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Improvement in Machine Performance with the Help of Vibration Analysis of Rotating Machine

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Abstract: ***In industries excessive vibrations in machines often results in reduced output and hence plant effectiveness is also reduced. Sometimes a simple vibration measurement with limited capability can help in reducing the impact of lost production before getting help of an expert. This is explained with the help of a case study in which the measured vibration spectrum was used to detect the unbalancing in rotor due to deposition of scale on the blades of PH fan in a rotary kiln in a cement industry.***

Keywords: PH fan, vibration analysis, balancing, cleaning.

1. Introduction

Condition monitoring of a machine helps in getting the health condition of a machine. Vibration analysis is one of the condition monitoring technique which is used to check vibration data of a part or machine for its health monitoring. This data helps in reduction or elimination of faults in critical industrial machines. Sometimes we can detect a slightest deviation of the vibration trends from the normal working condition. Thus by early detection of problem we have much time for maintenance of machine. Mostly rotating machine faults have their own different signature trends. By primary visualization of these vibration spectrums we can get the information of possible fault in the rotating machine. The proper understanding and utilization of these vibration signals can help in enhancing the overall plant effectiveness by implementation of simple first level maintenance activities. These primary steps includes cleaning, lubrication etc. which helps in improving the machine condition.

A case study presented here shows how vibration analysis can be used to detect unbalance in a PH fan in a critical cement production unit. The unbalance had caused an excessive vibration, due to which the hourly cement output was reduced by approximately 13%, over a period of about 57 days.

Upon the suspicion of unbalance in the fan impeller a visual inspection and cleaning of the fan impeller was recommended as a first aid treatment before a detailed vibration analysis and balancing could be performed by an expert. The primary diagnosis itself instantly restored the fan operation and cement output to near optimum.

2. Vibration Analysis

Vibration can be described as the mechanical oscillation about an equilibrium point. Nearly all machines emit certain amount of noise and vibration. Vibration sources in rotating machines are events that generate forces and notions during machine operations, these sources include imbalance in shaft, impacts due to bearing faults, fluctuating forces due to gear mesh etc. These vibration signals are received through sensors and plotted on graph. Vibration signals involve information about the cause of vibration and through its analysis an emerging fault can be detected.

3. Pre-heater Fan Unit

The PH fan unit is an important part in cement production process. The function of PH fan is to provide draught through the rotary kiln which is needed for fuel combustion. The PH fan works as heart of rotary kiln. This helps in production of clinker which is later mixed with gypsum to produce cement.

The performance of a cement plant is judged by the cement production which depends upon clinker production. The clinker is produced in rotary kiln which depends on performance of PH fan. There is a direct proportionality between PH fan speed, draught through the kiln and output. In other words output depends upon PH fan speed. The higher the fan speed, the higher the draught induced and the higher the raw material feed that can be burnt in the rotary kiln which is produced in the form of clinker. So the performance of the PH fan plays a great role in any cement producing industry.

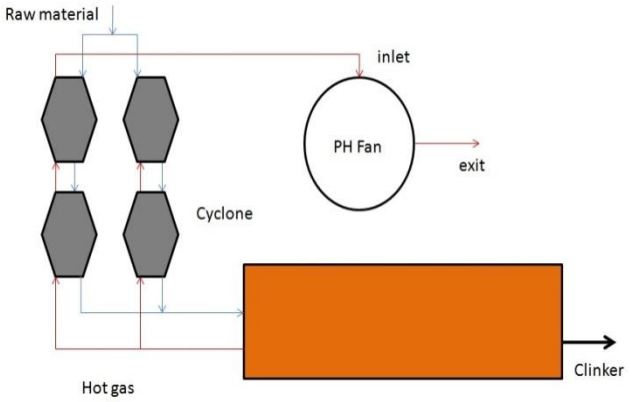

Figure 1: Schematic diagram of a rotary kiln and PH fan unit

Figure 2: Pre-heater fan

Table 1: Specifications of PH fan

Type	Exhaust fan (centrifugal fan)
Model No.	KZE 250-1400010-252*1.04(DIDW)
Impeller effective diameter	3690 mm
Fan speed	980 rpm
Fan shaft power	3069 KW
Fan capacity	793080 m^3/H
Weight of impeller with shaft	18000 kg
Fan static weight	52000 kg
Full-load torque	29492 N-m
Fan bearings	22224CC/C3/W33
Lubrication	SH 46

4. Pre-Heater Fan Vibration Problem

In normal working conditions the PH fan rotates at 910 rpm. The corresponding kiln feed rate at 910 rpm is 285 TPH. During inspection on 14 Nov 2014 the high vibration reading was recorded on the fan bearing. The fan speed had to be reduced to about 870 rpm. The corresponding kiln feed reduced to 250 TPH. This resulted in reduction of cement production and eventually overall plant effectiveness. Table-2 shows that approximately 35 TPH of clinker and about 27 TPH of cement production was lost due to reduction in the speed of PH fan over a period of 57 days (1368 hours), corresponding production loss of 47880 tons of clinker and corresponding 36936 tons of cement. This results in capital loss of Rs 147744000 over a period of 57 days.

Table 2: Production corresponding to running speed

	ID fan speed (rpm)	Kiln feed rate TPH	Clinker production TPH	Cement production TPH
Before 14/11/2014	910	285	190	212
After (14/11/2014 To 09/01/2015)	870	250	165	185

5. Vibration Measurement and Diagnosis

Vibration spectrum was measured at the PH fan and motor bearings. The vibration measurement showed a peak at the rotational speed (1×) as shown in fig 3(a). Primary analysis triggered an suspicion of unbalance in shaft. The reason behind the unbalance could be the deposition of moist limestone on PH fan impeller blades from the exit of the calciner.

Figure 2: deposition on blades

In order to reduce the further losses, an immediate visual inspection and cleaning of the fan impeller blades was recommended. Upon opening the fan casing, there was found a coating of limestone the blades. The cleaning was performed. After cleaning and restarting the fan, vibration signals were again collected (FIG 3(b)). This showed a significant drop in vibration amplitude even at higher speed.

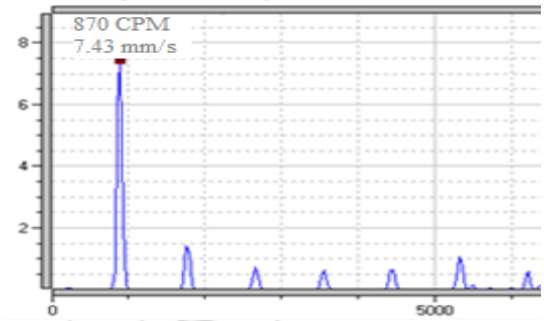

Figure 3(a): Before cleaning

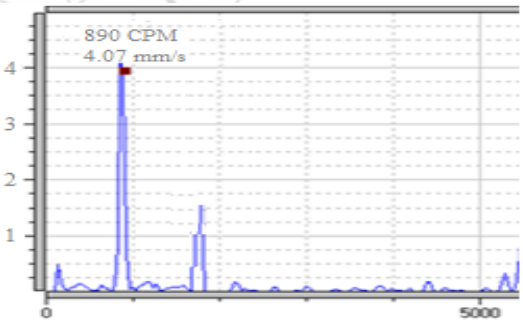

Figure 3(b): After cleaning

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The cleaning enabled the fan speed to be increased from 870 RPM to 890 RPM, which brought a gain in production of approximately 11 TPH of cement. If it would have been applied to the previous 57 days of reduced speed operation, the production loss due to less speed could have been reduced. The capital of about 60192000 could have been saved.

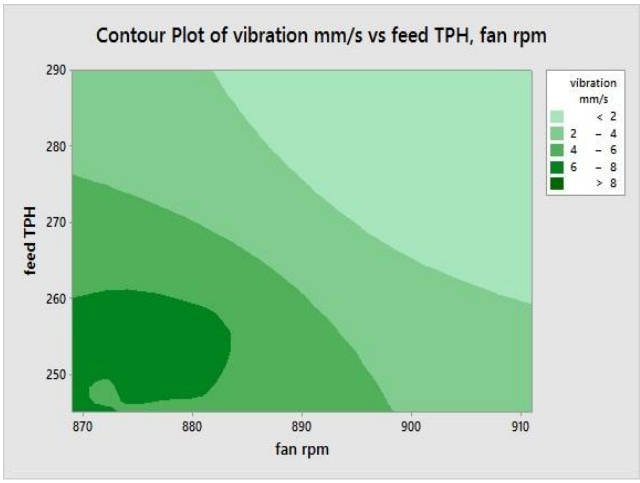

Figure 4: Relation between vibration, feed and fan speed

6. Conclusion

This case study has shows the use of simple analysis of vibration spectra to detect an PH fan unbalance. Visual inspection and then cleaning of the fan impeller was conducted, which immediately enhanced fan operation speed, and cement production rate, by approximately 11 TPH. The case study highlights the fact that the limited vibration measurement and analysis capability often available at a plant site can provide primary aid diagnosis and treatment. This can help in reducing the level of vibration and hence increase safety. The production loss can be reduced before the intervention of vibration experts. This also shows that if the cleaning of PH fan is performed regularly, the loss can be reduced. This experience encourages the belief that major benefits can be achieved through some small steps taken before a major step is taken in an industry.

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