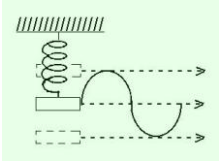

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27th Feb 2011

Att: XXXXXXX

#5 Dryer Circulating Cooling Fans

The following report is based on data collected on the 26th Feb 2011:

My initial test was to check to see if there was any possibility of resonance problems, I carried out a bump (ring) test on all of the motors and recorded the natural frequencies of each of them; the frequency did not change with or without the drive belt installed.

To avoid resonant vibration, the operating speed of the machine should not be within 10% of any natural frequency. If the motors are run at 60 Hz on the VFD; with slip, the operating rpm of these 4 pole motors would be 1775 rpm or 29.58 Hz, this would mean that the natural frequency should not be between 26.62 to 32.54 Hz. 17 out the 24 circ' fans are within this criteria and the remaining 7 fans are very close to these frequencies. This explains the high vibration levels recorded on the majority of the motors, a relatively small vibration source such as fan imbalance or belt slap is amplified through resonance.

To remove the resonance problem either the motor speed has to be changed or the motor base has to be stiffened. I inserted a hydraulic jack between the motor feet and casting that it hangs from an was able to change the natural frequency on drive motor #5 from 28.33hz to 23.75 Hz this removed the resonance vibration but increased the vibration attributed to sheave misalignment. One permanent method to stiffen the motor is to insert a piece of ready rod with a nut and washer under the bottom motor feet and tighten the nut/washer against the underside of the feet. The sheaves would then have to be re-aligned.

When checked, all of the motor belts were found to be out of spec' and 3 or 4 were misaligned, all of the sprockets on the motors are worn and should be replaced. A new belt has been installed fan #24, all of the belts set to the correct tension (37.5 Hz for new and 31.7 Hz for used), and sheaves aligned.
N.B. The recommended belt tension for used belts adds another exciting force for the resonance.

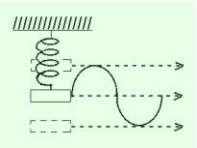
When all of the belts had been adjusted I analyzed all 24 fans and found a significant improvement in most of them, proof of how a small exciting force such as belt slap can have a huge effect on the motors because of natural resonance.

Fans #4, 12 and 18 have vibration because of unbalanced fans.

The vibration amplitudes listed in the chart below are the unfiltered levels recorded on the bottom of the motor before and after belt tensioning and alignment.
The natural resonance frequency was acquired by using a dead blow hammer to strike the motor and recording the frequency response.

Fan #	14th Feb Velocity In/Sec Peak	26th Feb Velocity In/Sec Peak	Percentage Change	Natural Frequency RPM /Hz
1	1.143	0.297	- 74 %	1652/27.53
2	0.858	0.318	- 63 %	1651/27.51
3	4.974	0.292	- 94 %	1828/30.46
4	4.539	1.125	- 75%	1910/31.83
5	1.106	0.298	- 73 %	1700/28.33
6	0.550	0.471	- 14 %	1500/25.00
7	0.314	0.415	+ 32 %	1440/24.00
8	1.007	0.428	- 57 %	163527.25
9	1.003	0.801	- 20 %	1491/24.85
10	0.428	0.378	- 12 %	1828/30.46
11	0.460	0.666	+ 45 %	1654/27.56
12	1.529	2.947	+ 93 %	1549/25.81
13	0.624	0.441	- 29 %	1910/31.83
14	0.674	0.650	- 3.5 %	1343/22.38
15	0.486	0.331	- 32 %	1580/26.33
16	0.803	0.420	- 48 %	1547/25.78
17	0.566	0.445	- 21 %	1549/25.81
18	6.18	3.715	+ 66 %	1667/27.78
19	0.530	0.385	- 27 %	1665/27.75
20	0.659	0.641	- 3 %	1667/27.78
21	0.689	0.342	- 50 %	1663/27.71
22	1.629	0.298	- 83 %	1600/26.66
23	0.680	0.285	- 58 %	1660/27.66
24	2.321	0.08	- 97 %	1575/26.25

The chart below is based on ISO Standard #10816-1:1995, the fan motors would normally fall in to the category "Class II". In my opinion it would be reasonable if we could achieve the amplitudes outlined as acceptable for a Class III machine due to the flimsy support structure.



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General Machine Vibration Condition Chart

RMS Vibration Velocity		Peak Vibration Velocity		Class I	Class II	Class III	Class IV
mm/sec	In/sec	mm/sec	In/sec				
0.28	0.011	0.395	0.015	A	A	A	A
0.45	0.017	0.636	0.025				
0.71	0.028	1.00	0.039				
1.12	0.044	1.58	0.062	B			
1.8	0.070	2.55	0.100		B		
2.8	0.110	3.96	0.155	C		B	
4.5	0.177	6.36	0.250		C		B
7.1	0.279	10.04	0.395	D		C	
11.2	0.440	15.84	0.623		D		C
18	0.708	25.45	1.00			D	
28	1.100	39.59	1.56				D
45	1.77	63.63	2.51				

A – Good, B – Acceptable, C – Monitor Closely, D - Unacceptable

Class I – Electric motors up to15 KW

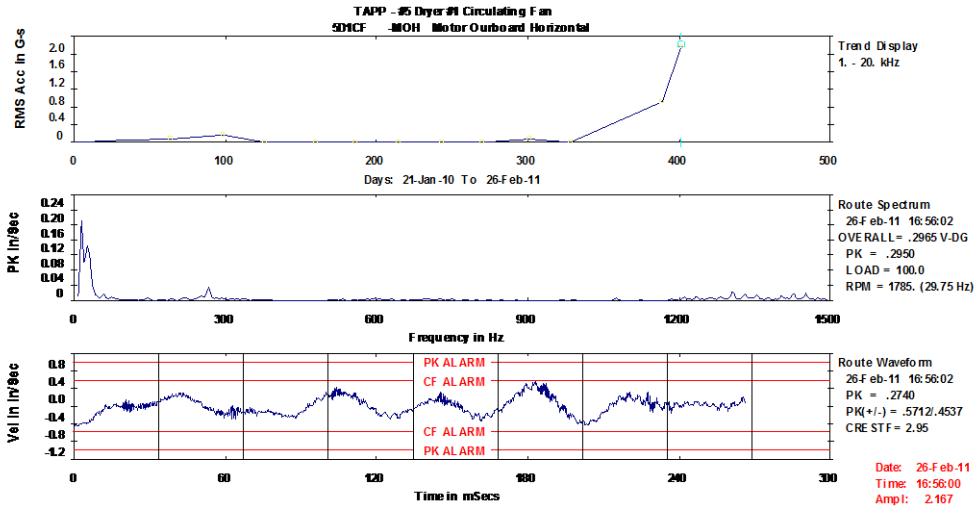
Class II – Medium sized machines (15 – 75 KW electric motors)

Class III – > 75 KW Large prime movers on heavy, rigid foundations

Class IV – > 75KW Large prime movers on relatively soft, lightweight foundations

The worn teeth shown in the photo below is typical of all of the motor sprockets:

Now that the overall amplitudes have decreased on the majority of the fans, It was possible to detect other issues i.e. the motor bearings on fan #1 are defective and the motor should be serviced, the motor bearings on fan #17 are deteriorating and as a minimum greased ASAP, if this is not possible (the bearings could be the "sealed for life" type) service the motor.



<u>Recommendations:</u>
Balance fans #4,12 & 18.
Install all new motor sheaves and belts as necessary.
Brace/stiffen the motors
Align sheaves and set belt tensions.
Service motors # 1 and # 17.

Regards: Rob
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