Intelligent Tool For Maintenance of Pulp and Paper Plant ´´ON THE GO´´


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ABSTRACT

This paper presents the tool which is a compendium of systems that provide real time activefailure prevention diagnostic and also "ON THE GO "alerts on the critical aspects of paper plant operation. The alerts are available for all levels of plant operation. The tool enables the paper plant personnel to monitor critical parameters on mobile and take quick decisions to increase uptime of their valuable assets.

The paper showcases few diagnostics and calculations eg: for fan vibration monitoring in boiler, specific steam consumption report analysis and maintenance schedule alerts.

The tool addresses the major problems faced by the plant maintenance personnel namely, absence of preventive intelligence, unavailability of data wherever and whenever and alerts for preventive maintenance and schedules.

Introduction

The main objective of maintenance manager of a paper plant is to provide maximum uptime of the paper machine, thus help maintain the production rate. However there are common failures which the maintenance manager has to face daily.

Major reasons for downtime which are to be addressed by the tool are:

- Absence of predictive intelligence

  Advance alerts about critical failures in the plant can shift the maintenance strategy from "Breakdown" maintenance to "Predictive Maintenance". The concept is utilized in this tool to predict failure of few critical components.

- Unavailability of data while the user is away from machine or plant

  The plant personnel need to know the data of the essential processes,whenever and wherever he is, which may contribute to the downtime of plant, to take immediate corrective actions.. In normal case, personnel have to be physically present in front of the control system to be aware of the problem. There are many such control systems in a paper plant which makes his availability for each system difficult.

- Absence of alerts for preventive maintenance and schedules

The maintenance personnel needs alerts on availability of spares and knowledge of which machine needs to be maintained. If this data is not organized prior to planned shutdown, few issues will be skipped and get unnoticed. This is possible if feedback is not logged from the plant while it is running. There is a need to receive comprehensive maintenance data of the plant.

The tool discussed in this paper addresses above issues by providing the plant personnel alerts and live data of the critical parameters of the plant "ON THE GO", e.g.: on the mobile. Thus he can take corrective actions immediately to avert breakdown of the machine.

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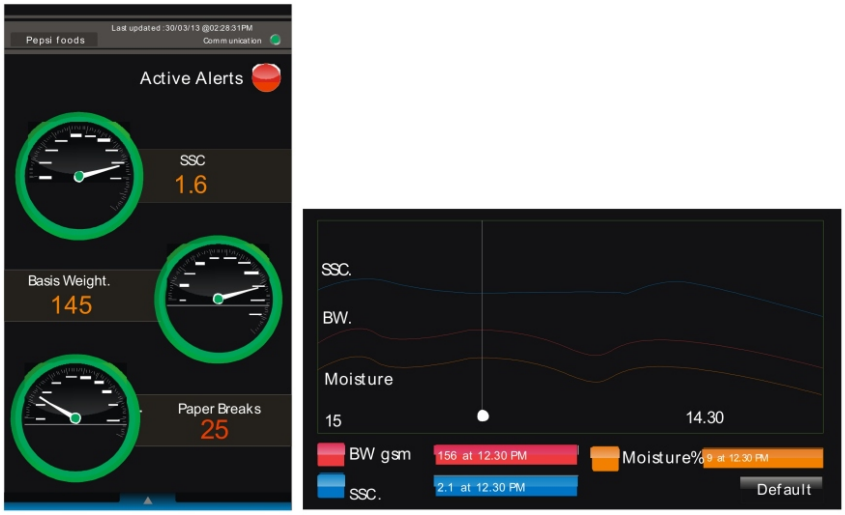
Need for the "ON THE GO" tool:

The critical parameters which need to be monitored for minimizing downtime and avoiding paper breaks are discussed below:

Excess steam pressures at different groups causes increase in specific steam consumption. The resulting over drying of paper causes paper breaks. If the differential pressures between two groups are not maintained properly, condensate flooding takes place in the dryers which causes drive load variations, resulting to paper breaks. The group pressures and condensate recovery factor thus becomes important to monitor.



The bearing temperature of the dryer increases if there is less greasing or friction resulting to unplanned downtimes. Monitoring of the temperature helps in preventive maintenance of the machine dryers.

The tool monitors usage of energy sources like electricity, water and steam as:

$$\eta_{paper\ plant} = f(\eta_{electricity}, \eta_{water}, \eta_{steam})$$

The boiler parameters such as drum level and steam pressures are monitored to avoid downtime of machine due to boiler trips. Alerts on mobile are generated when these boiler parameters crosses set limits. Similarly alerts on O2%, SPM levels and BOD in effluent which are critical for environmental safety are monitored.

Vibrations of fans and motors used in dryers and boilers (FD & ID) are monitored to predict failures.

The list of machinery which needs maintenance as per schedule has to be available during preventive maintenance or planned downtime. Similarly the alert of unavailable critical spares helps to reduce downtime.

The tool helps the maintenance personnel to monitor these critical parameters "ON THE GO".

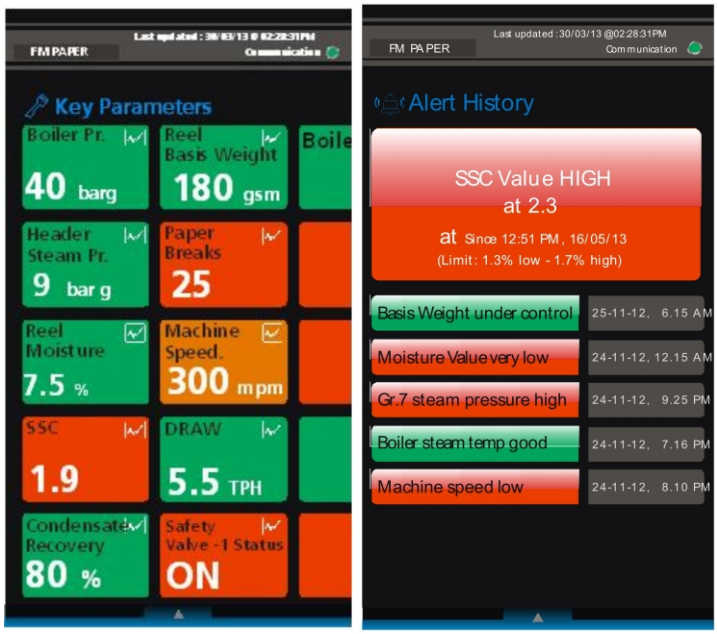


Figure 1 Screens Of Mobile Application

Results and Discussions

Few conceptual screens available to the maintenance and other management personnel in the plant are shown in Fig 1.

A. Fan Vibration Monitoring

Solid fired boilers typically have FD fan and ID fan. Fans are either mono-block (i.e. motor and fan on same shaft) or dual block (i.e. motor drives the fan through belt-pulley).

Performance of Fans = F{Vi, Phi, Sp, Pw}

Where Vi = Vibration level Sp = Speed in RPM
Phi = Phase imbalance Pw = Power Consumption

Fans can be monitored for vibration level, phase imbalance, RPM and power consumption. Also, it will be using O2 level, Steam load and Stack outlet temperature of the boiler for arriving at diagnosis. The standard ISO 10816- 3 is used for motors (driver) and ANSI/AMCA 204-05 for fans (driven). The standards define the vibration velocity limits for new machine condition, running condition and alarm conditions which forms the Green, Amber and Red zones respectively.

Parameters to be monitored for predicting failure of fans are steam load in kg/hr, O2 level in %, Vibrations level in mm/s, fan speed in rpm, current flow in amps and furnace pressure in mm WC.

The graph as shown in Figure 2is drawn between vibration and time for various rpm (±5 rpm). The graph is used to determine the health zone that the vibration level is currently in and also to develop the trend line so as to predict the time left for servicing.

Diagnosis displays resulting from the graph that is available for maintenance are:

- **Health Level**

The health level is 70% in amber green boundary, 40% in amber red boundary and so on. The latest point in the graph for a particular RPM represents the zone the vibration is in for the respective RPM. Among the various rpm recorded, the system shall display the poorest health level.

- **Time left for servicing**

Using the latest four points, the trend curve is generated by using both the exponential and polynomial equations defined by,

Exponential equation, $y = a \exp(b*x)$
Polynomial equation, $y = ix3 + jx2 + kx + l$

where, y vibration, mm/sec and x is time, hours or days

This trend line gives the time left for servicing at that particular RPM. The conservative (least) time left is displayed as the time left for servicing.

- **Furnace Pressure Fluctuation**

The furnace pressure is defined as fluctuating if the pressure varies more than 'u' mm WC from the average in a span of 'v' seconds for 'c' consecutive cycles.

- **Phase Imbalance**

The current through three phases cannot vary by more

	Specific Steam Consumption HIGH:	
	Possible reasons (Following alerts will be shown if parameter is out of limits)	
1	Excessive Venting of Steam	
	a	Check DPCVs Openings
	b	Low Motive Pressure of TC (Group No.)
	c	Check Level of Condensate Tank LIC PV (Group No. (X))
2	Dryer surface temperature	
		Dryer No (X) Ideal
		Dryer No (X) Actual
3	Drive Load Current	
		Drive Load No. 1 Ideal
		Drive Load No. 1 Actual
4	Paper Break	
	a	Number of Paper Breaks high: (Value)
	b	Duration of Paper Breaks high: (Value)
5	Control System Malfunctioning	
		Group No. (X)
	a	Set points not correct
	b	PID values not correct
	c	Pressure Transmitters malfunctioning
6	Check working Control Valve	

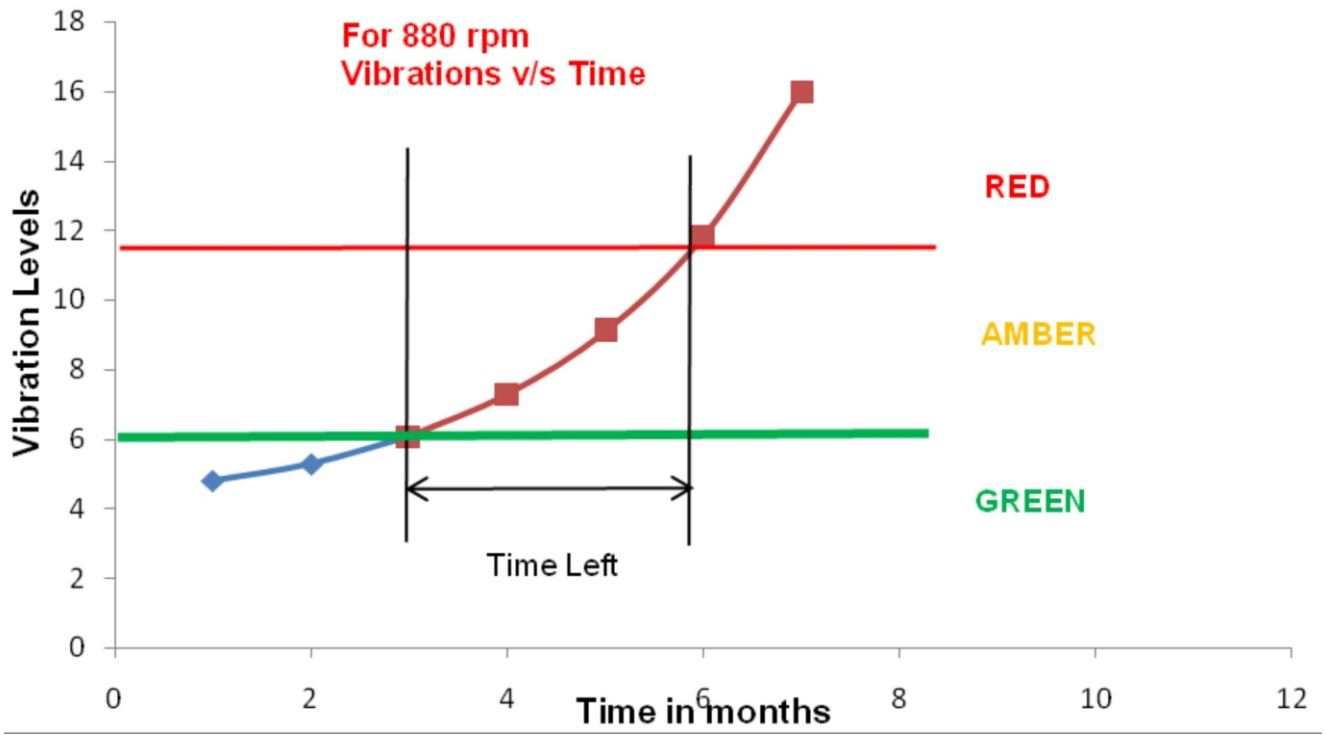


Figure 2 Graph of Fan Vibration monitoring

than 'r' (variable) percentage among themselves. If it happens then there is phase imbalance.

B. Plant Parameter Reports.

It is observed that the management receives the overall plant report every day in the morning. This report includes production, energy and safety parameters. There are many issues which are overlooked by the plant operators in the report. Hence, there is a time lag of 8-24 hours to take corrective action. However with this tool, trends, values and diagnostics are available "ON THE GO" with the management to take or initiate corrective action immediately in consultation with the respective division as and when required, thus reducing the time lag.

For example, it is observed that Specific Steam Consumption (SSC) is high even though the production target is achieved. The excess use of steam energy may be overlooked by the plant operator which is highlighted in the daily report. Corrective actions can be initiated when the online data and diagnostics are provided.

Production Tons/day (TPD) = 200
Cost of Finished Paper Rs/ ton (Pfp) = 20000
Fiber cost Rs/ ton (Pfb) = 10000 Draw (Tons/hr) Dr = 8
Steam flow rate Tons/hr (Fp1) = 14
SSC = Tons of steam / Tons of Paper = 14/8 = 1.68

Increase in flow rate by 10 % due to not attending or maintaining the pressure parameters (Fp2)

= (14 x (10/100)) + 14
= 15.4
Increase in SSC = 15.4 / 8 = 1.848
Cost of Steam in Rs/Ton = 1200

Loss due to increase in steam flow rate = ((Fp2 - Fp1) x 24) x 1200 = Rs.40320

Thus "ON THE GO" awareness of the SSC is essential to maintain the flow rate of the costly parameter like steam.
To analyze and trouble shoot the problem the following diagnostics are displayed to the maintenance and the production personnel using this tool.

C. Maintenance schedule alerts

The concept is to develop a comprehensive schedule that gives alerts to the maintenance personnel. He does not have to remember the schedule prior to planned downtime. Few parameters of the schedule are discussed below:

The most important scheduled work of a maintenance manager is that of changing the felt. It has a defined period and that has to be reminded on time. Lubrications of dryer bearings and other moving parts have to be done after fixed interval. QCS maintenance like cleaning and lubrication of internal moving parts has to be done once in a quarter. Other instrumentation products used in a paper plant need yearly calibration to give accurate readings. A plant boiler needs periodic maintenance to remove scaling of tubes, interlocks check and oil and water line cleaning.

Periodic cleaning of filters that refine the pulp like the refiner, centri-

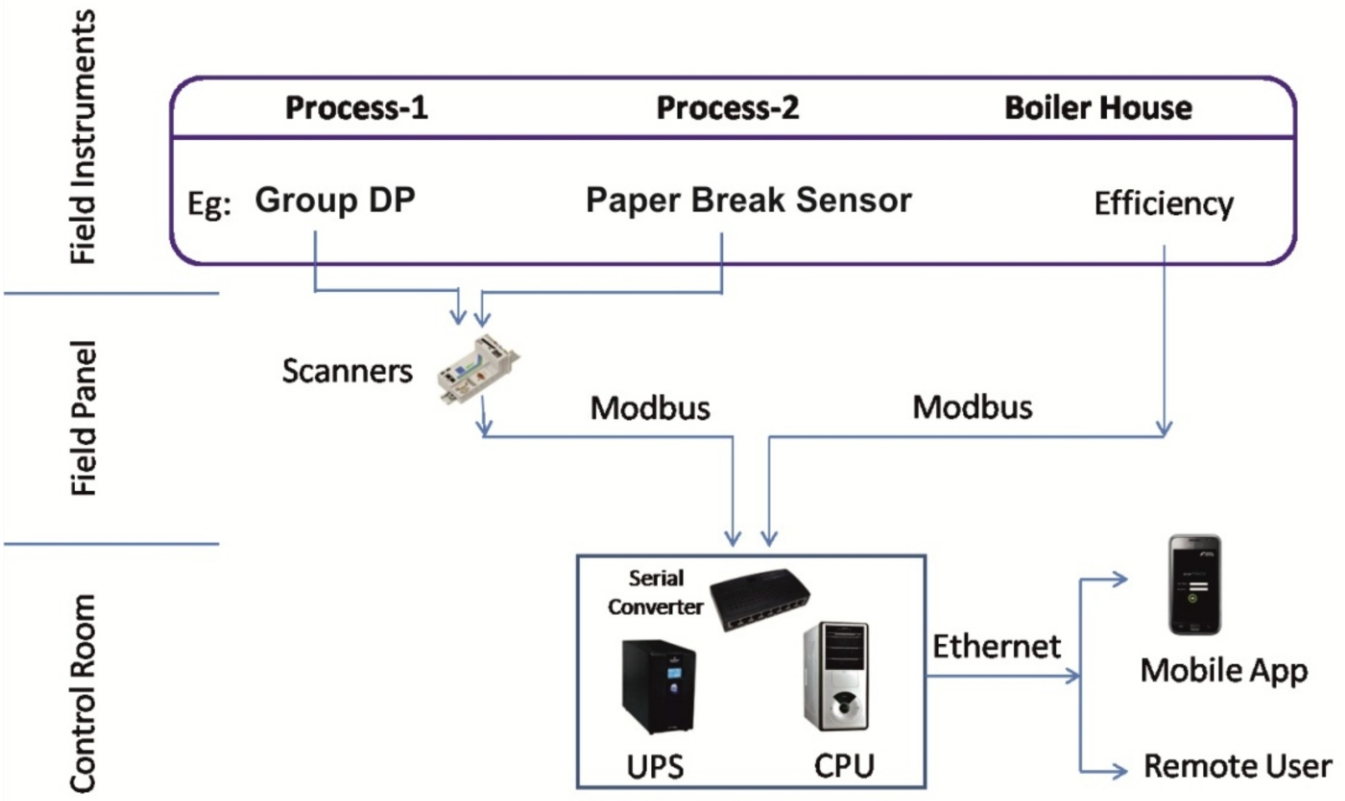


Figure 3 Device Architecture

cleaner and other air filters of hoods, moisture and oil separators are reminded by this tool in the form of mobile alerts. Tool reminds for checking of leakages of flammable gases system and environment compliances. For QCS radiations of radioactive sources have to be checked and reported to government organizations every 6 months. Lifting gears and safety devices have compliances and checks to be done each year during planned maintenance. Fire protection systems have to be checked for functionality

The tool is customized to provide these maintenance alerts as per the defined schedule.

The above discussed case studies are few of the many parameters that can be customized to monitor using this tool.

Device Architecture

The device architecture of the tool explained in this paper is shown in figure 3.

The concept has components as mentioned below.

- Remote display, Data acquisition and Computation unit: Located centrally to be used by super user or plant manager.
- Mobile Application: To receive alerts when the values cross the threshold value for quick action & optimization of the process.
- Sensors: Installed on the components in engineering room and process area.

Mobile Application tool which enables "ON THE GO" monitoring to the plant personnel, provides overall health summary, critical alerts of last 48 hours, live values of key parameters, summary of the day, trends, 'smart schedule' for maintenance scheduling and advance health alerts to predict failures.

Conclusions

The tool is a revolution in communication in the pulp and paper industry. It uses the latest technology of the electronic domain to enhance the uptime of the plant. It makes the life easy of several personnel from various domains like instrumentation, production and maintenance. The lower downtime results in avoiding monetary loss.

Essentially the plant information is always in the pocket of the maintenance manager and a click away.

References

Shire Systems Pvt. Ltd., *"Case Study Implementing Preventive Maintenance at a specialty paper mill paper"*, Best Practice Maintenance Conference, White Papers, www.shiresystems.co.uk.