High Efficiency Boiler Fans

Fan engineering has undergone a rapid process of development in recent years and a comprehensive selection of fans, fulfilling the most widely varying requirements has come into being. At the same time, certain types and designs that have particularly desirable characteristics have won a more or less predominant position.

An incorrect exhaust reduced the efficiency of the boiler considerably. The choice for an exhaust system is dependent on the kind of boiler operated. That is why the draught system for the boiler is very important, and the fans used for this system form the heart of the boiler's draught system. Good combustion depends on a good draught. These fans help burn fuels efficiently leading to complete combustion. The combustion air requirement from under grate is met by air supplied from the forced draft fans (FD fans), and the combustion product from the furnace is exhausted by the inducted draft fan (ID fan). The secondary air fan (SA fan) supplies air over the grate to create turbulence over the fuel. For spreading fuel over the grate and burning fuel in suspension the pneumatic spreader is used, and the pneumatic spreader fan (PS fan) plays an important role in spreading and burning fuel efficiently. The balanced draught system, thus, is very essential for the economic operation of the boiler.

Why High Efficiency ?

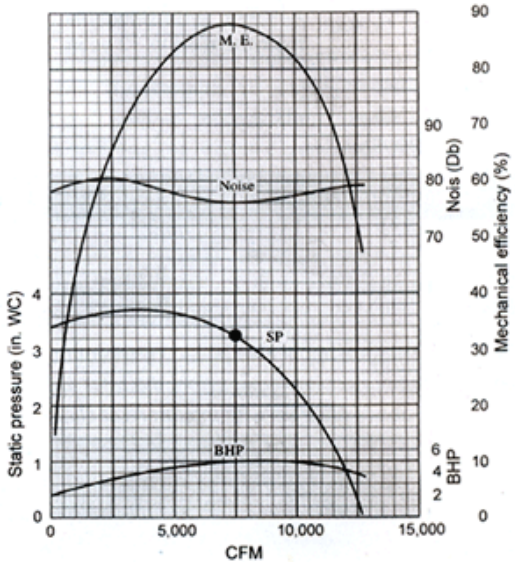
To remain competitive in today's world, efficiency is the key word for the successful running of an enterprise. Money saved from operations can be ploughed back for expansion and innovation that will help sustainable growth, which ultimately will help score over competition. A 100 tph boiler nowadays uses approximately 900 kW connected load for its fan operation. Thus, a moderate estimation of 10% enhanced efficiency in fans alone can save 90 kWh energy per hour. Based on a 300-day operation per annum and a unit rate of Rs. 3 per kWh, an enormous saving of around Rs. 19.44 lakh is possible.

High Efficiency Fans

Advance in fan engineering design has made it possible to design fans up to 91% efficiency in airofoil designs, and 88% efficiency in sheet metal blading. Many times this advantage is lost due to improper estimates of gas/ air handling capacities of fans. Also, higher efficiency fans are found operating far away from the "best efficiency" points selected from the design conditions.

Design Features

For a specified function, there is only one diameter of the impeller at a specified speed, which can give the best efficiency, provided the optimized inlet diameter and good blading is provided. A low lead edge angle and long smooth passage of air from the inlet to the outlet of the impeller, without separation of flow in the two blades will provide the highest possible efficiencies. It is therefore the responsibility of the designer to ensure the following:



Performance Curve for Lab-tested High-efficiency Fans

- Establish the best wheel diameter that is capable of the highest efficiency possible at the specified speed and function;
- Establish the optimum impeller inlet diameter at the specified speed and function;
- Select blade angles and number of blades to convert dynamic energy into static energy, without separation of flow and avoiding shock conversions.

As can be seen from the graph on the previous page:

- The maximum efficiency is 88%
- The optimal operating range is between 50 to 75% of free delivery.
- The maximum brake horse power (BHP) occurs at the highest efficiency point, making it possible to use small motors.
- The maximum noise level occurs at maximum efficiency.

Control of High Efficiency Fans

Using variable frequency drives (VFD) is the best way to control the flow of fans to suit various operating parameters of the boiler. The following fan laws apply for the control for fans:

- The flow is directly proportional to speed
- The pressure is directly proportional to speed ^2
- The power is directly proportional to speed ^3

This makes it possible to operate the fan economically. The variable inlet vane (VIV) damper is the second best option (see picture above). It also helps saving energy by giving pre-rotations to the incoming flow in the direction of the impeller rotation. The most commonly used multilouvered damper is not recommended as it simply converts static head into kinetic head, thereby causing unnecessary power loss. It is recommended to use a VFD and VIV dampers simultaneously to get the right duty point with the least energy consumption.

In engineering, fans are used mainly to produce flow of gases from one point to another. The movement of the gas itself may be the primary object, but often the gas is merely a medium for carrying heat, cold, moisture, etc, or solid substances like ash or saw dust.

Fans Accessories

Inlet Box

This should be built liberally and the use of turning vanes to guide the flow smoothly into the impeller eye, plays a very important role in retaining the fan's efficiency at a high level. There are examples where ill-designed inlet boxes have lost up to 35% in efficiency.

Evase

This is a slowly expanding piece of ducting at the fan's outlet, which regains kinetic energy into static head, which is useful energy.

Silencers

The silencers with low loss built with suitable materials of construction are required to be built with care.

Useful Hints to Save Power

- Use correct belt tensions as per the manufacturer's recommendations only. This will not only increase the life of belts, it also saves energy. The use of a belt tension meter is recommended.
- Excess tightening of the adaptor sleeve also heats up bearings causing more wear, and more power consumption. The use of filler gauges while tightening the adaptor sleeve is recommended.
- Fill grease into the bearings as per the correct quantity and quality recommended. It is generally observed that the plummer blocks are filled with grease fully, which overheats bearings.

Conclusion

The gains of technology of high performance fans is possible only if the following requirements are observed correctly:

- The boiler designer specifies the correct parameter for the performance of the fans with practical margins for excess air to enable fan operation in a high efficiency zone.
- The boiler operator operates the boiler with correct draughts, by constantly checking CO_2/O_2 to ensure complete combustion with power fan settings.
- The fan is maintained with recommended practices with correct belt tensions, lubrications and proper bearing fittings.

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Reference book

The Bulletin on Energy Efficiency
August 2005 Volume 6 Issue 1