By Walter F. Stridick and Noel Laukaitis, Lehigh Fluid Power, Inc.

Special Considerations for the Selection and Use of

Pneumatic AND Hydraulic Actuators

for Marine Applications

Pneumatic and hydraulic actuators are found in many various offshore and marine applications around the world. You will find shipboard actuators controlling vessel steering mechanisms, hatches, winch brakes, boom cranes, and engine governors. Other marine applications include use on remote-operated underwater vehicles, various uses on drilling platforms, process control valves, and even in tidal/wave action power generation devices.

Standard off-the-shelf steel or aluminum actuators (pneumatic or hydraulic cylinders) are not always the best choice in marine applications. Experience has shown that use of pneumatic or hydraulic actuators in marine applications demand that attention be paid to corrosion prevention and suitability for use in or near saltwater

In and around saltwater environments, corrosion is a major concern. As you can very well imagine, it would not be good if a critical actuator failed because the components rusted away. The easiest way to reduce corrosion is the use of corrosion-resistant materials such as stainless steel or plastics. Use of either of these materials has downside potential--stainless steel is expensive and plastics don't always provide the required material strengths.

Stainless steel is available in various grades, each with differing corrosion resistance and strength properties (Fig. 1). The most common grades of stainless steel used in actuators are: 303, 304, 316, and 17-4PH.

17-4PH is a hardened stainless steel suitable for use as actuator piston rod and tie rod material. While other grades of stainless such as 304 and 316 may have higher corrosion resistance ratings, they also have lower yield strengths. This may make 304/316 series stainless ill suited for cylinder parts that require high strength.

Whatever the material you have chosen for the piston rod, chrome plating the rod stock helps increase the seal life expectancy of your cylinder. If stainless steel is not required or deemed to be excessively expensive, composite or carbon steel materials can be used with caution.

Certain fiber-reinforced based epoxy matrix composites will resist corrosion no doubt, but they have pressure and fluid limitations that prevent their use in certain types of cylinders. Another factor that limits the use of some composites are their limited resistance to UV light, which can cause the materials to become brittle or weak.

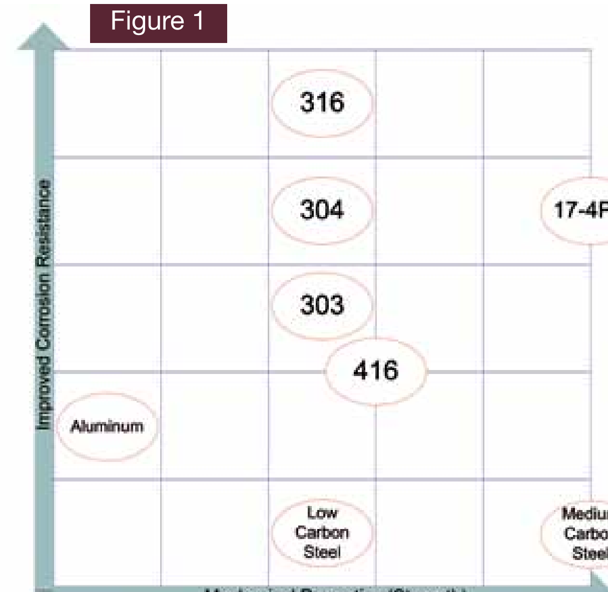
Carbon steel is the most common material used in actuators and in certain applications, and when combined with stainless steel piston rods and tie rods, steel can be a great, cost-effective alternative material choice, especially when the exterior of the cylinder is coated with marine-grade epoxy paint. When properly applied, this combination provides a durable cylinder that is substantially less expensive than a stainless steel cylinder. In some instances, epoxy paint can be applied over parts that have been electroless nickel-plated, which increases corrosion resistance even more (Fig. 2).

Corrosion resistance is not the only item to be concerned about when making choices about actuators for offshore and marine use. Material selection for seals and bearings also needs examination.

The increasing popularity of environmentally safe hydraulic fluids has increased the use of alternative materials for cylinder seals. Industry standard nitrile and urethane seals may not be compatible with certain hydraulic fluids that are used in the marine industry. It is always wise to determine the compatibility of the cylinder seal material with the hydraulic fluid you plan to use.

If your cylinder will be used in a submerged application, it is best to use a rod gland design that resists external pressures and fluids. Doing this will increase the life expectancy of the rod bearings and seals internal

Figure 1



Courtesy Lehigh Fluid Power, Inc.

Figure 2 Courtesy Lehigh Fluid Power, Inc.

Figure 3

Pneumatic Spring Retract Cylinder
Courtesy Lehigh Fluid Power, Inc.

to the cylinder, which prolongs the cylinder's MTBF rate.

Rod bearings create another potential trouble area for marine actuators. While ductile iron is commonly used in various cylinder rod bearings, corrosion and abrasion are two good reasons to seek alternate bearing material. Bronze rod bearings have been used for many decades in the actuator industry. This material is well suited for use as a rod bearing due to its anti-corrosive nature and ability to resist wear. Other materials that are well suited for marine use include composites such as Rulon and Duralon.

In addition to material choices, there are design criteria that need to be considered when employing actuators. Certain applications require extra attention be given to failure modes and fail-safe operation. While not many mechanical devices can be 100% reliable throughout their lives in or near the ocean, thought must be given to the possibility of pressure loss, hose failure, or other events that would cause damage to the environment or to the safety and welfare of living things.

In these situations, spring cylinders are often employed for safety's sake. When engineered and commissioned properly, spring cylinders can provide a predictable fail-safe position. Simply stated, spring cylinders are designed to move the piston and piston rod to the fully extended or fully retracted position upon loss of operating pressure.

Process valves such as pinch valves or knife valves often use spring cylinders to ensure that the flow of material is automatically stopped in the event of pressure loss.

Another example of a spring cylinder application in a marine environment is for use with shipboard hatch locks (Fig. 3). If pressure is lost, spring cylinders will automatically close the hatch and engage locking pins ensuring that the hatch will stay locked until pressure is restored or a manual override is employed.

Spring cylinders have also been successfully used to engage braking mechanisms on winches to prevent unintended runaway of the winch in power loss situations. Pressure is applied to a band brake when the piston rod is fully extended or retracted (depending upon the cylinder and brake design), thus preventing unintentional runaway by the winch spool.

Successful use of spring cylinders is a bit more complicated compared with typical double-acting cylinders. Three critical requirements must be known to ensure the proper design of the spring cylinder: spring preload, spring final load, and minimum operating pressure. Be sure to consult with cylinder personnel that have the experience level required to properly design a cylinder that will meet your specifications.

Whether used in a small-bore pneumatic or large-bore high-pressure hydraulic application, the double-acting, spring extend, or spring retract actuators, when properly designed with the right materials and seals, can provide robust, simple, cost-effective means of movement in many marine applications.

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