Improving motor efficiency

The following is an extract from ABB Review the Corporate Technical Journal of the ABB Group. It covers the area of cost and energy saving as well as reducing the environmental effect of electric motors.

The article states that an estimated 65% of industrial energy is used by electric motors and that this can be reduced in two ways; efficient control of speed at which they run, and making motors themselves more efficient. In the latter case, ABB claim that design and production of motors and the drives that control them are both areas of expertise of ABB Automation.

Optimum motor speed brings best efficiency.

According to the article by far the most effective way of controlling a motor's speed is through the use of variable speed drives. Much control is still performed with throttling valves in pump systems or vanes in fan applications while demands for rotating machinery are solved by gears or belt drives.

Speed control with belt drives, gearboxes and hydraulic couplings all add to the inefficiency of the system to varying degrees and require the motor to run at full speed all of the time. The example is given in trying to regulate the speed of the car by keeping one foot on the accelerator and one on the brake pedal. It is this sort action of running the motor at full speed whilst throttling the output that has the same effect with an estimate of a loss of 20% of industrial energy.

In pump and fan applications. using variable speed drives can cut the energy bill by as much as 60%. A pump or fan running at half speed is claimed to consume only one eighth of the energy compared to full speed.

The efficiency of motors and drives have improved considerably over the years. Motors have improved their efficiency by an average of 3% while ABB AC drives delivered in the past 10 years for the speed control of pumps and fans are claimed to reduced electricity consumption world-wide 30,000 GWh per year with a global CO2 reduction of 25 million tonnes every year.

The report states that in spite of obvious energy saving advantages, 97% of all motors in applications under 2.2.kw have no form of speed control equating to 37 million industrial motors sold annually word-wide. This may have been understandable in the past when a small drive costed in the region of US$500 per kW. But over the past few years, drives across the range have become smaller and cheaper and now start at about US$150 per kW.

The fact they are smaller also means that they can be installed where previously only a belt drive could be used. Another estimate quoted is that by 2002 40% of the value and 90% in units of drive shipped will be rated at 40kW or less.

A new feature announced in the article is the development by ABB of a radical new control technique such as Direct Torque Control (DTC). DTC is claimed to produce dramatic energy saving compared to conventional control methods.

A feature that contributes directly to the energy efficiency is motor flux optimisation which greatly improves the efficiency of the total drive, the controller and the motor in pump and fan applications.

A case in point is the German company Stadtwerke Strausberg, which operates the district heating scheme in the town of Strausberg, 30 km east of Berlin. Its 86-MW power plant produces 190,000 MWh of heating energy, distributed through a 32-km distribution network with seven substations, to most official buildings and 50 per- cent of the private households in the town. The company decided. to upgrade its control system, which was using throttling valves, to one with variable speed drives.

Using the throttling valves to reduce flow increased the head, making the system less efficient as the pump worked harder to overcome the extra head. Temperature changes were too large and fast, and high pressure through the control valves caused loss and noise. The system is now equipped. with variable speed. drives, and works on the principle of keeping constant pressure in the network.

The other major energy efficiency strategy is to make the motors more energy efficient and encourage companies to use them.

USA and Canada which has introduced legislation to improve the environment and specifically target electric motors.

The European Union who have introduced energy efficiency policies under the SAVE and PACE initiatives. It quotes the co-operation between of the EU with CEMEP, the European Committee of Manufacturers of Electrical Machines and Power Electronics to improve the efficiency of motors.

One of the problems that has to faced is the reluctance of users to replace damaged motors with newer more efficient ones opting for re-winds and test carried out show conclusively the fallacy of the argument on cost saving even in the medium term.- See table.

Manage your motors
It claims that users can do a great deal manage their motors and to ensure they are getting the highest efficiency from their motors. A defined motor management policy needs to be in place.

One policy decision should be to select high-efficiency motors when purchasing new plant. Users need to specify minimum acceptable efficiency values. A replace or rewind decision can be made long before failure occurs - there needs to be clear guidelines for all responsible personnel. High efficiency also means improved reliability, and less downtime and maintenance.

Lower losses give;

• Better tolerance to thermal stresses resulting from stalls or frequent starting

• Higher tolerance to poorer voltage and current wave shapes

• Better resistance to abnormal operating conditions, such as undervoltage and overvoltage or phase unbalance

• Increased ability to handle over- load conditions

Rewinding a motor versus purchasing a new one
Example: 75-kW 4-pole motor; continuous running; US$0.063/kWh

Original motor rewind

New ABB motor

Cost of rewind: US$ 2226

ABB high-efficiency motor

Typical capital cost: US$ 3585

Increased annual cost with

Annual energy saving with % efficiency loss:

US$ 613

3% increase in efficiency:

US$ 1435

Actual cost in 1st year: US$ 2840

Actual cost 1st year : US$2150