COMPOSITE FINISHED CYLINDERS DESIGN GUIDE
INTRODUCTION

An innovator inherently requires the ability to create new solutions for existing engineering obstacles. Polygon’s custom finished cylinders are just such a creative solution. Since the inception of composite materials, there has existed a tension between traditional metallic manufacturing methodologies and those more suited for composites.

For over twenty years Polygon has supplied the fluid power industry with cylinder tubing know as PolySlide®. PolySlide has and continues to be a superior substitute for cylinder manufacturers currently using aluminum, stainless steel or brass. The most significant issue facing traditional metallic cylinder companies is how to design fluid power devices incorporating the unique material properties of composites. Without having a thorough understanding of the interplay between fiber path geometry and resin performance capabilities, which afford unique and differing architectures, the full utilization of any given composite construction may not be fully utilized.

Polygon has been addressing this engineering conundrum for over 60 years, so educating the engineering community while simultaneously offering creative solutions is a natural part of our culture and heritage. We actually registered a phrase years ago to describe the special way in which composites can be engineered to handle specific loads via fiber path geometry coining the term Stress Vectored Composites®. Composite materials are not “plastic” or “metallic” therefore requiring a fresh approach to manufacturing and assembly.

Polygon has created a significant amount of intellectual property (IP) revolving around the ability to create fluid power pressure vessels. This technology is part of Polygon’s commitment to enable cylinder entities with the ability to incorporate PolySlide cylinder tubing into finished products without compromising the beneficial properties composites afford. In unique markets not being addressed by established cylinder suppliers, Polygon provides a finished cylinder solution. Polygon licenses other companies with the ability to approach this market incorporating this vast resource base of existing and evolving IP.
SNAP FIT ASSEMBLY
This is a very unique design for a traditional market sometimes referred to in the industry as a “throw away”. Injection molded heads are mechanically locked via a machined groove on the inside diameter of the composite tube. A thermoplastic wedge is placed within the cylinder to secure end caps. The burst pressure of this patented approach actually exceeds that of aluminum or stainless rolled end retained cylinders. Some standards are available incorporating this approach.

PINNED ASSEMBLY
In this assembly design studs, rivets, pins or fasteners are used to mechanically affix the cylinder heads to the composite tube body. A very robust design which has been used for many years in the trucking industry supplying hundreds of thousands of cylinders in a very vibration filled and demanding application.

PRESS ASSEMBLY
Probably the area in which Polygon has created the most unique attachment design technology. Composites are elastic materials which can be used as retention forces to hold things in place if designed properly. The marriage of fiber path geometry and the elastic properties of composites have yielded an ability to insert metallic ends into the cylinder and hold them solidly and rigidly in place. No secondary conditions are necessary to create this pressure vessel. Thousands of these cylinders are produced every year primarily in pneumatic applications serving the transportation industry.

ADHESION ASSEMBLY
Many engineers get uncomfortable when the idea surfaces regarding the incorporation of adhesives into a pressure vessel design. The aircraft and aerospace community has successfully demonstrated for decades that bonding composites can actually prove to be a superior design over metallic welded or fastener attachment approaches. Polygon has produced bonded metallic ends to PolySlide cylinder tubing in hydraulic applications achieving ultimate burst pressure strengths approaching 10,000 psi.
**COMPOSITE CYLINDER TUBING**

Composite pneumatic and hydraulic cylinders

---

**THREADED/SNAP RING ASSEMBLY**

There is an opportunity for carrying forward some existing and traditional cylinder manufacturing approaches used similarly with metallic constituents. PolySlide® can be threaded to some degree, as well as having a machined snap ring groove for head retention purposes. Special engineering attention is warranted with respect to thread and snap ring profile geometry. Composites require radiuses to minimize or assist in diminishing localized sheer forces.

---

**EMBEDDED SENSING ASSEMBLY**

No where are the unique design properties more evident than in the ability to embed metallic or sensing materials within the wall of the composite laminate. Polygon is leading the design community by advancing this technology through the creation of sensing cylinders. As part of the manufacturing process Polygon is able to incorporate, within the laminate wall, various conductive agents, metallic wiring or even circuit logic to create devices that are not only pressure vessels but sensing devices as well. Please contact Polygon's engineering department to discuss the unique developments in this cylinder approach.

---

**METALLIC SLEEVED ASSEMBLY**

Polygon has developed a unique approach that allows a hybrid design incorporating a composite sleeve within a metallic outer tube. The composite inner tube carries almost the entire pressure force; while the metallic outside tube keeps the structure round as well as enabling the assembly using traditional approaches such as threaded or welded end caps. Inexpensive and low grade aluminum or steel tubing can be used as the outer tube which does not require honing, plating or other secondary preparation.

---

**COMPOSITE ROD ASSEMBLY**

The quest for lighter weight cylinders has uncovered the single largest element contributing to weight is the piston rod. Solid metallic rod is both expensive and heavy. Polygon has engineered, designed and manufactured its own composite piston rod for several years. This composite rod has also proven successful after years of field testing and actual use. The use of composite rods within the fluid power industry is growing rapidly and new technology is constantly being applied. Corrosion resistance is a natural byproduct of incorporating composite rods into the assembly.
TIE-ROD ASSEMBLY
Incorporating traditional tie-rod designs into composite cylinders is easy and natural. In most instances all of the metallic constituents can be inter-changed by simply swapping the metallic barrel for a composite one. Seals, clevis ends, rods and nuts are all the same as in a conventional metallic tie-rod cylinder. Torque forces used to compress the tie-rods are slightly different when using a composite barrel. Recommended torque forces are published and available for these applications.

BUSHING ASSEMBLY
PolyLube® rod guide bushings are the natural choice when building any metallic or composite cylinder. The PolyLube rod guide bushing has demonstrated capability through years of use outperforming bronze, thermoplastic or any variation of alloyed cast iron bar products. The unique semi-elastic conformal properties of composites allow the bushing to wear in a more unified and load distributed manner.

COMPOSITE PISTON ROD
Another issue in weight reduction while maintaining optimum strength, other than the barrel material, is the piston rod. Polygon has engineered a family of composite piston rods that can replace their metallic counterparts in certain applications, offering significant weight reduction (see photo to right).

Polygon Company’s composite piston rods have been used successfully in commercial applications, proving their worth as a method of weight reduction. An added side benefit is that composite rods are corrosion resistant. This property is especially helpful when used in machinery exposed to caustic materials and/or cleaning agents.
DO NOT: use any other colors than what is listed, unless you get permission from Jim Shobert.
DO NOT: use this logo with any fades or 3-D effects.
DO NOT: use any outlines or drop shadows.