MV Drives in energy savings

From Yaskawa

Energy efficiency provided by Medium Voltage Drives

Variable frequency drives (VFD) are reliable electronic devices that control three-phase electric motor speed. They are used in industries like Oil & Gas, Cement, Steel, Paper, and utilities Water etc. to control fans, pumps, conveyors etc. and building automation for controlling HVACs. Drives reduce amps during motor starting, lowering demand charges; another significant part of the electric bill. These are less expensive to maintain than mechanical controls. Drives inherent soft-starting reduces wear and tear on motors, sheaves, belts, couplings and other system components.

Upgrading with VFDs is a major part of the Environmental Protection Agency's effort to improve energy efficiency. In addition to making good business sense, installing drives demonstrates corporate environmental consciousness.

Yaskawa the pioneers of drive technology made Japan's first commercially produced PWM (pulse-width modulation), medium-voltage inverters with multi-output connected in series. Building on these already high-level techniques, Yaskawa has made further improvements. The efficiency of the drives relies on the technology it uses and its maintainability. Yaskawa's MV Inverters are compact and maintenance friendly. Most of these drives support built-in PLC function, making them intelligent drives which can function smarter.

MV drives are highly energy efficient and reliable and support functions such as high-level control, trace function, speed searching at momentary power loss, over-load operation for quick acceleration, V/f control for multiple motor operation which make them easy to use.

Higher energy efficiency of MV Inverter is due to the fact that this direct medium-voltage inverter does not need an output transformer, it can maintain power conversion efficiency of approx. 97% so as not to waste energy. Power supply factor is always kept above 0.95. Since the power factor does not change even if the operation speed changes, no power factor improvement capacitor is needed. High efficiency drive is realized by minimizing the motor current to the required output torque. In this way, greater energy saving effect is shown in the drive of fans and pumps to machines for general use.

MV drives are low-cost and space-efficient system to start and operate more than one motor with one drive system. It allows motor systems to have reduced starting current and be transferred between the drive and a fixed frequency line supply without stopping.

MV drives draw minimal inrush currents while starting, minimizing voltage drop and system electrical-stress and facilitates cost savings and system flexibility by using one VFD with synchronous transfer capability, and several input/output/ bypass contactors for multi-motor operation and optimizes energy savings through higher system efficiencies, with much greater savings seen at lower speeds The payback period for installing drives is usually less than three years and can be less than a year.

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(Large energy saving by using inverter drive is enable because power consumption varies due to the drive frequency cubed as following calculation)

$P = (2\pi \times T \times N) / 60$

$T = k \times N^2$

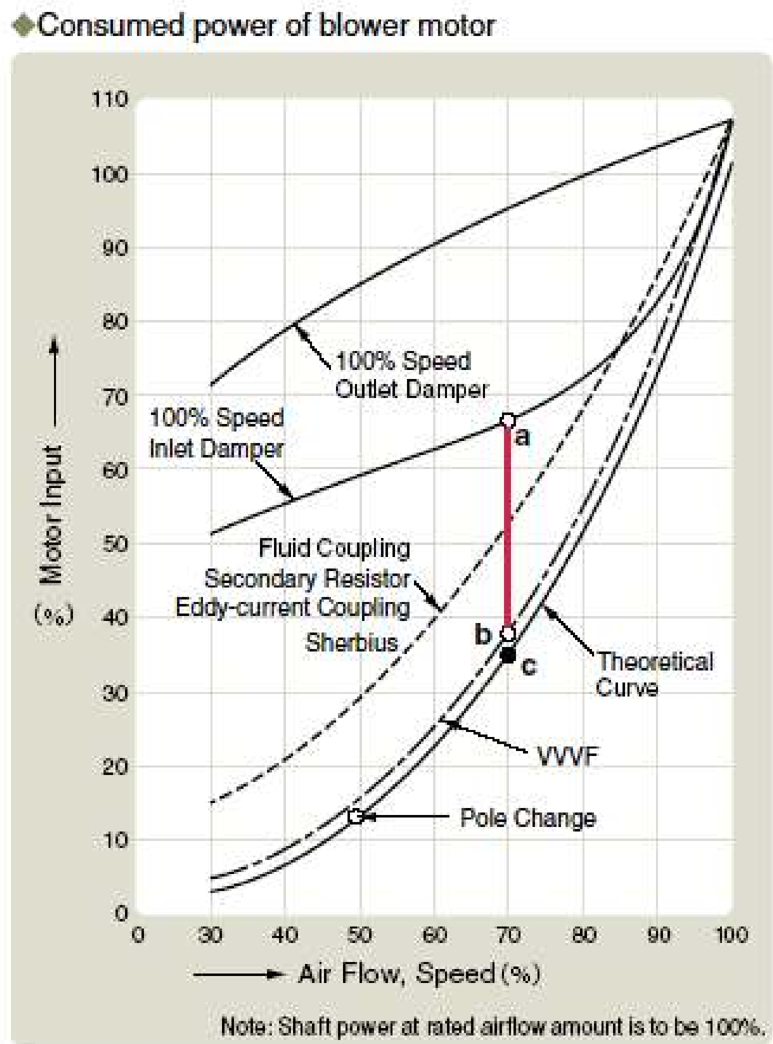
$P = (2\pi \times K \times N^3) / 60$

(P: Power, T: Load torque, N: Motor rotation speed)

Example of energy saving effect calculation

The conditions for calculation are as follows:

(1) Motor applied is SCIM, 3300V, 500kW, 6P Motor efficiency is 95%
(2) 70% airflow operation motor load at 100% airflow operation is 90% of the motor rated load



<u>**Power at inlet damper control**</u>

500 x 0.9 x 0.68 * x 1/0.95 (Motor efficiency) ~ 322 kW

* point a in characteristic curve

<u>**Power at inverter energy saving control**</u>

Motor output (point c in characteristic curve)

$500 \times 0.9 \times (0.7)^3 = 154.3$kW

Motor input power

154.3 x 1/ 0.95 (Motor efficiency)= 162.4 kW

Inverter input power (point b in characteristic curve)

162.4 x 1/0.97 (Inverter efficiency) ~ 167 kW

Power saved

Annual power saving using inverters

(322 – 167) kW x 6000h = 930,000 kWh (assuming that the annual operating time is 6000 hours, equivalent to 8.2 months when operating continuously for 24 hours)

Inverter has frequency control and voltage control function. MV drive has "energy saving control" function which proactively utilizes advantage of voltage control function of inverter. "Control the voltage due to the load"

Following figure shows the connection between motor's slip, torque and efficiency.

Suppose a machine which operates at the rated load T_{L1} have changed its operation condition (the load drops to T_{L2}).

In case of the operation at T_{L1}, the motor runs at slip S1, calculated by P1 (intersection of torque characteristic curve T_{M1} and T_{L1}. At that time, motor efficiency is 90%. In case of the operation at T_{L2}, the motor runs at slip S2, calculated by P2 (intersection of torque characteristic curve T_{M2} and T_{L2}. at that time, motor efficiency is 72%.

But by controlling (reducing) the voltage, MV Drives enables 90% motor efficiency at T_{L2} operation. (Reducing the voltage so that the torque characteristics curve becomes T_{M2}. Then motor slip changes from s2 to s1 and motor efficiency returns to 90%)