Visualize VISIBLE Losses in Belts & Pulleys in Your AHU AIR Handing Units.

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The critical part of the Air-conditioning / Air washer plant circuit is the final delivery that is diffused thro Supply Diffusers inside the AC premises, in terms of supplied cool air's volume, temperature, static pressure and RH. If the Supply Air is diffused only, it gives sustained heat transfer and comforts the users in AC premises for long hours. Now, the Air-conditioning, Air washer OEM and the user industry can target this area to give the above optimized parameters of their input conditioned air and this trivial exercise will give an APPRECIABLE Savings in the AHU electricity consumption. Industry, Please concentrate on your slippage from motor to blower now. The Slip between the Cup & Lip in the energy flow is there always, but in some cases we find now, the Cup is Slipped in between! And Slip is reported above 20 % when slip during installation was recorded as only 2 %, few years back.

This is happening in all of your AHU Air Handling Unit blowers in the air circuit of your Air Condition / Air washer plants. In the blower system, if your belts are Actively Gripping the pulley, then you are maximizing your Belt Transmission Efficiency. If your belts are only Passively Touching the pulley, then your belts & pulley consume More Power and Less Belt Transmission Efficiency now. The industry must visualize TODAY, the visible loss in their belts and pulleys. If you change your V belt today to Raw Edged Cogged REC belt, this transmits power without loss, compared to the V belt to deliver near the rated RPM, Revolutions per Minute and hence it gives you more circulation i.e. Air Changes. Simultaneously if you optimize the 'motor & load's pulley to suit to the same output as load RPM, then it is power saving for you. Keep in Mind "Your Belts transmit Power from Motor to Blower only by Friction." This Friction needs to be sustained and as well optimized for better grip of belts at both running ends, for energy saving.

If you want to optimize for both power- saving & comfort air-circulation, then reduce the pulley weight and optimize its drive to match to the running load, under-number the belts from say 3 no V belts to 2 no REC belts (this is subject of many factors) for the same given load. So focus on belt & pulley change TODAY (and not only the belts only as a routine change), and anticipate more Air Changes at less power consumption. Kindly Monitor and Record the 'Before & After' Power Readings for the power saving, and RPM change for increase in air circulation. This exercise will indicate you, how much you had lost in belt transmission in each machine, till date.

EXISTING VEE BELT TRANSMISSION PRACTICES:-

1. The motor is coupled to the AHU blower by V belts, either one or in multiples say 2,3 & more, to suit to the demands.
2. The V belts are designed for motor at full load rating and 7 out of 10 cases, over belting is designed.
3. The motor and blower pulley are heavy mass when designed and this adds more to Tare-load consumption of 'motor + belt + pulley' upto the load, thus increasing unproductive load on the motor power.
4. Because of overweighing-belting, the pulley sizes, belt width and the number of belts go up to increase power demand to motor.
5. Motor designer of IE 2 and above versions, are reducing the motor cooling fan size so as to reduce the no-load motor power, but Blower designer and the user increase the power demand in between by strong heavy belts and multiples of belts, matching heavy pulley at motor & load, and silently ignore the KW demand that has increased to his motor now.

Motor drive transmission efficiency :-
Visible Losses seen in Belt Losses from motor to load

Table 3.4: Losses in V Belts

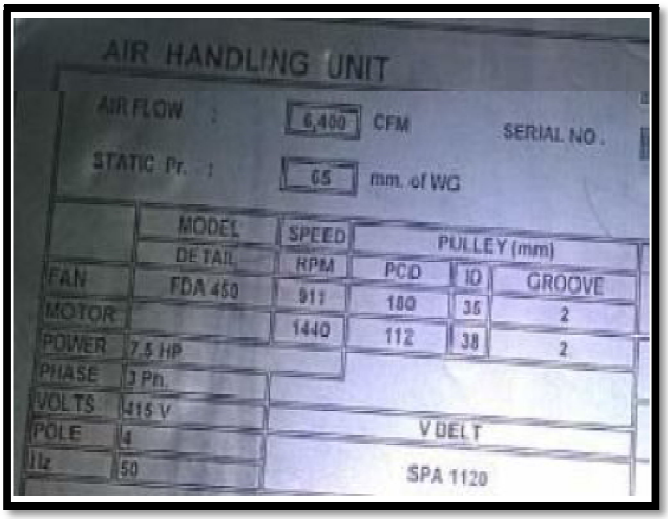
Sr. no.	Motor HP	Losses %
1	2	8-15
2	3	7-13
3	4	6-12
4	6	5.5-10
5	8	5-9
6	10	4.5-8.2
7	20	3.5-7
8	30	3.2-6
9	40	3-5.5
10	60	2.8-5
11	80	2.5-4.5
12	100	2.5-4.5

Details	V Belt drive - 4 Drives SPC	Cog belt Drive - 3 Drives - XPB	Cog Belt drive - 2 Drives - XPB
Motor HP	75	75	75
Motor KW	**55**	**55**	**55**
Motor Pulley Dia	258	245	245
Machine Pulley Dia	425	406	406
Actual RPM	890	890	888
Actual KW	**38.27**	**34.67**	**33.96**
Kw savings with Cog belt drives		3.6	4.31
Savings attained in %		**9.4**	**12.4**
Kit Investment cost		**21746**	**19500**
Expected savings /Year		**192207**	**230115**
Payback in Months		**1.4**	**1.2**

I image :- BEE Table indicating the losses happening due to V belts and its variation based on the Motor HP.
I I image:- Case study of 55 KW centrifugal blower in waste collection centrifugal blower system in a textile mill in South India.

6. Say for example, 10 HP motor losses vary from 4 to 8 %. So the Loss band is 4 to 8 % implies that the losses are there in V belts and in pulley drives as well. If loss is from belt only, say it is 4 %. If loss is due Belt +Pulley drive, say it is 8 %, this is what we inferred from our case studies. So it is not only the change from V belts to Cogged belts, but also the pulley drive needs to be optimized to the running load.
7. The blower was running with 4 V belts before, and the same is swapped with REC belts of less pulley size, but the same speed ratio. The V belts had slippage before, and now cogged belts the slippage is reduced, weight of belt and pulley is reduced to achieve 12 % power savings. Here the anticipated saving by this exercise was around 5 % belt losses as per the BEE table.
8. This is a typical case study and this power savings will be possible in this centrifugal application only. This saving varies on the load like either like centrifugal / axial flow blower, centrifugal / screw type compressors or pumps etc.
9. This saving varies depending on the nature of rotation in axial / tangential load like blower, pump, and compressor application.
10. The savings will be different for shock loading, pulsating, grinding, agitating, reciprocating working application etc.
11. The AC user industry is in the habit of allowing the belt to tear during running and then only change at the eleventh hour.
12. Instead of 4 matched belts, the user changes only one or conveniently tries to run with balance belts between machine & motor.
13. That too, since the Air-conditioning AMC is contracted out, this belt issue is considered trivial to them and silently ignored.
14. Please visit your AHU chamber today, and you will be surprised that this is most likely the neglected area in your day-day activities. Loose belts, hotter motor, and dust choked heat exchanger of the AHU.
15. This is one of the factors that contribute your IAQ, the Indoor Air Quality, in terms of air changes, air circulation & starvation.
16. Even while changing, the industry views that the belt as OTC (Over-The-Counter) commodity and buys from nearby retailer and somehow manage to run the blower, so as to get relieved of the problem for that day.

OPTIMIZE YOUR AHU BLOWER'S OUTPUT & ACHIEVE ENREGY SAVINGS:-



BLOWER NO 1			
KW	22	KW	22
RPM	1464	RPM	1464
MOTOR PULLEY DA	180	MOTOR PULLEY DA	150
MACHINE PULLEY DIA	270	MACHINE PULLEY DIA	280
ACTUAL M/C RPM(CAL)	976	ACTUAL M/C RPM	784
RPM MEASURED	771	RPM MEASURED	772
SLIPPAGE	21%	SLIPPAGE	1.50%
BELT USED	B 125	BELT PROPOSED	XPA
NO OF BELTS	3	NO OF BELTS	2

III image – Typical AHU Name plate that shows V SPA type Belt transmission and this can be replaced with XPZ .REC belts.
IV image- AHU / Air Washer parameters old belt loss un-noticed at 21 % slip, and now with REC belts Slip reduced to 1.5 % only.

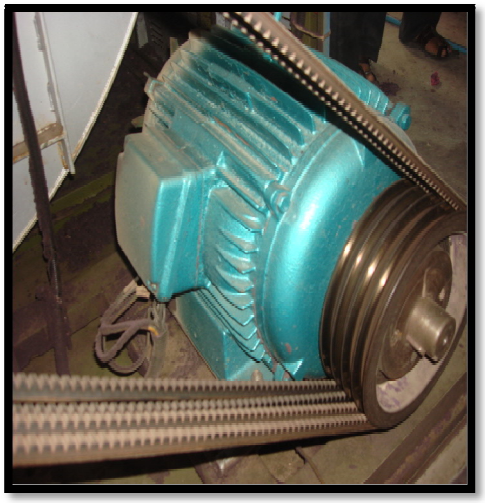
1. The above AHU name plate image shows this motor shaft output is 7.5 KW / 10 HP & blower gives 6400 CFM @ 65 mmWC.
2. Confirm with Digital Pascal Meter and Anemo meter, the blower output in CFM and Pascal when measuring the input KW.
3. Based on case to case basis, when air balancing is done for the inside premises, plan to add VFD to the existing blower to deliver only what is wanted inside i.e. in required Pascal & CFM for better heat transfer across the Heat Exchanger and as well the required CFM to maintain air balance between the Supply & Return Air volumes by way of Air Changes.
4. RPM reduction leads to Square of Static Pressure and in turn reduction in terms of Cube of KW Power consumed by blower.
5. So Optimize RPM of blower. Huge energy savings are achieved in Electrical and as well thermal related by above measures.

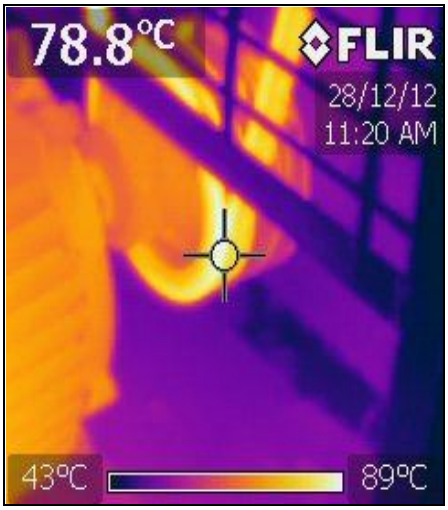
HOW TO ASSESS THE EXISTING V BELT LOSSES:-

1. Today, with your Infra red Thermal Imager, scan and screen the hundreds of belt driven motors in all your AHU.
2. Use your Non-Contact Tachometer to routinely measure your motor and blower speeds and confirm the slippage is within the limits as measured dimensions and calculated Speed Ratio Limits. Slippage happens More and Silently in these applications.
3. Right from installation and during the change of belts, Never Ever Lever the belts while putting on the belts on pulleys.
4. Take care not to elongate the belt right from commissioning and as well take action immediately once you see elongated belt.
5. You focus on the motor & Blower Drive End bearings, the motor & blower pulleys, and belts end to end.
6. Assuming the ambient cool temperature, the relative temperature increase on belt & pulley drive must not increase above 10*C above the Ambient. Any relative temperature deviation shows the nature of ab-normality in the alignment.
7. After screening, you can concentrate on the hot spots like belts & pulleys. This is apart from the bearing monitoring on motors.
8. Measure the motor & blower speeds by non-contact Tachometer, for the normal running load, the dia of motor & blower pulley, calculate the speed ratio and check for slippage losses in each belt transmission.
9. Also, measure the motor running load, its rated KW, and the motor running frequency in Hz.
10. Visually check for cracked or worn-out belts, belt tension, alignment and the pulley for heavy wear & tear.

WHY SHOUD YOU REPLACE WITH COGGED BELT & PULLEY TODAY?

1. The motor is always not running to the designed full power ratings.
2. The V belts are not used as matched set and out of say 4 belts, and say 2 out of 4 belts only actively transmit the power.
3. You have changed your motor starting from Harsh DOL, Star Delta starting to smooth VFD starting now and so now your belt & pulley also needs to under-sized to withstand only slow & soft ramp of VFD starting current.
4. Discuss about the weak transmission points happening in your V belts now with the AHU OEM.
5. The origin of In-efficiency due to over-design of belt & pulley drive transmission starts from the AHU OEM only. When designed, this REC belt was not focused before and priority towards Energy conservation was not there, previously.
6. The efficiency of the mechanical power transmission depends on grip between pulley & belt, further depends on the co-efficient of friction and tensile strength of the belt transmission.
7. This Thermal Image of belt & pulley will show how much your KW input to motor is un-wantedly heating up the belts & pulley drives. You will also find rubber burnt smell and screeching sound when blower is started and these are the signs of wear-out, happening now. This is not safe especially in AHU chamber where they don't' get user's daily attention.





V image – Cogged Belts and Drives rightly changed for this motor drive system and Energy savings achieved.
VI image shows the thermal imaging of worn-out pulley due to belt and alignment issues raises temperature to 89 *C.
VII image AHU motor Heavy belt loosely touching and not gripping the small pulley motor drive pulley.

8. We the Energy Auditors, suggested to the industry till date, to replace with cogged belts only on same pulley so as to instantly achieve energy savings by this Swap. After replacement, this reduced the transmission losses by say 3 % in terms of RPM and hence increased the power demand from load shaft.
9. The user does not analyze the overall AHU's performance and air flow improved, but blames that the power demand increased from blower and not satisfied with the exercise done, from V belts to cogged belts.

10. You the industry need to be aware that your pulley (also due to this cyclic belt movement under harsh conditions) needs to be replaced around 5 years duration, based on the loading nature and thermal imager inputs on pulley.
11. Now we always demand the industry after our energy audit, to replace belts, and optimize power in their pulley & drive.
12. Here, we have to look into the design aspects of what parameter is wanted in each machine either Pascal, RPM or parameters required for the air flow @ given static pressure from this motor & belts system.

BENEFITS OF COGGED BELTS & PULLEY OVER V BELTS:-

1. The cogged belts by design, is having 30 % power carrying capacity for the same V belt weight now.
2. The cogged belts run cooler, run say, 50 % more longer hours, and occupy less space in pulley.
3. The narrow & cogged belts operate higher speed ratios using smaller diameter pulleys.
4. Hence this needs the existing pulley to be replaced with say 20 % around, less weight pulley.
5. Kindly study the above 4 FINE POINTERS, this will catalyze you to change to cogged belt immediately, Today.
6. After thermal imaging and measuring the slippage losses, we the Energy Auditors now suggest to the user, to replace both belts & pulley from V belt to cogged belt now.
7. Citing the above factors, let us first re-size the pulley, discuss with the belt & machine OEM to achieve the same RPM or the desired RPM after reduced slip, possible now due to this cogged belt.
8. Belt swap case study on 45 KW blower motor shows motor pulley got reduced from 18 Kg to 10 Kg weight. The Blower pulley got reduced from 55 Kg to 25 Kg weight. This is how power savings space-saving and less weight in transmission yields.
9. The industry is now looking at ways and means of energy saving in their motor driven systems. You are planning to change your motors from IE 1 to IE 2 and IE 3 motors with VFD compatible versions to improve your motor efficiency levels by few percentage points. But instead of replacing the motor only, you can FIRST FOCUS TODAY on the motor as a system as 'Motor + Belt & Pulley transmission' to deliver the power, without any slip in between, upto the Blower's shaft.
10. We suggest going in for cogged belts due to the additional factors of Correction Power Rating, Speed Ratio, Belt length Correction Factor, and Arc of Contact Correction Factor. These factors aid in optimizing the pulley drive for cogged belts.
11. When you view your running Blower's belt transmission, the running belt must look STANDSTILL. This is the visual symptom of healthy power transmission from motor to blower, by belt. Actively-gripping belts will look like Standstill when Blower is running. Passively touching belts vibrate more to prompt the losses.
12. If you see wobulations in your belts, this shows the belt transmission efficiency is losing and energy losses due to slippage, mis-alignment, poor matching of belts to drive, hotter Drive-end bearings.

CONCLUSION:-

Energy Auditing involves about optimizing the Design parameters to suit to the running conditions and this is a classic case of material conservation in optimizing the 'pulley & belt change' for the same given output from the Blower shaft at the given running condition, in turn this will lead to power saving too. We the Energy Auditors have to be the focal point between the Blower OEM and the user industry, and maximize machine efficiency and this is WIN-WIN situation for All of US. Consult the Belt Specialist, Blower OEM and bring them to your ECON Table to achieve Energy Savings at one Stroke.

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The Objective:- SHARING KNOWLEDGE TO SAVE OUR ENERGY! CONSERVING OUR ENERGY IS OUR COLLECTIVE RESPONSIBILITY TODAY, FOR A BETTER TOMORROW!