

Fig. 6 is a flow diagram illustrating the metric based performance monitoring system of the present invention in further detail; and

Fig. 7 is a flow diagram illustrating the metric based performance monitoring system in a bottom up mode.

DETAILED DESCRIPTION

Referring to Fig. 2, diagnostics are performed at plant level 10, loop level 12 and device level 14 by diagnostic means 15. For example, at the device level, factors such as the device healthiness, device and process interface, and the deviation between design condition and actual process conditions are formulated in diagnostic step 16, and

algorithms for the diagnostics are derived for example, from a combination of the equipment suppliers specifications and end users experience. At the loop level, various factors which influence quality and quantity of production are diagnosed in step 18. At the plant or equipment level, methods such as Overall Equipments Effectiveness (OEE) or other known methods are modelled in step 20 to monitor production downtime as a factor of asset performance, production quality or turnaround.

The diagnostic results 22, 24 and 26 of each of the three levels are converted by a converting means 27 into respective KPIs 28. The KPIs 28 are then transmitted to comparator 30 which compares them against predetermined benchmarks 32. Those performing at or above the benchmarks are then identified as "good performers" versus those below as "underperformers". The performance levels of the former are then transmitted through feedback loop 34 to become the revised, current benchmarks for future comparison with newly sensed and analyzed outputs from the three levels.

In addition to determining the problem; i.e. the underperformer(s), the performance levels of all of the other devices, loops and equipments are continuously determined and displayed for monitoring by the operators, and other personnel. For example, data such as quality and production rate may be segregated and displayed to personnel such as management and on-line operators, while the operators may also see other operating data such as that at the device and loop level. Figs. 3, 4 and 5 further illustrate this important feature as the segregated data may be displayed and viewed by three or more different types of personnel such as Management, Engineering and Operators, each of which groups is interested in entirely different types of data illustrated by way of example.

A further example is shown in Fig. 6 in which a user may use the present invention to manage plant performance KPI as previously described. In this scenario, the production KPI 60 for a given day is determined to be lower than the target, or lower than that of the previous day as illustrated at 62. The user then uses the present invention to

go to the next lower level; i.e. the loop level and identifies that the APC loops are operating in manual mode with the APC inactive as shown at 64. Control valve controllability diagnostics are then used to identify that the control valve has been experiencing high deviation from the set point as shown at 66, thereby forcing it to hunt as is displayed on the interface as shown at 68. That is, the valve hunting has affected the production quality, and therefore, lowered the production KPI which has been brought to the user's attention by the present invention. The user is therefore able to identify a cause-effect relationship between the device and control loop diagnostics to take the necessary corrective actions.

Accordingly, the problem has been determined to require correction of the loop tuning, as shown at 70. The valve hunting is thus solved at 72, and the controllability 74 is improved with the APC back to active mode at 76. The production 78 is then on spec as shown at 80. The present invention is therefore capable of allowing the user to identify the area for improvement by observing a correlation between the equipment, loop and device diagnostics.

In another aspect of the present invention, as shown in Fig. 7, it will be assumed that there is a problem of inadequate air supply to one of the control valves which is displayed on the user interface at 90. The personnel also see, at the loop level, that there is a deviation in the corresponding control loop between the set point and measured value as illustrated at 92. Additionally, it is seen that there is an effect on the production quantity or quality KPI at 94, and the overall effect on the KPI of the entire plant as shown at 96. Therefore, it will be apparent that the present invention provides monitoring the plant in both a bottom up as well as the top down mode.

In the foregoing examples it will be noted that the entire sequence is performed while the production continues, whereas in the previous example of the prior art, the user is not made aware of the identity of the problem until after there has been a device or

equipment failure, after which more production time is lost in trouble shooting by trial and error.

From the foregoing description of one embodiment of the invention, it will be apparent that numerous variations will be apparent to those skilled in the art without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the foregoing description is intended to be illustrative of the principles of the invention rather than exhaustive thereof, and that the true invention is not intended to be limited thereby, nor limited in scope other than as expressly set forth in the following claims.

CLAIMS

1. A method of monitoring the performance of a plant including devices, control loops and equipment comprising:

a. performing diagnostics at a device level, control loop level and equipment level;

b. converting results of the diagnostics of each of said levels into respective KPIs;

c. comparing said KPIs with predetermined operating benchmarks for each of the said devices, control loops and equipment; and

d. determining the performance levels of each of said devices, loops and equipment.

2. The method of Claim 1 including the step of displaying said performance levels to plant personnel.

3. The method of Claim 2 including the step of displaying different performance levels to different plant personnel.

4. The method of Claim 2 including the step of colour coding said performance levels.

5. The method of Claim 2 including the step of displaying the performance level as only three levels of performance.

6. The method of Claim 5 wherein the displayed levels correspond to performance levels as being excellent, good but deteriorating or bad.

7. The method of Claim 1 including the step of drilling down from the equipment level to the device level.

8. The method of Claim 1 including the step of drilling up from the device level to the equipment level.

9. The method of Claim 1 including the step of continuing plant production while performing steps a – f.

10. A system for monitoring the performance of a plant including devices, control loops and equipment comprising:

a. a diagnostic means for performing diagnostics at a device level, control loop level and equipment level;

b. a converting means for converting results of the diagnostics of each of said levels into respective KPIs; and

c. a comparing means for comparing said KPIs with predetermined operating benchmarks for each of the said devices, control loops and equipment for determining the performance levels of each of said devices, loops and equipment.