AC Adjustable Frequency Drives for Cement Kiln ID Fans

CEMENT KILN ID FAN APPLICATION

The kiln ID fan is a central element in the cement production process. Kiln airflow must be continuously varied to match the requirements of the cement making process. Because cement making is a thermal and a chemical process, both volume of air moved and the mass rate of flow of air must be controlled. Process control systems continuously monitor major process conditions such as inlet air temperature, kiln feed, cement composition, and required fuel-mix. The process control system determines the required flow rate to match the operating point, and directs the blower and flow control system to provide the optimum fan flow required.

MECHANICAL SYSTEM SOLUTIONS

Originally, the only available methods to achieve variable airflow were mechanical. These usually consisted of a combination of inlet and outlet dampers, and flow guide vanes, or variable-slip clutches. The motor and fan providing the airflow turn at constant speed, while opening and closing the inlet or outlet dampers, varying the flow control vanes, or varying the clutch slip varies airflow.

Mechanical solutions to the ID fan variable flow requirement have significant disadvantages, including:

- High energy consumption at even slightly reduced flow rates
- High mechanical wear and maintenance
- Process interruptions due to mechanical problems
- Limitations on motor starting duty

ADJUSTABLE SPEED DRIVE SOLUTIONS

Variable flow can be provided by varying fan RPM to precisely match process operating conditions. The adjustable speed drive provides variable speed. Figure 1 shows how varying fan speed is used to select the proper operating points A through E of the ID fan system. Notice how fan input power falls sharply with speed.

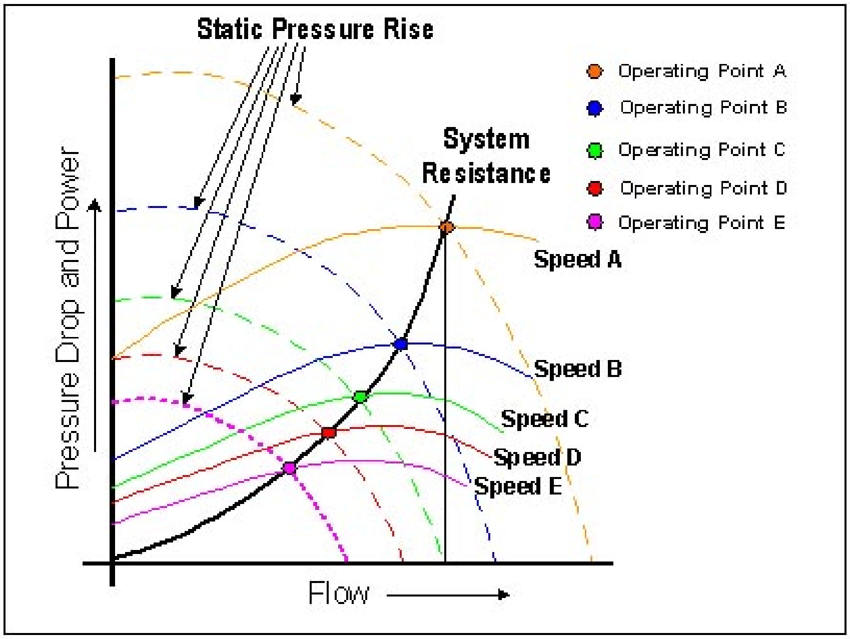

Figure 1. Fan System with Adjustable Speed Drive Applied

Depending upon the size of the cement kiln, the required ID fan output power can vary from a few hundred hp to several thousand hp. Such large drive systems have significant impact on power systems and overall process efficiency.

EARLIER DRIVE SOLUTIONS
Previous generations of large hp drives delivered the energy savings, process control benefits, and mechanical system benefits required. However, these drives were physically large, complex, and tough on the plant power system. The installed cost per hp was high.

MODERN PULSE WIDTH MODULATED (PWM) DRIVES - EASY ON THE POWER SYSTEM AND BUDGET
Advances in power semiconductor technology and microprocessor control have led to a whole new generation of high power drives. The TMEIC Dura-Bilt5i MV™ is such a third generation drive system. It features characteristics such as:

- True power factor of 0.95 over the operating range
- Efficiency of 96.5 %
- Utility current harmonic distortion that is much lower than IEEE 519 - 1992 recommendations
- Medium voltage insulated gate bipolar transistors (IGBT) for minimum parts count and super-reliable 16.4 year mean time between failures (MTBF)
- Extremely small footprint
- Advanced maintainable packaging
- Low installed cost per hp
- Third generation Ethernet compatible software toolbox, including state-of-the-art auto tuning
- Practical power range from 300 through 10,000 hp at 4160 Volts output

ADJUSTABLE SPEED DRIVE PAYBACK AREAS
Energy Savings
Elimination of the mechanical losses is usually the most compelling and easily quantified reason for applying drives.

Figure 2 shows a system using mechanical dampers to achieve flow control. Pairs of flow and pressure operating points corresponding to points A through E of Figure 1 are shown in Figure 2. Power level percentages shown are total input power including all motor, transformer and system losses as percentages of required fan output power. The energy deltas for a series of such operating points allow calculation of energy savings and drive cost justification. A table of expected annual operating times and power level differences is developed. Energy cost factors for the site are applied and the annual savings calculated are shown in Table 1.

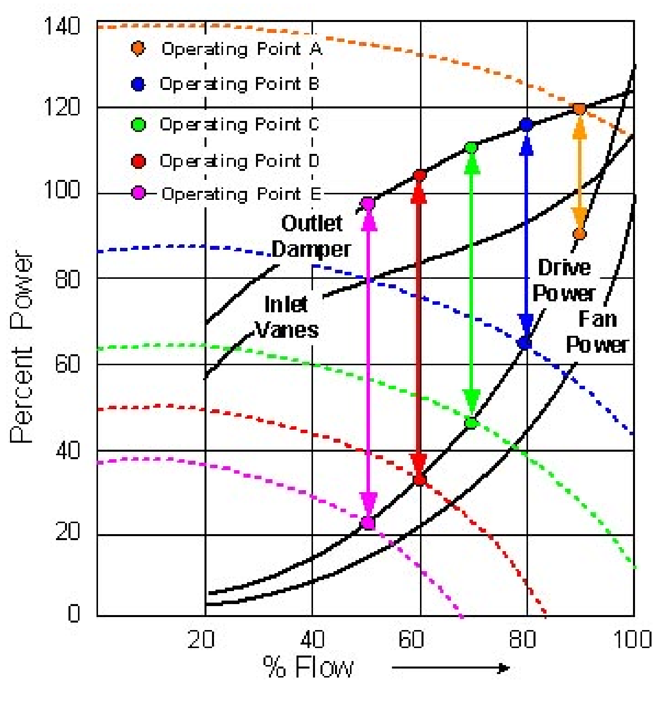

Figure 2. Mechanical Flow-Controlled Fan System

Ref Point	Required Flow %	% Power Using Outlet Damper Control	% Power Using Adjustable Speed Drive	Delta % Power Saved	% Time on Annual Basis	% Saved on Annual Basis
A	90	120	91	29	15	4.35
B	80	117	66	51	25	12.75
C	70	111	46	65	25	16.25
D	60	103	34	69	20	13.8
E	50	96	23	73	15	10.95
Total Annual % Energy Consumption Savings						**58.1**

Table 1. Example Annualized Fan Energy Savings

Based on the annualized percent savings in Table 1, an ID fan system with 1000 hp output, operating for 8000 of 8760 hours per year, at an energy cost of $0.035 per kWh is:

1000 x 0.746 x 58.1% x $.035 x 8000 = $ 121,359

If installed added costs of drive equipment are $150,000, the gross payout period will be only 15 months. A good return on investment!

LESS MECHANICAL MAINTENANCE
This area is more difficult to quantify, but is nonetheless real. Using a drive significantly reduces the effort required to keep the variety of airflow-controlling mechanical equipment both operational and calibrated.

REDUCED STARTING DUTY FOR DRIVE MOTORS
Drives greatly reduce the starting duty for ID fan drive motors when compared to conventional across-the-line starting. High-starting currents and voltage dips associated with across-the-line starting are eliminated since only running load current levels are required for acceleration.

NO MORE REPETITIVE STARTING RESTRICTIONS
Due to the high starting duty normally experienced by fan motors, there are often severe repetitive-starting restrictions placed on these motors. The restrictions allow the motors to cool between starts. Such repetitive starting restrictions frequently cause extended delays in plant startup after shutdown. Applying drives to the fans eliminates both the starting restrictions and delays.

LOWER SHORT-CIRCUIT CURRENT
During faults in the auxiliary power system, drives such as the Dura-Bilt5i MV, do not contribute to short-circuit current levels as do constant-speed motors. Since the ID fan motors are often the largest motors in the plant, the reduction in fault duty for switchgear and other system components can be substantial. The net result of the reductions in starting current and short circuit contributions is an increase in the total motor load that can be applied to a single switchgear bus or, for existing systems, a reduction in motor-starting voltage dips and short-circuit duties.

REDUCED WEAR ON FAN SYSTEM
Reduced speed fan operation results in less erosion and wear to fan impellers, tips, and other surfaces subject to erosion. The impinging speed of particulates in kiln gasses is reduced, improving the life of induced draft fan impellers.