Advantages of hydraulic actuators

The global market for actuators is dominated by electro-mechanical and pneumatic devices, with electro-hydraulic coming a poor third, this is despite hydraulics been around for many years for example in 1883 the London Hydraulic Power Company was set up which provided a water hydraulic ring main round central London using water from the river Thames to power lifts, theatrical scenery and other devices, the system was disbanded in 1977. There are a number of key factors that have kept the use of hydraulics to a small part of the market such as cost, historical domination of electric and pneumatic actuators, and potential oil leakage. The following article extols the benefits of using hydraulic actuators from ultra low power requirements to high speed control and looks at how the factors above are being tackled.

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Electro-hydraulic systems are highly efficient in converting electrical energy into useful work whether it be a linear thrust or torque output, couple this with the flexibility of hydraulics due to the huge range of components available to make up an actuator you end up with a range of products that can meet both standard and specialist applications.

Speed

The speed of a hydraulic actuator can be achieved by several methods, by fitting a large pump, using hydraulic accumulators or by using an integral spring pack. Electro-hydraulic actuators have been manufactured to move valves with a thrust requirement of 900 kg (1980lbf) a distance of 60 mm (2.36 inches) in 45 milliseconds The speed of the actuator to a greater degree is almost independent of the load or torque unlike an electro-mechanical device where the higher the load the slower the speed generally applies.

Accuracy

For very precise positional control hydraulics come in to their own, with the near incompressibility of hydraulic oil coupled with the use of hydraulic servo valves that regulate flow to the actuator, positional accuracies of 5 micron, repeatable, have been achieved. Such systems were designed using standard hydraulic components.

Generated forces

The incompressibility of oil gives another benefit that of being suitable for working at high pressures. Pneumatic systems tend to work between 4 to 10 barg whereas hydraulic units using standard, readily available components can operate up to 207 barg. This means that for high torque or high thrust applications there is a significant size reduction compared to pneumatic actuators. One has not only to consider the size of the actuator but the knock on effect regarding the size of compressor and receiver needed to support a large pneumatic actuator.

Consider a thrust of 5000 kg using the basic formula - Pressure = Force/Area, we can calculate the area needed for a piston type actuator to move this load. We have to use the minimum operating pressure supplied by the pneumatic system which is 4 barg, this gives an effective area of 1250 sq cm. If we use 180 barg for the hydraulic unit then the effective area is 28 sq cm about 45 times smaller than the pneumatic equivalent. As a further example Advanced Actuators has been asked to look at an actuation package that will develop 700,000 kg force, we can achieve this with a hydraulic cylinder with a diameter of 760 mm.

Ultra low power

Conservation of energy is an important factor in today's world, it is expensive and it is believed that conventional power generation adds to global warming, plus we only have a finite amount of carbon based fuels.

With the efficiency of the hydraulics in converting electrical energy to useful work the graph below shows what is achievable comparing power required against linear force that can be generated. The power required is for the complete electro-hydraulic actuator to which a low power position controller can be fitted to give modulating duty.

Such small power requirements can easily be provided by solar arrays or other unconventional low power generation systems.

It can thus be seen that hydraulic actuators have a high degree of flexibility, can be used to reduce power requirements and physical size, but what about cost and leakage?

In the past most hydraulic actuators were bespoke as they were only ordered in small batches and generally for applications that were of a specialised nature, however there has been a push on standardization of the product which has allowed for components to be bulk purchased and thus driven the cost down.

Leakage has always been an issue with any hydraulic system; this has generally been down to engineering design with the engineering capabilities not being to the standard required for hydraulic systems. The better machining techniques and sealing systems leakage can now be engineered out of the equation. Consider the car, vintage cars are renowned for leaving puddles of oil but today's modern cars do not suffer from this problem, it has been engineered out, the same applies to the modern day actuator.

The historical usage of electric and pneumatic actuators can only be changed with time and education that hydraulics should be considered more often as a solution to actuator requirements.

About the author

Chris Woodhead is an experienced actuator specialist with over three decades of manufacturing, design and sales expertise. As director of Yorkshire-based Advanced Actuators, Chris oversees and facilitates international contracts across multiple industries including oil & gas, power generation, nuclear and industrial markets.