SIEMENS

White Paper

Energy savings in the pulp and paper industry

ID and FD fans performance optimization

In U.S. pulp and paper mills, there are more than 900 boilers. Power and recovery boilers are equipped with induced draft (ID) and forced draft (FD) fans to provide the air for combustion. These fans may have power ratings ranging up to 1000 hp but can greatly benefit from some optimization.

The problem

Boilers in the pulp and paper industry have been typically fitted with dampers to control the airflow, while the fans are connected to a constant speed motor and run continuously. The motor is run at 100 percent only for the air flow to be throttled back mechanically. Furthermore, the induced draft and forced draft fans that provide the air for combustion have a strategic role in defining boiler efficiency, as the accurate control of the air is critical for the combustion process. This mechanical method of control via dampers is inaccurate, which leads to excess air in the combustion chamber of the boiler, and lowers the efficiency of the boiler and potentially affects the flue gas. This inability to precisely control the air flow also may lead to flame instabilities. Therefore, the optimization of the air to fuel ratio to create the most efficient combustion is very important.

The paper industry

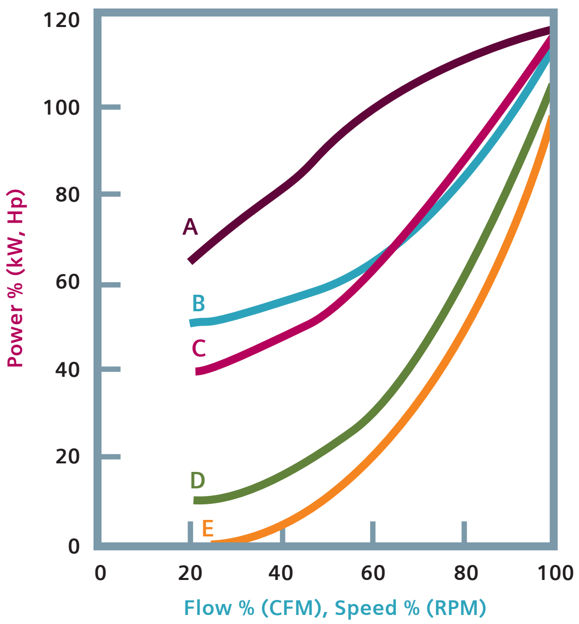
In paper making, electric power use represents more than 20 percent of the overall costs in the manufacturing process. In a 2006 report conducted by the U.S. Department of Energy, it was concluded that the paper industry has the potential to reduce its energy consumption by at least 25 percent and cut down on the $7.5 billion spent annually on the purchase of fuel and electricity in 2006 (U.S. Census Bureau). Throughout the pulp and paper industry, fan systems consume roughly 20 percent of the total electric power used for all motor-driven systems in the U.S. Basic fan system improvements could save the industry about 1100 GWh of electricity per year (U.S. DOE 2002a) according to the United States Department of Energy's estimates.

The solution

The efficiency of fans delivering air for combustion is low and the introduction of flow (air volume) control by Variable Frequency Drive (VFD) instead of conventional dampers will increase efficiency and save approximately 30 percent of energy used by constant speed motors. Controlling the air flow by reducing the fan speed has the potential to save substantial amounts of energy as the power required is proportional to the cube of the shaft speed, while the air flow is directly proportional to the shaft speed. For example, a 1000 hp fan run for 75% air flow will only require approximately 422 hp, saving more than 50 percent of the energy consumption. This means that to achieve the estimated 30 percent energy savings, the fan will only need to be reduced by 13 percent and run for only 87 percent air flow. Based on initial studies, this is easily achievable and widely necessary.

As shown in Figure 1, controlling the air flow by a VFD (Curve D) results in a power curve very close to the theoretical fan curve (Curve E) and is far more efficient than mechanical control of the air flow (Curves A, B, and C).

Figure 1: Power curves for various applications



Curve A – Discharge Dampers
Curve B – Variable Inlet Vanes
Curve C – Eddy current Clutch
Curve D – Variable Frequency Drive
Curve E – theoretical Fan Curve

Source: White Paper by Stephen Prachyl, "Variable Frequency Drives and Energy Savings" 2010

The risk

Furthermore, a medium voltage Perfect Harmony VFD can be installed during a mill's annual shut-down and will take a few hours. Developments in drive technology allow mills to install a Perfect Harmony drive without substantial supporting upgrades. The basic work needs to be done up front, but the medium voltage drive offered does not require a change of motors or special cabling and can simply be located between the existing starter and the fan using the existing cabling. The Perfect Harmony drive has an included isolation transformer and power converter and is designed with the inherent benefits of harmonic filtering, power factor correction and a motor filter. This further reduces the amount of supporting equipment that must be engineered and installed. As a result the installation is very low risk, as the investment is relatively low cost. The supplier can provide the engineering and the support to define and install the drive. This will give the customer a solution that will fit seamlessly into the mill's system.

The benefits

A VFD will not only save in energy consumption, but also in the facility's maintenance costs. The elimination of the mechanical flow control reduces moving components which, in turn, will reduce main-tenance. Furthermore, direct online starting stresses the motor and also the electrical equipment as the current draw can spike up to seven times the name-plate Full-Load Amperage when starting the motor across the line. With the installation of a VFD, smooth starting is made possible, which again lessens the amount of mainte-nance required for the machine.

Large boilers that produce more than 100 metric tons of steam per hour (more than 220,000 pounds per hour steam capacity) will see the most dramatic impact. This size boiler requires ID and FD fans with a large capacity and power demands of more than 250 hp, and requires a medium voltage drive. According to data collected from the RISI database, there are approximately 500 boilers with steam capacity greater than 100 tons per hour in the United States. Each boiler shall have at least one (but likely two or three) fans with MV motor over 250 hp. Considering the size of fans, kWh cost and the cost of installing VFDs for medium voltage motors, this kind of investment shall result in a pay-back (by energy savings) in approximately one to one and a half years.

Key features of Siemens Perfect Harmony Drive

- All motor types and voltages supported
- 400 to 43500 HP (single channel)
- Low harmonic input
- .95 P.F. any operating point
- Smallest MV AC drive in the world
- As low as a 12 week lead time

This retrofit, made possible by the Perfect Harmony Drive, has the potential to create huge savings for companies, especially larger companies that own multiple facilities. Assuming a 30 percent energy saving of a 1500hp motor at $0.07 per kWh will result in more than $200,000 worth of energy savings each year per boiler. For a larger company that owns 50 to 100 boilers, this can total from $10 to $20 million a year. With such a large opportunity for economic savings, a mill cannot afford to not investigate.

Sources

"Energy Efficiency Improvement and Cost Saving Opportunities for the Pulp and Paper Industry" – October 2009

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Siemens Industry, Inc.
3333 Old Milton Parkway
Alpharetta, GA 30005

1-800-241-4453
info.us@siemens.com

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