International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 05 | Aug-2015 www.irjet.net p-ISSN: 2395-0072

ENERGY SAVING ANALYSIS OF CENTRIFUGAL BLOWERS

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Abstract: ***Centrifugal blowers are the single most popular application for ventilation and industrial process requirements. It uses variable frequency drives since it is easy to retrofit and the energy savings typically pay for the drive within 4 to 12 months. The paper describes different types of blowers used in industrial processes. Then it identifies inefficient blowers. Information regarding blower's energy efficient operation is provided in this paper so that informed and educated decisions can be made regarding energy savings of blowers.***

Keywords: *Fan, Blower, efficiency, energy, economy.*

1. INTRODUCTION

Fans and blowers are used by most manufacturing plants for industrial processes and for ventilation that need airflow. Fan systems consist of a fan, a drive system, an electric motor, ducts or piping, flow control devices and air conditioning equipment such as filters, heat exchangers, cooling coils, etc. and they are essential to keep manufacturing processes working [1].

Fans and blowers are differentiated by the system pressure they must operate against and by the method used to move the air. To define fans and blowers, the American Society of Mechanical Engineers (ASME) uses the specific ratio which is the ratio of the discharge pressure over the suction pressure as illustrated in Table 1 [2][3].

Table 1: Differences Between Fans and Blowers

Equipment	Specific Ratio	Pressure Rise (mmW2)
Fans	Up to 1.11	1136
Blowers	1.11 to 1.20	1136 to 2066

An example system is illustrated in Figure 1.

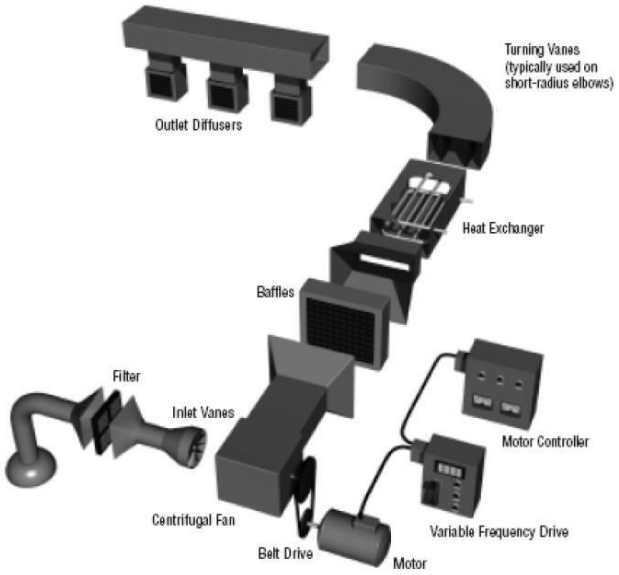

Figure 1: Typical Fan/ Blower system components.

2. OPERATING PRINCIPLES OF BLOWERS:

Figure 2 shows a typical centrifugal blower wheel with backward inclined blades. Figure 3 shows the same blower wheel in a scroll housing. The airflow enters the unit axially, but then spread outs in a funnel shaped pattern, turning 90^0 into various radially outward directions before meeting the blades. The blades then deflect these

individual air streams into a spiral pattern to an almost circumferential direction. All these air streams are finally collected by scroll housing and are reunited into a single air stream that leaves the unit at a right angle to the axis (Bleier F. P., 1997) [4].

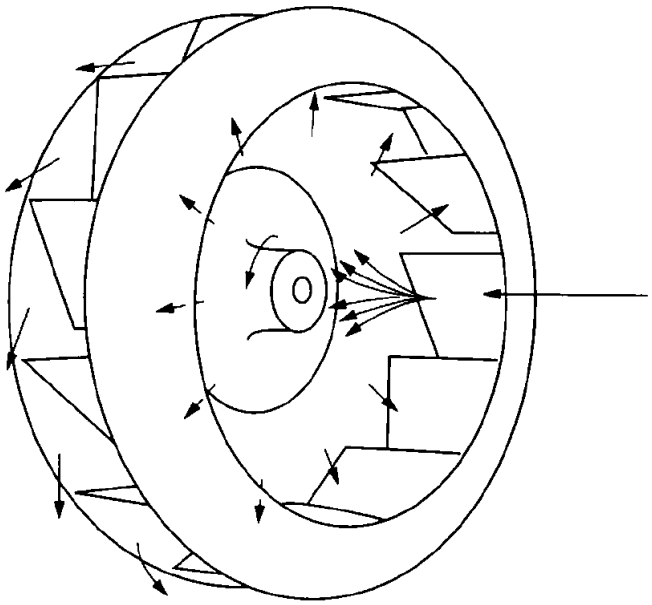

Figure 2. Centrifugal blower wheels with backward-inclined (BI) blades welded to back plate and shroud.

3. TYPES OF BLOWERS

More high pressures can be achieved by blowers in comparison to fans. The pressure can reach up to 1.2 kg/cm^2. As far as vacuum systems used in industry are concerned, blowers can be used for producing negative pressure. Mainly two types of blowers are there in the market:

1. Centrifugal blowers
2. Positive displacement blowers

These blowers are described below:

3.1 Centrifugal blowers

In comparison to fans, centrifugal blowers are similar to centrifugal pumps. Impeller of centrifugal blower is driven by gear. Its rotational speed is up to 15000 revolutions per minute. In case of blowers of multistage type, when air goes through every impeller, it further accelerates. As far as blowers of single stage types are concerned, they are more efficient because many turns are not taken by air. Higher pressures are achieved by centrifugal blowers even though their typical operation is in the range of .35 kg/cm^2 - 0.7 kg/cm^2. With the increase of system pressure, the tendency of air flow is that it decreases drastically. In material conveying systems, it is disadvantageous because it depends upon steady volume of air. Due to this reason application of centrifugal blowers are in no prone clogging systems [5].

3.2 Positive displacement blowers

Through housing, positive displacement blowers have rotors, which "trap" air and push it. Even in case of variation of system pressure, constant volume of air is provided by these blowers The use of these blowers are more suitable for applications prone to clogging. This is because sufficient pressure of up to 1.25 kg/cm^2 can be produced by them which help in blowing clogged material free. For facilitating speed changes, these blowers are often driven by belt. The speed of positive displacement blowers are much lower (3600 rpm) with respect to centrifugal blowers. A positive displacement blower has curved impeller which is kept between faces of two housing which are kept apart along axis of impeller. A housing inlet is defined by its one of the faces. Except outlet & inlet, there is a substantial close off of housing. The characteristics of positive displacements are given below:

- Area of outlet of blower is more than 70% of the area of a section of the housing taken perpendicular to the direction of airflow along the impeller axis.
- Spaces among impeller blades & at least one of the housing faces is greater than 30% of the impeller blade depth; and
- The impeller diameter is at least 70% of the housing dimension along that diameter;.

4. INEFFICIENT BLOWERS

Fans and blowers not operating efficiently are revealed by the following clues [6][7]:

- High operating cost
- High level of noise

- High maintenance cost
- High air leakage in ducting or system
- Inability to adjust flow rates according to production needs
- Inadequate air flow through branches

5. ENERGY SAVINGS AND ECONOMICS

Production processes are often directly supported by blowers which results in substantial annual operating costs due to significant energy consumption. Often the operating costs are so high that improving efficiency of blowers will significantly save the energy & operating costs. In this regard, the following points should be noted [8].

- Often persons operating blowers are not familiar with high operating costs of blowers. They also don't know that by improving the performance of blower systems, tremendous amount of money could be saved.
- Costs of maintenance and electricity are part of the operating costs. Simple measurement gives electricity cost but maintenance costs depend largely upon service conditions, therefore, case-by-case evaluation is required. To estimate these costs, history of similar types of blowers in similar applications should be reviewed.
- The load factor and amount of time affects the operating costs of blowers.

Determination of blower systems' load factor can be achieved by noting operating hours' numbers over a specified period of time like one week at each output level in a plant. A blower systems' average load factor can be calculated by the following formula:

$$\frac{\sum (\text{Level of outputs} \times \text{No. of hours})}{\text{Total No. of hours in entire period}}$$

For consumption of electricity, following methods can be used:

- With the help of performance curve data of blower;
- By electrical measurements; or
- Using motor nameplate data.

6. IDENTIFICATION OF INEFFICIENT BLOWERS & FANS

- High maintenance cost
- High noise level
- High operating cost
- Insufficient air flow through many branches
- High air leakage in ducting or system
- Incapability in flow rates adjustment according to needs of production

Belt adjustment and alignment and motor used for driving blower are the main cause of high maintenance costs. Following are the main reason for high cost of maintenance.

- Wrong selection of blower for a particular application
- Oversized blowers
- Over-tightening of belt
- Large motor loads' frequent start-ups.

Wrong selection of blower for a particular application and oversized blowers are the main cause of high noise level

Following are the reasons for high operating costs

- Inefficient operation of blower
- Wasteful air flow controls choices and operation even though when it is not needed.
- poor system design
- Operation in the range of wrong pressure.

In many a times and in many cases of little backpressure or no backpressure operation, centrifugal blower motor will be overloaded. Over-current or thermal cutout switch will shutdown the overloaded motor if backpressure is not corrected.
Insufficient balancing and duct configuration will cause insufficient air flow through certain branches which will result in airflow resistance or leakage. These drawbacks can be overcome by providing more power to blower system causing additional energy and operating costs.

7. ASSESSMENT OF BLOWER SYSTEM REQUIREMENTS

If right pressure flow characteristics are not achieved through a single blower, a number of options are available as given below:

- As an alternative to single blower, multiple blowers can be combined in parallel or in series.
- An alternative option is to replace the existing blower with a different and more suitable model.

- Blowers must match to motor so that the blower-motor combined together must deliver the required air flow when need arises.
- There are many other options for adjusting air flows to match requirements of the system. Examples are airflow dampers, controllable-pitch blades, inlet vanes, variable frequency drives (VFDs) and multiple-speed motors for driving blowers.

8. CASE STUDY: MECHANICAL VENTILATION (MV) SYSTEM

Consumption of energy of MV systems is through blower motors operation. The used energy amount relies upon the system pressure as well as the transported volume of air. Energy savings depend upon:

- Avoiding excess air supply
- Selection of efficient blower and
- Reduction of pressure drop.

Following components constitute the MV systems:

- An extraction fan with a duct system from the conditioned space to the outdoors;
- Ductwork drawing air from the outdoors;
- Ductwork leading to the conditioned space;
- An air handling unit containing the filters, exchangers, heaters, and supply fans; and
- An optional heat recovery system between the supply and exhaust ducts.

9. CONCLUSION

Fans and blowers are used by most manufacturing plants for industrial processes and for ventilation that need air flow. There are two types of fans: centrifugal fans & axial fans and two types of blowers: centrifugal blowers & positive-displacement blowers. Fans and blowers are differentiated by the methods used to move the air. Last section of this paper describes different methods and ways to save the energy and use the blower system economically.

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BIOGRAPHIES

Usmani Fahad Ziaul Ain received his Bachelor of Engineering (B. E.) degree in Production Engineering from Anjuman-I- Islam's M. H. Saboo Siddik College of Engineering, Mumbai (Mumbai University), India and Master of Engineering (M. E.) degree in Mechanical Engineering from K. J. Somaiya College of Engineering, Mumbai, (Mumbai University), India in 2010 and 20013 respectively. He is currently working towards his PhD degree in the department of Mechanical Engineering from JJT University, Jhunjhunu, Rajasthan, India. His current research interests include CAD/CAM, FEA, Material Technology and Engineering and Machine drawing. Presently, he is working as an Assistant Professor in Dilkap Research Institute of Engineering and Management Studies (Affiliated to Mumbai University), Neral, Maharashra India.

Dr. Gulabchand k. Gupta is working as a Principal of Western College, Navi Mumbai. He has more than 27 years of teaching experiences. He has done M.Sc., M.Tech. and completed his Ph.D. degree from University of Mumbai in the year 1999. He has taught diverse set of subjects. He has 18 years of research experience and published more than 26 research papers in national and international Journals & conferences.