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AC DRIVES AND FAN ENERGY SAVINGS

AC Drives Provide Fan Energy Savings Up to 50 Percent

Providing significant benefits in terms of operating energy cost savings, improved reliability, and increased productivity, ac adjustable speed drives are compared to other methods of controlling flow in fan applications.

Estimates put the total quantity of 1/6 horsepower and larger ac motors in service today at 700 million units with approximately 47 million units being added each year. Over 50 percent of the total motors in use are for fan drives and nearly half of these are potential candidates for adjustable speed drives using inverter power supplies.

Two types of fans normally are used to handle air and gases. Axial fans develop static pressure by changing air velocity while centrifugal fans develop the same by increasing kinetic energy. Variable flow systems increasingly are being used because of interest in driver efficiency and the resulting energy savings. Figure 1 illustrates the characteristics of a 300 horsepower HVAC fan for a range of speeds. If constant speed operation is assumed, at a given flow point Q and volume is decreased by a damper, point B, the required horsepower essentially remains constant and static pressure increases.

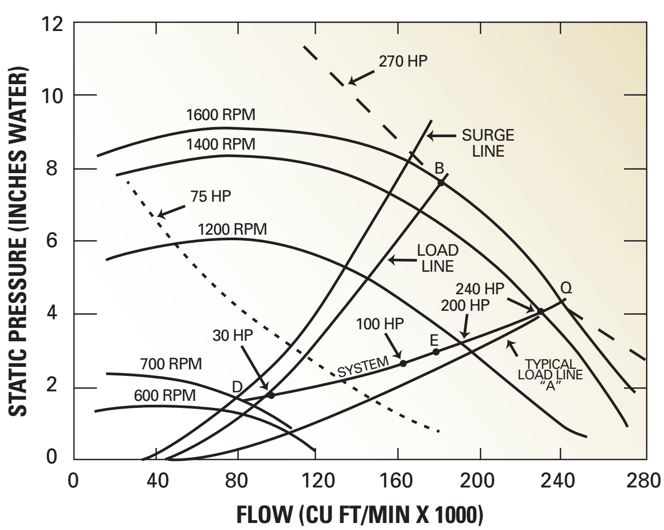

Figure 1

An alternative method of varying flow and reducing power consumption is by controlling fan speed with an ac adjustable speed drive. In the preceding example, moving from point Q to point E, results in a dramatic reduction in required horsepower, almost 50 percent. In this case, the system curve could be followed down to about 700 rpm, which is 2.3:1 speed range change resulting in a 3:1 flow range, and horsepower required decreases by a factor of 9:1.

Energy usage calculation

To calculate the overall energy savings potential of an ac adjustable speed drive in comparison to other methods of flow control requires the load profile of the system (percent time and percent flow) and the fan rated hp at the design flow.

Load Profile	
% Time	% Load/Flow
15	90
25	80
25	70
15	60
15	50
5	0

$$\text{Fan horsepower} = \frac{PQ}{6350N}$$

Where P = Pressure Differential, Inches of H20
Q = Flow, Cubic Feet per Minute (CFM)
N = Fan efficiency

% Power Consumption				
% CFM	Fan	Adjustable Speed Drive Control	Inlet Guide Vane Control	Outlet Damper Control
100	100	124	118	123
90	70	91	99	120
80	50	66	90	116
70	32	45	83	110
60	21	30	78	104
50	13	18	75	96
40	8	12	70	78

Data includes fan, motor and inverter efficiencies as applicable.

Figure 2

The calculation of comparative power requirements is reduced to a table power consumption. Fig. 2, and a set of curves, Fig. 3. Both the table and the graph show comparative power for: ac adjustable speed drives; outlet damper control; and inlet guide vane control.

AC adjustable speed vs outlet damper control

The comparison of the energy savings potential of an ac adjustable speed vs outlet damper control for a 200 horsepower fan at rated flow and at an energy cost of $0.10/kWh is detailed below. In this calculation refer to Fig. 4.

Step 1. For each flow select from Fig. 2 or 3 the percent power consumption for both an ac adjustable speed drive and the flow control method being evaluated, in this case an outlet damper control.

Step 2. Calculate the difference between PPC in Percent Power Consumption (Δ%PC) (see Fig. 3) between the two methods of flow control and then multiply ΔPPC by the percent time run at the design flow rate. This equals the energy savings.

Step 3. Total the energy savings.

Step 4. Calculate the total energy savings for one year as follows:

Total Energy savings =
= .746 x ES x Horsepower x Annual Hours x $/kWh
= .746 x .559 x 200 x 8760 x 0.10
= $73,060.85 saved annually using an ac adjustable speed drive in comparison to an outlet damper control.

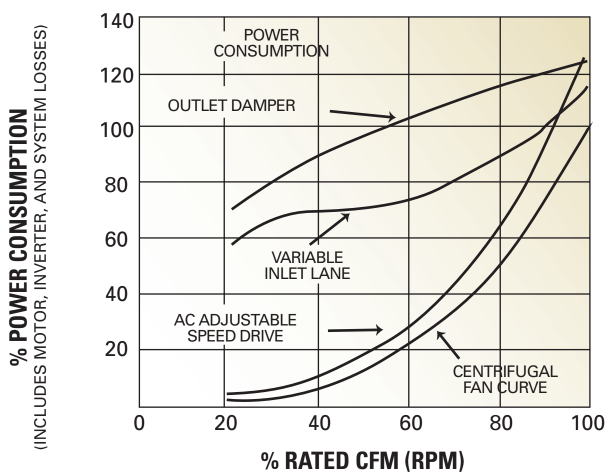

Figure 3

% Flow or System Output	Outlet Damper Control %PC	Adjustable Speed Drive Control %PC	= Δ%PC x	% Time	= Energy Savings
90	120	91	29	15	.0435
80	116	66	50	25	.125
70	110	45	65	25	.1625
60	104	30	74	15	.111
50	96	18	78	15	.117
0	0	0	0	5	0

Figure 4

To determine the profitability of investing in an ac adjustable speed drive, only the difference in inverter and motor starter cost is considered. Motor, isolation/stepdown transformer, feeder breaker and installation costs are approximately the same for either system. However, in new installations additional savings are possible by elimination of damper or inlet vane control and traditional motor starter costs. The energy savings of an ac adjustable speed drive is then compared to the additional inverter cost to determine the Gross Payout Period (GPP).

$$GPP = \frac{\text{Additional Cost}}{\text{Annual Savings}}$$

For many ac adjustable speed drive installations, the gross payout period will range from less than one to two years when flow rate variations are 50 percent.

Other features of an ac adjustable speed drive include a reduction in fan noise. Typically at ½ speed, the reduction in fan noise is 12 dba overall sound pressure level. AC adjustable speed drives also increase mechanical life as the "soft start" feature reduces shock and peak loading on mechanical and electrical equipment during starting.

For specifications not mentioned here, contact TMEIC

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