FAN PERFORMANCE AND UTILIZATION OF COMPRESSED AIR IN THERMALPOWERPLANT

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***Abstract*— PA are used in thermal plants for circulation of air in the boiler furnace so boiler performance depends on PA fans so fan performance is essential in thermal power plant .leakages and gaps between the inlet cone and impeller of the fan causes decreasing fan performance. The air compression system in the thermal power plant plays important role. Generally the compressed air is used in pneumatic equipment and ash handling system for ash drained out to silo through conveyor pipes. The compressed air is very expensive but the compressed air is misused for purpose like body cleaning liquid agitation, floor cleaning, Drying, Equipment cooling other similar uses must be discouraged.**

***Index Terms*— Introduction-Fans And Blowers, Types Of Fans, Laws Of Fans & Air Compression System.**

I. INTRODUCTION

FANS AND BLOWERS

Fans and blowers are used to move gases around a boiler plant. Fans generate a pressure to move air (or gases) against a resistance cost by ducts, dampers or other components in a fan system.

Difference between Fans Blowers and Compressor

Fans, Blowers and Compressors are differentiated by method used to move the air, and by the system pressure they must operate against. The ratio of the discharged pressure over suction pressure is used for defining the fans, blower compressors.

Equipment	**Specific Ratio**	**Pressure raises (mmwg)**
Fans	Up to 1.11	1136
ts	1.11 to 1.20	1136-2066
Compressor	More than 1.20	

Fan Types

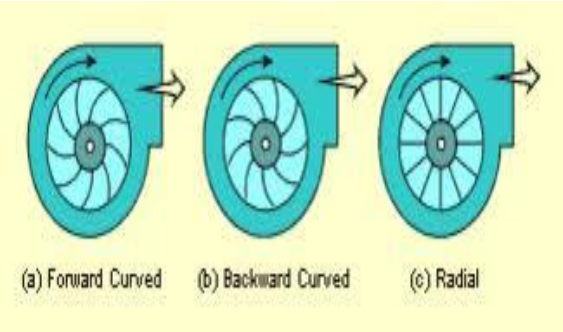
Fan and blowers selection depends on the volume flow rate, pressure, type of material handled, space limitation, and efficiency.

Fans are classified in to two types

(1) Centrifugal Flow Type fans
(2) Axial flow type fans

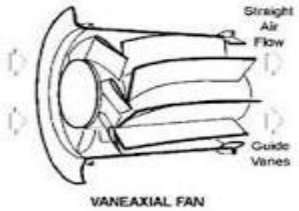
Centrifugal flow type fans

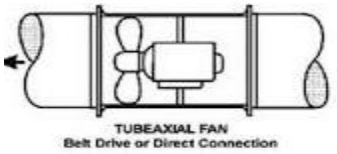
In centrifugal flow, airflow changes direction twice – once when entering and second when leaving.

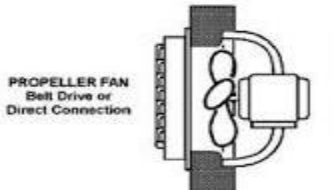


	Efficiency
1) Backward curve	79-83
2) Forward curve	60-65
3) Radial	69-75

Axial flow type fans







In axial flow, air enters and leaves the fan with no change in direction.

	Peak Efficiency Range
1) Propeller	45-50
2) Tube axial	67-72
3) Vane axial	78-85

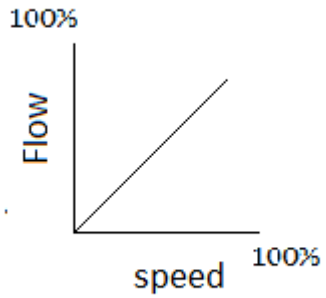
Fan Laws:-

The fan operates under a predictable set of laws cancelling speed, power and pressure. A change in speed (RPM) of any fan will predictably changes the pressure rise and necessary to operate it at the new RPM.

Flow ∝ speed

Q1/Q2 =N1/N2

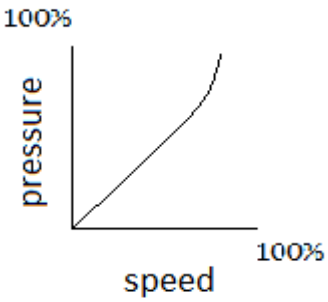
Varying the Rpm by 10% decrease or increase air delivery by 10%



Pressure ∝ (speed)^2

SP1/SP2 = (N1/N2)^2

Reducing the RPM by 10% decreases the static pressure by 19% and an increase in RPM by 10% increases the static pressure by 21%



Power ∝ ($\boldsymbol{Speed}$)^3

KW1/KW2 = (N1/N2)^3

Reducing the RPM by 10% decreases the power requirement by 27% and an increase in RPM by 10% increases the power requirement by 33%

Flow Control Strategies

The fan operates at constant speed. There may be occasions when a speed change is desirable i.e., when adding a new run of duct that requires an increase in air flow (Volume) through the fan. There are also instances when the fan is over sized and flow is required.

Various ways to achieve change in flow

- Pulley change
- Damper control
- Inlet guide vane control
- Fluid coupling
- Variable speed drive

Pulley Change

The simplest way to change the speed is with pulley change. For this, the fan must be driven by a motor through a V-belt system. The fan speed can be increased or decreases with a change in the drive pulley or the driven pulley in some cases both pulleys.

Damper control

Some fans are designed with damper control; damper can be located at inlet or outlet. Dampers provide a means of changing air volume by adding or removing system resistance. However, dampers provide a limited amount of adjustment and they are not particularly energy efficient.

Inlet Guide vanes

Inlet guide vanes are another mechanism that can be used to meet variable air demand. Guide vanes are curved sections they lay against that inlet of the fan when they are open. When they are closed, they extend out into the air stream. As they are closed, guide vanes pre-swirl the air entering the fan house

Voith variable speed turbo coupling

The Voith variable speed turbo coupling is a fluid coupling which transmits the energy input by the mass forces of a fluid which is circulated in a closed system between an impeller on the driving (primary) shaft and a runner of similar design on the driven (secondary) shaft.

In contrast to the constant-fill type turbo coupling, the oil filling of the variable-speed turbo coupling can be varied between completely filled and drained while in operation. In this way, infinitely variable speed control of the driven machine is achieved over a large range when the coupling operates against the load characteristics. This control range is dependent upon the load characteristic (torque relative to speed) and the required governing accuracy.

The working oil circulation is maintained by a continuously running pump which delivers oil from the integral sump below the coupling into the working compartment. The working compartment is the chamber between the primary (impeller) and the secondary (runner) wheels which is connected to a rotating scoop chamber consisting of an inner and an outer shell. The amount of oil in the working compartment determines the speed at the output side of the coupling and is dependent upon the radial position of a scoop tube located in the scoop chamber. The flow capacity of the scoop tube far exceeds the pump delivery; thus, with respect to control and governing, reaction times are held to a minimum.

Variable Speed Drives

Variable speed drives Provide almost infinite variability in speed control. Variable speed

operation involves reducing the speed of the fan to mid reduced flow requirements. Fan performance can be predicted at different speed using the fan laws. This will usually be the most efficient form of capacity control. The efficiency of the control system (fluid coupling, eddy current, VFD etc...) should be accounted for the analysis of power consumption.

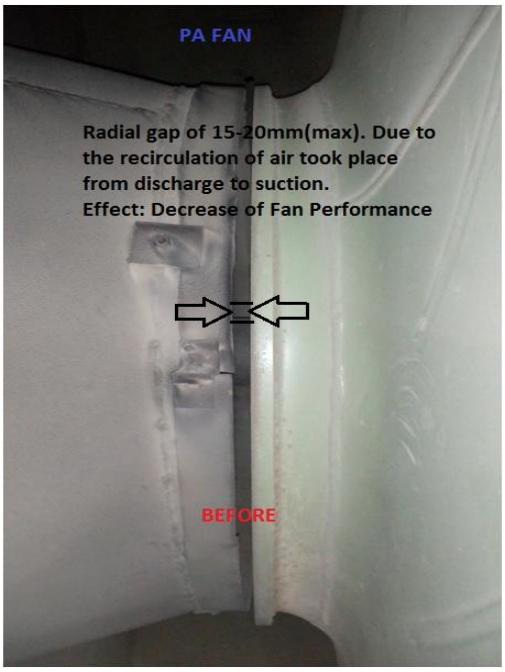
II. ENERGY SAVING POINTS IN FAN

1. Change of impeller by a high efficiency impeller along with cone.
2. Use smooth, well rounded air inlet cones for fan intake
3. Avoid poor flow distribution at the fan inlet.
4. Clean screens, filters and fan blades regularly.
5. Use aerofoil-shaped fan blades
6. Minimize fan speed.
7. Use low-slip or flat belts.
8. Eliminate variable pitch pulleys.
9. Use variable speed drives for large variable fan loads.
10. Use energy-efficient motor for continuous or near – continuous operations.
11. Eliminate leak in duct work.
12. Minimize bends in duct work.
13. Turn fans off when not needed.

III. PRACTICAL OBSERVATION

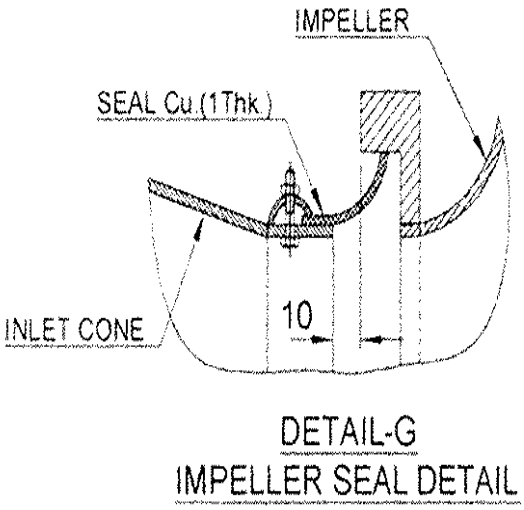
Practical observation on PA fan which is used in the boiler. We found there is a gap between the impeller eye and inlet cone. The gap causes the recirculation of air which comes from the impeller so the fan performance is decreased and causes energy loss.

PA FAN



The radial gap between inlet cone and impeller eye is 20mm causes recirculation of air. the gap should be reduce or seal with copper sheet.

Copper sheet is a soft, malleable and ductile metal. It suited for sealing the gap because if the copper sheet damage it breaks into small pieces it does not causes any damage to the fan



After reducing the gap between inlet cone and the impeller by sealing with copper metal sheet

IV. AIR COMPRESSION SYSTEM

An air compressor is a device that converts atmosphere air into pressurized air by the compressor. It is kept under a pressure that is greater than the atmospheric pressure

Types of compressors

According to the design and operation

(1) Rotating compressor
(2) Reciprocating compressor

According to pressure delivered

(1) Low-pressure air compressor
(2) Medium pressure compressor
(3) High-pressure compressor

According to the cooling methods

(1) Air Cooling compressor
(2) Water cooling compressor

According to displacement

(1) Positive displacement
(2) Negative displacement

Positive displacement

Reciprocating compressor

Reciprocating compressors are most widely used type for air compression. They are characterized by flow output that remains that remains nearly constant over a range of discharge pressure. Also, the compressor capacity is directly proportional to the speed. The output, however, is pulsating one.

Reciprocating compressor is also available in various types.

- Lubricating and non-lubricating.
- Single or multiple cylinder
- Water or air cooled
- Single or multistage

Rotary compressor

Rotary Compressor has rotors in place of piston and gives a continuous pulsation free discharge air. They are directly coupled to the prime mover and require lower starting torque as compared to reciprocating machine. They operate at high speed.

Rotary Screw air compressor

Screw Compressors are widely used. It consists of rotors within the casing where the rotors compress the air internally. There are no valves. These units are basically oil cooled (with air cooled or water cooled oil coolers). Since the cooling takes place right inside the compressor, the working parts never experience extreme operating temperatures. The oil has to be separated from discharge because of the simple design and few wearing parts rotary screw air compressors are easy to maintain, to operate and install the oil free rotary screw air compressor uses specially designed air ends to compress air without oil in the compression chamber producing oil free air. These compressors are available as air-cooled types.

There are wide range of availability in configuration and in pressure and capacity. Dry types deliver oil free air and available in sizes up to 20000 cfm and pressure up to 15bar. Lubricated types are available in types ranging from 100 – 1000 cfm with discharge pressure up to 10 bar.

V. COMPRESSED AIR SYSTEM COMPONENTS

Compressed air system consists of following major components

Intake air filters:

Prevent dust from entering compressor, dust causes sticking walls excessive wear.

Inter-stage Coolers:

Reducing the temperature of air before it enters the next stage to reduce the work of the compression and increase efficiency

After coolers:

The objective is to remove the moisture in the air by reducing the temperature in a water cooled heat exchanger

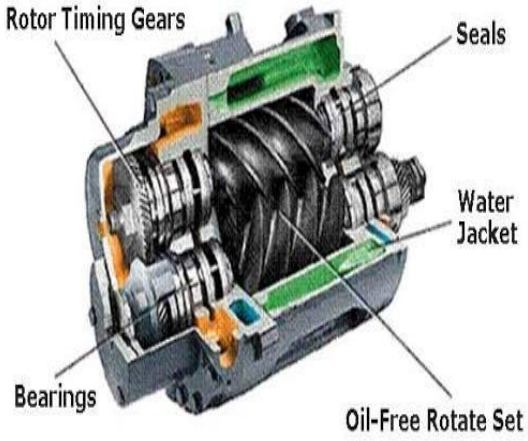
Air Dryers:

The renaming traces of moisture after after-cooler are removed using air dryers, as air for instrument and pneumatic equipment has to be relatively free of any moisture is removed by using absorbents like silica gel etc.

Moisture drain traps:

Moisture drain traps are used for removal of moisture in the compressed air. These traps resemble steam traps. Various types of traps used are manual drain cocks, timer based automatic drain valves etc.

Receivers:



Air receivers are provided a storage and smoothening pulsating air output reducing pressure variations from the compressor.

In power plant we use two types of compressed air

Instrument air

This air controls the operating of valves in pneumatic instruments the air is filtered, oil free and dehydrated. This air is not lubricated to avoid contaminating the air passing through valves with oil or lubricant. This air is so that it may not damage the valves by jamming or rusting, reduce the methane emission and ensure the safety of the equipment.

In any case oil content should not be more then 1ppm of the air

Service air:

Service air is for maintenance and cleaning. This type of air used to drain out ash into silo.

Process for instrument air:

Air is sucked by low pressure suction then it is compressed released by low pressure discharge to inlet of inter cooler it is cooled up to some extend and then the outlet is connected to high pressure unit it is compressed again and then sent to after cooler there its temperature is again reduced and sent to air drier there any water, oil, moister is present then it is removed and stored in tank

Process for service air:

Air is sucked by low pressure suction then it is compressed released by low pressure discharge to inlet of inter cooler it is cooled up to some extend and then the outlet is connected to high pressure unit it is compressed

again and then sent to after cooler there its temperature is again reduced and sent to storage tank.

Misuse of compressed air:

Misuse of compressed air for purpose like body cleaning liquid agitation, floor cleaning, Drying, Equipment cooling other similar uses must be discouraged.

Excess utilization of compressed air

The compressed air is misusing for purpose like body cleaning liquid agitation, floor cleaning, Drying, Equipment cooling other similar uses causing energy wastage. We need to decrease the load on the compressors for energy saving. By avoiding air leaks in the compressed air system we can save the energy.

Capacity utilization:

In many installations, the use of the air is intermittent. This means the compressor will be operated on low load or no load conditions, which increases the specific power consumption per unit of air generated. Hence for optimum energy consumption of proper compressor capacity control should be selected. The nature of the control device depends on the function to be regulated. One of the objectives of good compressed air management system would be to minimize unloading to the least as unloading consumes up to 30% of full load power.

- One way of doing this is to use a small compressor
- The option to switch off when air is not need in a particular section/equipment
- If a compressor is oversized and operates at unloading mode for long periods, an economical way will be suitably change the pulley size of the motor or compressor and reduce the RPM

  To de-rate the compressor to a lower capacity
- The option to maintain constant pressure in the system and to avoid unloading operations at very low speeds

ENERGY CONSERVATIONS POINTS IN COMPRESSOR SYSTEM

- Consider variable speed drive for variable load on positive displacement compressors.
- Use a synthetic lubricant if the compressor manufacturer permits it.
- Be sure lubricating oil temperature is not too high (oil degradation and lowered viscosity) and not too low (condensation contamination).
- Change the oil filter regularly.
- Periodically inspect compressor intercoolers for proper functioning.
- Use waste heat from a very large compressor to power absorption chillers or preheat process or utility feeds.
- Establish a compressor efficiency-maintenance program. Start with an energy audit

  and follow-up, then make a compressor efficiency-maintenance program a part of your continuous energy management program.

Suggestions was taken from OEM of the power plant on Compressors for energy saving

There are two methods of ash handling by the compressor to transfer the ash from furnace and ESP to dumping yard by using compressed air through conveyor pipes.

- Probe method
- Timer method

Probe Method:

In probe method we have probes in the vessel. Its work is , after sufficient amount of ash is filled in the vessel then it drain, it means that until the ash is filled up to the set level is will get signal to drain that material.

Timer Method:

In timer method we set minimum time to drain the ash material. So if the ash material is filled completely or not it doesn't matter at that particular time it will convey the ash material to ash silo.

(Probe method is best efficient method then timer method because in probe method power consumption is low)

VI. CONCLUSION

After analysis in thermal power plant layout we focused to improve performance on these following systems (air compression systems, fans and blowers). Suggestions were taken by the power plant management.

ACKNOWLEDGMENT

Behind every achievement lies an unfathomable sea of gratitude to those who energized it, without whom

it would never come into existence. We were pleased to thank our Project Guide Mr. V HARI KIRAN, M. TECH, ASST.PROFESSOR, H.O.D .Department of Mechanical Engineering for his whole hearted cooperation, unfailing inspiration and valuable suggestions. We thank him valuable time at odd hours and his patience and his encouragement at every step in completing this project successfully.

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