VIBRATION BASED CONDITION MONITORING OF INDUCEDDRAUGHT FAN: SOME INTERESTING FINDINGS

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Introduction :

There are two general types of machinery monitoring using vibrations, machine diagnostics and predictive maintenance. Machine diagnostics is examining the vibration signals reaching theouter casting of machine and then determine internal condition. This is analysis of an existing problem. Predictive maintenance (PM) is letting a machine run as long as it runs smoothly. The vibration signals are periodically measured. This is a health checkup. When defects develop and the vibration signature changes, then PM raise a warning and predict the remaining running time before a breakdown occurs. [1]

During this routine machine checkup it was found that the Induced Draught fan (IDFan) vibrations are on very higher side. All the possible measures were taken to reduce these vibrations by maintenance and operation engineers. The suspected problem was found to be unbalance. The ID fan cannot be balanced in running condition and could not be withdrawn due to load sharing. Hence it was decided to run the fan with controlled loading (Scoop position) with minimum vibrations. The machine was continuously monitored as it was in dangerous zone of vibrations. One day it was found that the vibrations reached to normal, within the acceptable range. This paper illustrates the possible causes of increased vibrations and also gives the reasons why these high vibrations became normal.

Constructional Details of ID FAN

Induced draught fan (ID Fan) is the main auxiliary in boiler side of a steam power plant. It serves as the dual purpose such as to create draught inside the boiler and to carry the flue gas to atmosphere through the chimney. ID fan comes under the flue gas cycle. The flue gas cycle comprises of Boiler furnace, two ID fans, air heater, Electro-static Precipitator (ESP) and chimney.

ID fan has got prime importance as the permissive for ID fan allows the one air cycle to come in to service during light up. Otherwise during outage of one ID fan only one air cycle will be in service. (See Figure 1)

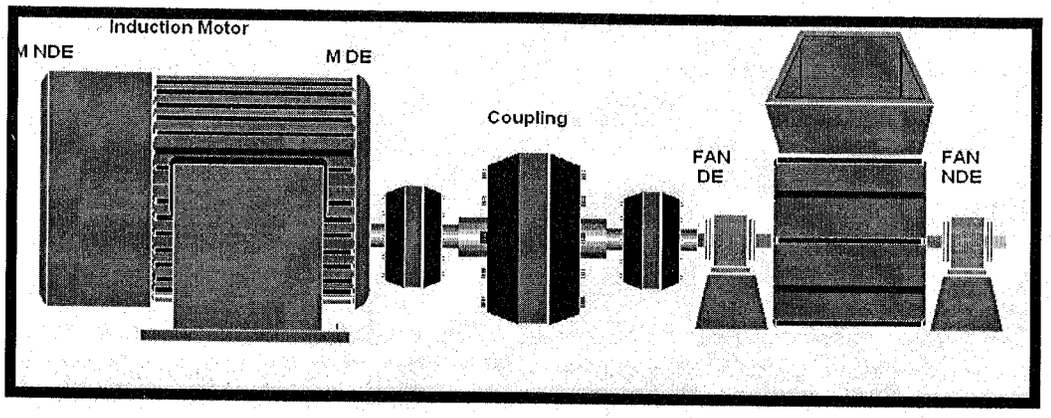


Figure 1.ID fan

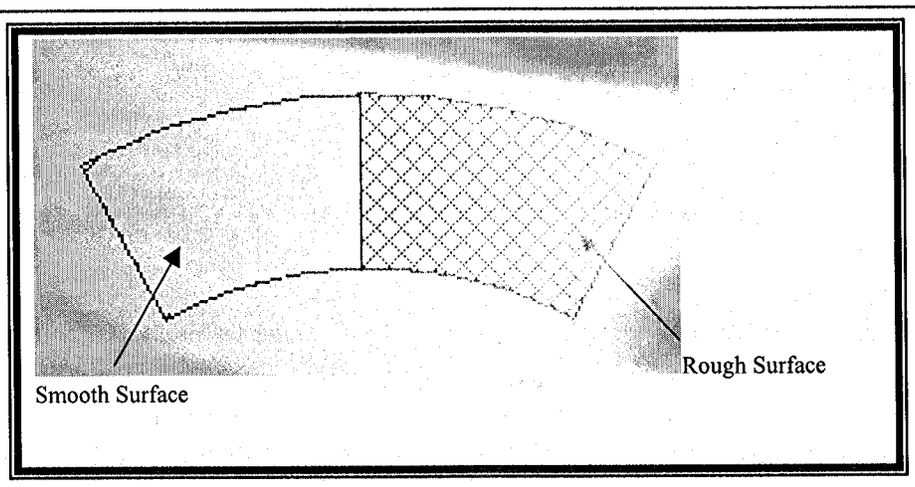
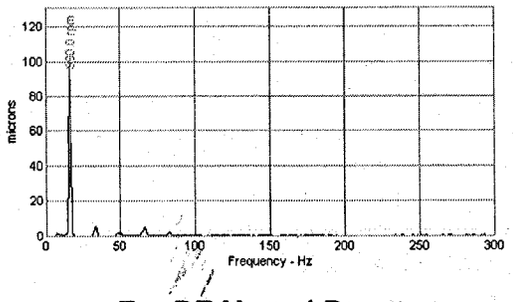


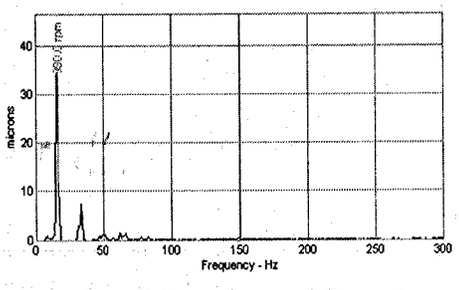
Figure 2: Blade with dual surfaces.

ID fan rotor consists of eight blades welded to the hub and end ring. Each blade forms two sections with mixed surface as shown in figure 2. One surface is extremely smooth where as adjacent is very rough. Although we are using ESP's for fly ash collection but some part of it, along with flue gas, passes through ID fan. The blade surface is much prone to erosion due to these components. Hence we cannot keep the blades with smooth surface. Therefore some part of blade is made rough and remaining as smoother.

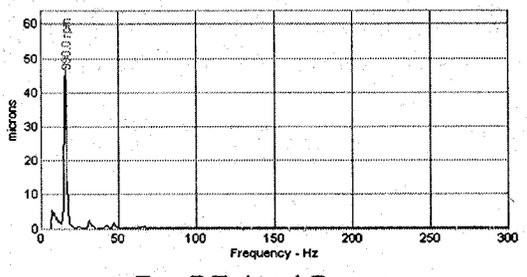
NATURE OF SIGNATURE BEFORE INCREASE IN VIBRATIONS



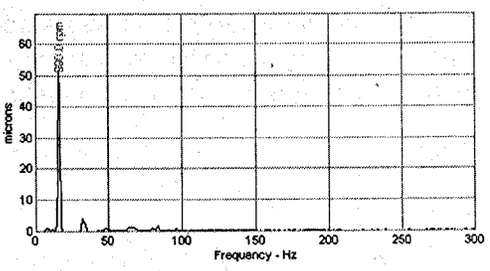
Fan DE Vertical Direction



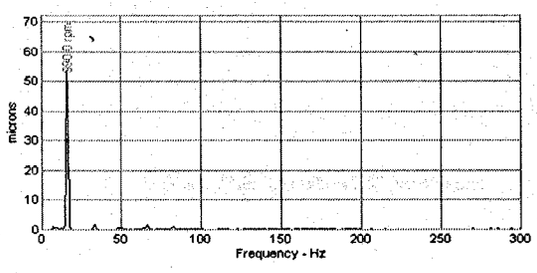
Fan DE Horizontal Direction



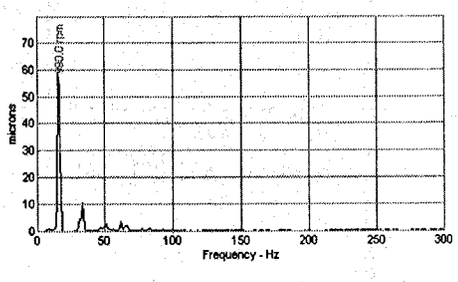
Fan DE Axial Direction



Fan NDE Vertical



Fan NDE Horizontal



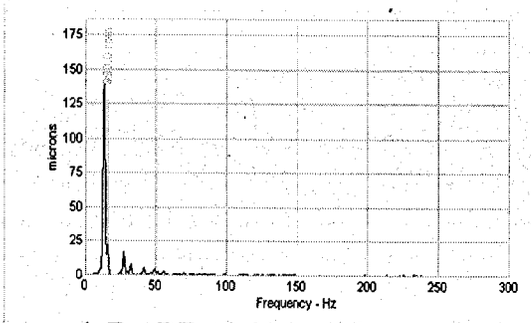
Fan NDE Axial Direction

Figure 3 Signatures of ID Fan before occurrence of high vibrations.

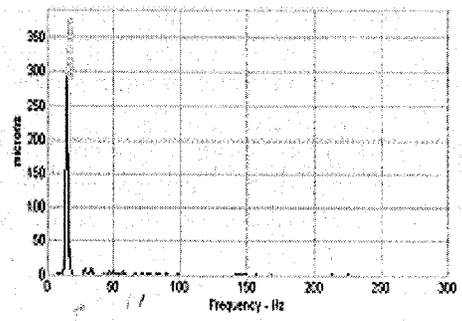
Figure 3 (a,b,c,d,e,f) are spectrums collected before the occurrence of high vibration. The spectrums show that there is 1X component predominant in radial as well as axial direction.

INCREASED VIBRATION LEVEL SIGNATURE

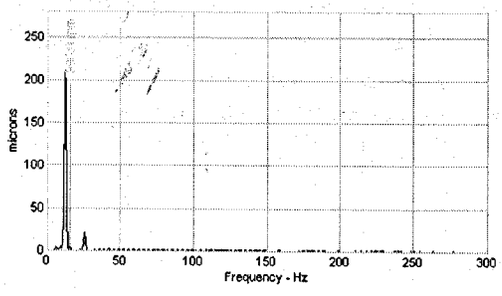
On day one (the date of increased vibrations) the vibration signature shows the 1X component as predominant at fan Driving End (DE) side as well as Non Driving End (NDE) side in radial and axial direction with increased amplitude. This indicates the unbalance at fan [1,2] along with some misalignment. The next reading taken after 45 days shows the high amplitude 1X peak with 215 microns amplitude in radial direction. Also in the axial direction this 1X component is dominating with amplitude 210 microns. It was not feasible to run the fan in such conditions. Previously it was found that by reducing the scoop (Loading of Fan), the high vibrations were reduced. Hence it was decided to reduce the scoop gradually and monitor the vibrations accordingly. Hence by gradually reducing the scoop position it was found that the fan vibrations were under acceptable zone at 55 % scoop position. Table 1 shows the vibration at different scoop positions on DE and NDE side of fan. (H-Horizontal, V - Vertical, A - Axial). The vibration spectrums having maximum vibrations are given in figure 4.



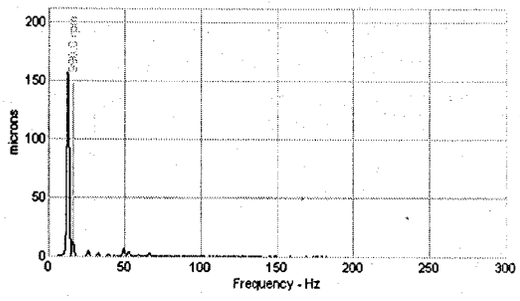
Spectrum1. Fan DE side Vertical direction



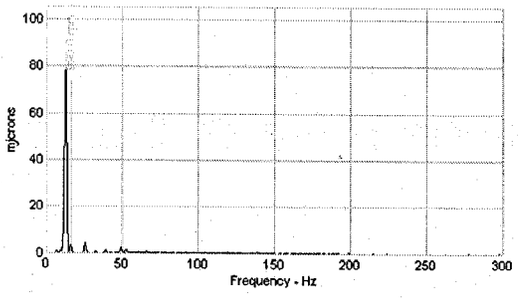
Spectrum 2. Fan DE side Horizontal direction



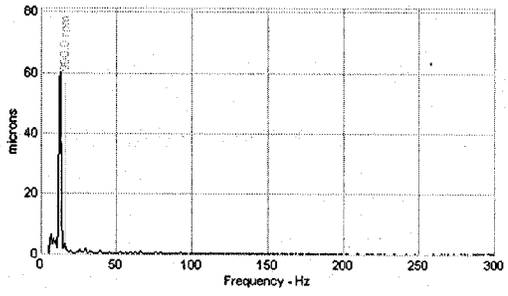
Spectrum3. Fan DE side Axial direction



Spectrum 4. Fan NDE side Horizontal direction



Spectrum5. Fan DE side Vertical direction



Spectrum6. Fan NDE side Axial direction

Figure 4: Vibration spectrums at maximum level

Table 1. The vibration at different Scoop positions on DE and NDE side of fan.

Scoop Position	80%	70%	65%	60%	55%
DE H (μ)	212	152	104	100	86
DE V (μ)	103	77	67	65	56
DE A (μ)	118	161	114	98	83
NDE H (μ)	120	73	48	44	35
NDE V (μ)	57	37	26	23	19
NDE A (μ)	56	39	28	27	24

Looking at available spectrums, it can be pinpointed that only 1X component is predominant in radial as well as in axial direction. The high unbalance leads to increase in axial vibrations. Hence we concentrated only on unbalance.

The only solution to reduce these high vibrations was to carry out balancing of fan rotor. This leads to outage of auxiliary. As discussed earlier, outage of one ID fan cut one air cycle from service and we have to run the set on half load. By maintaining the scoop at 50% and keeping fan out of biasing, we ran the fan until next opportunity came for balancing. This fan was under continuous supervision as it was operated in the dangerous zone of vibrations.

One day it was found that vibrations are absolutely normal under acceptable zone. Now this was the fact, which was observed several times before by operations engineers.

Table 2: Overall values of vibrations of fan DE and NDE side at different dates.

Days	1	97	98	119	145	155	207	218	228
Scoop	80	50	50	42	57	75	85	Balancing carried out	70
DEH	132	259	174	198	44	55	49		23
DEV	71	131	110	128	27	33	36		7
DEA	98	202	138	146	38	48	59		14
NDEH	108	181	119	133	45	81	73		33
NDEV	48	96	65	71	28	44	41		19
NDEA	54	83	56	58	27	35	35		13

OBSERVATIONS

To move the large volume of air/flue gas without compression, large chambers and passageways are required. We are provided with small passage for flue gas to chimney. This may lead to high vibrations but this may not be affecting the machine component.

Fans are running with high vibrations than any other category of machines, this may be due to their construction and function. They need periodic attention as they handle large amount of air / flue gases. Ideally they should be operated in clean environment and handle the clean air / flue gases. But practically this is not the case. They handle grease-laden air; exhaust corrosive gases, sand, ash, cement, dust etc. Under these conditions they either gain or loose material and require frequent balancing. The level of balance must be very fine because of their large diameters. As discussed earlier these high vibrations may be due to unbalance in fan. But it is an experience that the ID fan vibrations get dropped to acceptable range after some running hours of fan.

After collecting the details it was found that the set was tripped due to some reason and after taking the set into service the post light up vibrations were normal. After some days from light up, the vibrations

were observed to be high. Thus we can correlate these high vibrations with taking the set on load. In this power plant the boiler light up starts with oil support. This oil burning produces the flue gas, which is greasy in nature. These greasy fumes get stuck up on the fan blades. Then the boiler is taken with coal support. The coal dust / un- burnt particles, while passing through ID fan, gets deposited on these greasy surfaces of fan blade. As discussed earlier the half part of blade surface is rough and forms the favorable surface for dust particles to be deposited on it. This phenomenon increases the centrifugal force on rotor and increases the vibrations. The small deposition on the surface or removing small material from rotor may act as the cause of unbalance.

Another reason of this ash deposition on blade can be discussed here. At the time of light up only one air cycle comes in to service, that is only one ID fan comes in service and another is on standby mode, looking for the permissive to come in to service. At this time, the greasy fumes of flue gas gets deposited on only upper half of the stationary ID fan and dust gets stuck on only half part and create unbalance.

After achieving full load both the fans are kept on biasing. This will operate both the fans according to the loading and results in change in scoop position according to sudden load change. This sudden change in scoop position may provide some shock on rotor. These sudden shocks remove the deposited material on blade surface and thus reduce the vibrations.

CONCLUSION

The material, which was deposited on the rough surface of fan blades, is removed by sudden change in forces acting on the blades during the starting and stopping of fan, at the time of tripping of Turbo generator set, leads to reduced unbalance. This automatically solves the problem. This phenomenon is observed several times by operations engineers in past and this analysis prove it.

REFERENCE

1. Wowk Victor, 1991, Machinery Vibration - Measurement and analysis, McGraw-Hill, Inc., New York.
2. Collacott R. A., 1979, Vibration Monitoring and Diagnosis, John Wiley and Sons, New York.

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