Benefits of Modern Drives in Mining Applications

White Paper
August 2009

Jeff Boris
Senior Product Engineer
Magnetek Mining

This paper is intended to shed light on modern motor control through past and present control method examples. It is not an in-depth engineering discussion, but is an overview of the state of this technology and its positive impact on future energy use.

Today, there is an increased focus on the cost of energy, both in terms of its monetary value and how its use impacts the environment. Recent fluctuations in the costs of fueling automobiles and heating homes have focused more attention on the energy issue. With the need to reduce energy costs and the focus on the environment, the efficient control of machines that power the mining industry is crucial.

Throughout history, the chosen method of motor control was as simple as turning a motor full on or full off by the use of a contactor control. No means of varying the motor's speed or power requirement was provided or needed. This is still a method used today to reduce control complexity and initial cost and is a sufficient method for some applications. It is the equivalent of an automobile having only two speeds: full gas pedal on or full gas pedal off. As soon as the gas pedal is pressed the engine revs to full RPMs. To slow down, the pedal needs to be full gas off and the car coasts to the intended speed, which would result in poor fuel efficiency.

The inefficient use of energy is also found when electric motor drives are used in applications in which the load requires a varying source of power. Examples include typical fan applications with a drive that varies the speed of the fan to match the air flow requirement in a typical building HVAC system, or a water pump application that needs to pump the flow to match utility customers' demand at any given time during the day.

Just like switching from incandescent light bulbs to more energy efficient fluorescent bulbs in homes and commercial buildings saves energy and money, switching to more efficient methods of motor control can have dramatic effects on energy use. Estimates state that 80% of the motors in use are controlled by "old", inefficient technological methods. This outdated means of controlling electric motors can now be replaced with modern, efficient technology in the form of variable frequency drives.

The real benefit of the modern variable frequency drive is reduced energy costs. A modern drive can reduce a company's or building's electrical needs. Matching the motor's power to the requirement of the load can increase the efficiency of the machine. Multiply this example by the tens of thousands of motors used throughout the world, and one can easily see the need and benefit of more efficient motor control schemes.

To understand today's technologies, it is helpful to look to the past to illustrate the progress made with motor control methods. One of the best uses of motors for transportation is the electric street car. Once used in every major city, the trolley represents how inefficient the use of DC motor control can be.

Using two DC motors, one on each wheel set, or truck, the street car was powered by an overhead wire, or trolley system. The wire conducted the electrical power through the trolley pole to the operator control system. This control was relatively simple: the motor's speed and torque was controlled by varying the field current through a bank of fixed resistors. A simple series motor with the armature and field wire in series is used. The operator controller jumped out fixed resistors in series with the motor, which had the effect of controlling motor speed. With the fixed trolley voltage, the only way to reduce power to the motors was to burn off energy by tapping the resistor banks. The resistors wasted energy in the form of heat. The efficiency of this control method can be as low as 50%. Later advances put the motors in parallel or series with each other, but still caused inefficiencies.

A good example of using the modern AC or DC drives is the mining locomotive. Mines have long used these rail machines to transport personnel or equipment and to haul coal and other minerals. Sometimes called mantrips, personnel carriers or locomotives, these machines are extensively used throughout the mining industry. Often controlled by the same method as the old trolleys, these machines have been slowly changing to more efficient motor control schemes. These machines most often have two electric motors, one powering each drive axle, and are powered by an overhead wire, or trolley system; DC battery; or both. Typical supply voltage is usually in the 120 Vdc to 300 Vdc range.

What if we could increase the efficiency of motor control, using only the torque or speed requirements for a given application and not waste valuable supply energy, greatly decreasing our demand on the utility or battery supply? Fossil fuel usage would decrease along with the emissions that result from generating this electrical energy. The same regenerative technology used in the most fuel-efficient hybrid cars has been used for many years in the mining industry. When traveling down a grade in a hybrid vehicle, the braking force can be converted to electricity from a generator connected to the wheels of the car. This energy can then be stored in rechargeable batteries used when accelerating by means of an electric motor coupled to the wheels.

Employing either a modern DC or AC drive system, these machines have become more efficient with the use of modern Insulated Gate Bipolar Transistor semiconductor technology. The regenerative braking capability allows these inverter drives to deliver energy back into the battery during braking as hybrid cars do. Another important advantage of the regenerative braking is less wear on the air brake system. Applications using regenerative drives include mining locomotives, coal haulers and other machines.

Magnetek's Severe Duty AC Traction Drive, the SD500™, is an example of a modern inverter drive used for mobile equipment applications in the mining industry. It is designed to be used in underground environments on such machines as scoops, battery haulers and locomotives. Other high-performance applications include hybrid cars, buses and airport ground support mobile equipment. With the capability to run in Flux vector mode, this drive can deliver as much as 240 kW of peak power. It can be connected to a permanent magnet motor or a typical induction AC motor. These modern digital drives have diagnostic tools to help maintenance personnel troubleshoot the drive for increased up time.

Modern electric motor controls must safely and reliably power the machines that produce the country's energy supply while also conserving the energy needed to power the machine. Today, the coal mining industry is actively conserving precious fossil fuels, not only in their customers' power plants, but also during the mining operation. To increase coal production while reducing energy, labor and accident rates, the mining industry is in the forefront of using this innovative, regenerative drive technology.

122 Gamma Drive RDC Park Pittsburgh, PA 15238 888.428.2299 f 412.963.1428 www.magnetekmining.com