Mobile Actuators Reach Lofty Goals

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Off-highway vehicle manufactures are taking another long, hard look at the way they have been using motion-control systems to move loads and other articulating members on their mobile machinery. The reason is, they can improve at least three significant factors; reduce fuel consumption by making the vehicles lighter and more efficient, maintain a cleaner environment when the components don't leak fluids, and most significantly, reduce installation and maintenance costs with simpler systems. And one successful approach many manufacturers have taken recently is to replace hydraulic systems with electric actuators. However, actuators aren't limited only to retrofitting existing hydraulic systems. The same design rules apply equally well for those OEMs that want to start with an advanced vehicle -- perhaps already on the drawing board.

Pros and Cons

Of course, not all mobile, off-highway vehicles are perfect candidates for electric actuators. For example, hydraulic cylinders may be better suited for loads over 2,000 lb or when moving loads with extremely short strokes at 100% duty cycle. But it's definitely worthwhile to investigate all other applications -- and there are many -- because the dividends benefit more than the environment, it also brightens the company's bottom line. For instance, electric systems eliminate bulky, heavy hydraulic power packs and use the existing battery power, replace cumbersome and dangerous hydraulic hoses with relatively small wires, and use actuators that are usually smaller, lighter, and faster than hydraulic cylinders developing the same force and stroke. Moreover, electric actuators run quieter, while hydraulic power supplies are notoriously much noisier. All these factors add up to more sense and less expense.

How to Size and Install Actuators

It's fairly easy to figure out how design engineers can attack the problem of electrification. Only three relatively simple steps are needed to determine the size of the actuator for an application: measure the load, determine the actuator's duty cycle, and specify its stroke and retracted length. The first step -- know the load -- may not be straightforward or as easy as it may appear. Often, the precise load or forces placed on the actuator (whether it is a hydraulic cylinder or an electric actuator) is not immediately known because intermediate linkages can generate mechanical advantages or worse, disadvantages. More sophisticated designers may have the tools to simulate the mechanical system on a computer and calculate the loads with some precision. However, most designers measure the actual load with a load cell on the mechanism or select the worst-case load, and with trial and error, find the actuator that can lift that load. The latter approach might be a little costly for a hydraulic system, but it's relatively inexpensive and simple for an electric actuator. For example, when the first electric actuator selected might not lift the load with the stroke and velocity required, often all that's needed is to replace the internal clutch and the gears with a different ratio and run with the same size package.

Yet another alternative for determining the load is to install a "calibrated" actuator of more than sufficient size to move the unknown load. This actuator comes with a calibration curve that shows a plot of load or force in lb vs. the motor current. Working in reverse, anyone can measure the motor current while moving the load over the specified displacement, record the maximum current, enter that current on the graph, and read out the load. Then select an actuator based on that load for production that is just sufficient to move the load over all the duty cycles that will be required.

A major difference between hydraulic cylinders and electric actuators is the way they are rated. Their operating parameters can't be compared on a one-to-one basis. That is, cylinders operate under continuous ratings while actuators operate only intermittently. Hydraulic power supplies must run continuously to provide a reservoir of pressure with sufficient fluid flow for potentially any move to be commanded. These requirements demand that the system pressure always be at full rated value and driven with a pump that is usually overrated to handle peak loads. Consequently, hydraulic systems consume energy continuously. Actuators, on the other hand, use power only when they are activated, and are normally rated to handle the full load at a minimum of 25% Furthermore, the power consumed at the rated duty cycle is so minimal that the OEM's original batteries are usually sufficient to handle the load. They need not be supplanted nor "beefed up."

The third major design consideration is the full-length stroke required and the retracted length of the electric actuator, especially when it replaces a hydraulic cylinder. Cylinders may have a smaller retracted length than actuators, so mounting hardware might have to be modified slightly. But such modifications are seldom necessary.

Another concern is the ambient temperature range in which the system operates. Actuators come with internal thermal overload switches that self-reset after exposure to excessively high temperatures, whether the heat comes from the surrounding environment or is internally generated by occasionally operating the actuator above its rated duty cycle. On the other hand, electric actuators run efficiently at low ambient temperatures, while hydraulic cylinders tend to become more sluggish.

One last consideration deals with the load's motion. Actuators push and pull, raise and lower, roughly position, shake, and rotate the load consistently with constant force and displacement in one direction, but they experience a little gear lash when reversing direction. Cylinders are not quite as stiff; they tend to be somewhat cushy in both directions.

When to Use Electric

The decision to go electric, however, hinges on considerably more than just the actuator, although it's a key component. A basic electrical system is much simpler. It comprises only the actuator, a three-position DPDT switch, a fuse, and a few wires. Such an electrical system can be put together by almost anyone who can read a simple wiring diagram. Compare this architecture to the hydraulic system that requires special technical expertise to fabricate hydraulic hoses and lines and install fluid power components so they leak only minimally. Hydraulic systems need many more components including pumps, valves, hose fittings, a pressure regulator, and a manual, joystick-type control valve. Moreover, electric wires can be installed anywhere, especially in places that are not as easy to reach or as safe for cumbersome hydraulic lines. And the few electric components that do comprise a complete system are generally smaller and lighter than most fluid-power components. Simplicity is the overwhelming, compelling feature of the electrical system. Electric actuators have the additional flexibility of being controlled by switches using IR or RF hand-held controls.

Electric actuators also are easy to control when the application calls for more than simple two-way manually operated motion. Some systems, for example, require an actuator to cycle for a specified number of times at various strokes and then halt. This is an easy task for a small programmable logic controller (PLC), and it's just as easy to interface to an electric system. And even more complex motions are quickly and easily programmed with the PLC. Similarly, an extremely simple electric speed control is no more than a potentiometer regulating a pulse-width modulated (PWM) system. Obviously, it's not quite as easy or inexpensive to interface a hydraulic or an electric controller to a fluid-power system and run the same profile.

In addition to a programmable response, a basic requirement for most applications calls for the cylinder or actuator to hold the load in a specified position for a period of time. Actuators inherently hold loads in position either under power or without, making them safer than one-way cylinders. Nothing more needs to be added to the electric system to accomplish this, but the hydraulic cylinder needs safety check valves in the cylinder to hold the load in the event a hose breaks. In comparison, a cut, removed, or damaged wire in the electric system does not affect it.

Electric actuators also are easy to adapt to a variety of power supplies. The most common power used on off-highway vehicles is 12 Vdc, but 24, 48, and 90 Vdc or 115 Vac supplies are just as easy to handle since a wide range of motors are readily available that fit the same actuator envelope. In fact, moving up to 24 or 48 Vdc is a benefit since the current draw becomes less without decreasing the peak torque delivered to the load. Lower current at a higher voltage also means that smaller diameter wires can handle the same power, lowering the system's installation cost.

Safety Concerns

Electric actuators also are safer for operators because they reduce fatigue with simpler, easier-to-use controls, and they eliminate the inherent dangers to the people who maintain hydraulic power supplies and high-pressure fluid hoses. Moreover, electric actuators can push and pull the load and don't depend on ancillary brakes, directional control valves, or the load itself to hold position, as do hydraulic systems.

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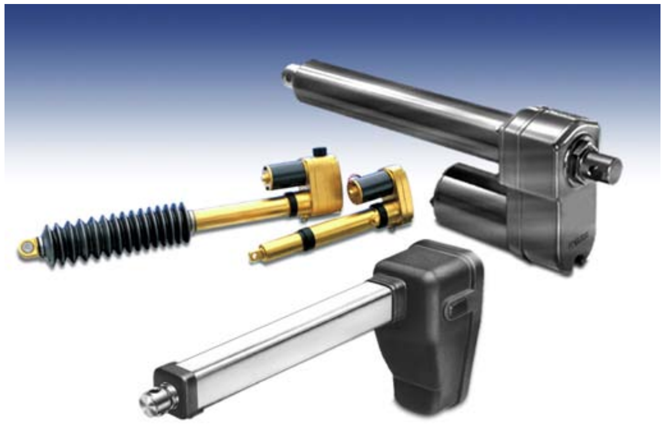
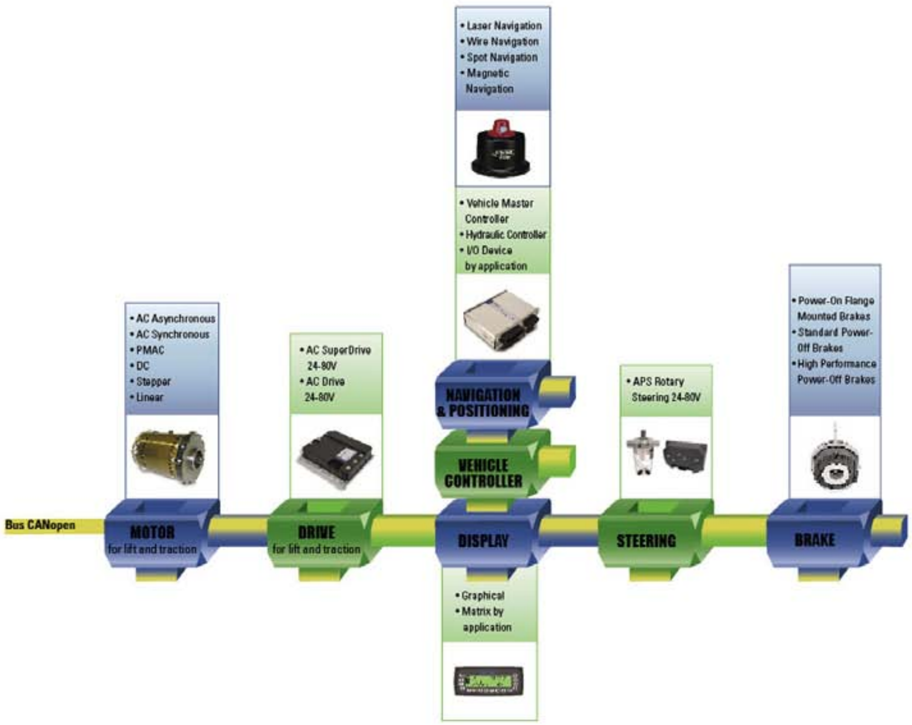
Electric actuators are increasingly being used to position loads on new mobile, off-highway vehicles and machinery including recreational vehicles, sprayer booms, snow blowers, and turf, garden, and agricultural equipment. Actuators are also replacing hydraulic cylinders in existing equipment where more compact, rugged, and cleaner positioning components are essential, such as in lawn-care equipment for expensive golf greens where hydraulic leaks can't be tolerated.



Electric actuators replace hydraulic cylinders in mobile off-highway vehicles to eliminate troublesome fluid leaks and make the vehicles smaller, lighter, and quieter.

Thomson Electrak long life actuators are compact, light duty DC actuators that deliver unparalleled performance under adverse conditions, such as mobile off highway and agricultural applications. Completely self-contained and sealed for outdoor use, these actuators fit into small areas without sacrificing power or reliability. The load/length configurations available cover a diverse range of intermittent duty applications requiring lifting, positioning, sorting, opening, clamping and adjusting.



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