Tie Rod Cylinders
Sales Guide

The Features, Advantages and Benefits which make Parker's tie rod cylinders the right choice for every application
FROM FIRST PRINCIPLES...

A *hydraulic cylinder* uses pressurised fluid bearing against a piston to generate a controlled force which can be used to move, lift, hold and compress. The simplest type of cylinder, which applies force in one direction only, is called a single-acting cylinder. Single-acting cylinders are usually returned to their unpressurised or starting position by the effect of gravity on the mass which they have raised.

By applying pressurised fluid to both sides of a *piston* in turn, fluid energy can be used to ‘cycle’ a cylinder in both directions – this type is known as a double-acting cylinder. These are the most commonly used type of cylinder, found on equipment as diverse as machine tools, wind turbines and backhoe loaders.

Hydraulic cylinders are not new – water-based systems were in use over 100 years ago – but today’s hydraulic cylinder is a highly sophisticated product. The Features, Advantages and Benefits (FABs) shown on the following pages illustrate why the tie rod hydraulic cylinders produced by Parker Hannifin are the best available.

**Technical Terms**

Some of the terms used in this guide have specific meanings in the context of hydraulics. Words shown in *italics* can be found in the glossary on page 22.

---

*A single-acting cylinder*  
Gravity

*Fluid Pressure*  
Double-acting cylinder

---

**CONTENTS**

<table>
<thead>
<tr>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gland and Seals</td>
<td>4</td>
</tr>
<tr>
<td>FAB 1 Detachable gland</td>
<td></td>
</tr>
<tr>
<td>FAB 2 High performance seals</td>
<td></td>
</tr>
<tr>
<td>Piston Rod</td>
<td>6</td>
</tr>
<tr>
<td>FAB 3 Rod material</td>
<td></td>
</tr>
<tr>
<td>Piston Assembly</td>
<td>7</td>
</tr>
<tr>
<td>FAB 4 Design and construction</td>
<td></td>
</tr>
<tr>
<td>FAB 5 Spiral piston grooves</td>
<td></td>
</tr>
<tr>
<td>Piston Seals</td>
<td>9</td>
</tr>
<tr>
<td>FABs 6-11 Standard seal range</td>
<td></td>
</tr>
<tr>
<td>Body and End caps</td>
<td>13</td>
</tr>
<tr>
<td>FAB 12 Materials and construction</td>
<td></td>
</tr>
<tr>
<td>FAB 13 Specification</td>
<td></td>
</tr>
<tr>
<td>FAB 14 Torque-loaded tie rods</td>
<td></td>
</tr>
<tr>
<td>FAB 15 Pressure-energised body seals</td>
<td></td>
</tr>
<tr>
<td>Mountings</td>
<td>16</td>
</tr>
<tr>
<td>FAB 16 Wide standard range</td>
<td></td>
</tr>
<tr>
<td>FAB 17 Nitro-carburised trunnion pins</td>
<td></td>
</tr>
<tr>
<td>Cushioning</td>
<td>18</td>
</tr>
<tr>
<td>FAB 18 Self-aligning cushions</td>
<td></td>
</tr>
<tr>
<td>FAB 19 Adjustable cushion valves</td>
<td></td>
</tr>
<tr>
<td>FAB 20 High-flow check valves</td>
<td></td>
</tr>
</tbody>
</table>

“*The twenty facts you need to know to sell tie rod cylinders successfully*”

**And don’t forget...**

Ports, air bleeds, gland drains, transducers, position switches, double-rod cylinders

Glossary of terms

Range summary
GLAND AND SEALS

If a cylinder develops a leak, it is most likely to be from the gland. Premature seal failure may be caused by the presence of abrasive particles – either from the external environment or carried in contaminated fluid. Seals can also fail due to excessive temperatures or unsuitable seal materials for the application, or through premature wear caused by excessive side loading.

FAB 1 – Detachable gland

FEATURE
Separate, detachable gland assembly, manufactured from high strength bearing brass and featuring a long bearing surface. (Note – some competitors, eg: Rexroth, fit gland seals into grooves machined directly in the head)

ADVANTAGES
+ maintenance is quick and easy – tie rod torque is unaffected by removal, and cylinder alignment and body sealing are undisturbed
+ gland is lighter and easier to manage and easier to store than a complete head assembly
+ gland assembly is more economical to replace than a complete head assembly
+ seal fitting is easier
+ gland can often be replaced without removing the cylinder from the machine
+ lubrication by system fluid minimises wear

BENEFITS
✓ lower cost of ownership
✓ minimal downtime
✓ reduced handling risk
✓ minimised fluid loss
✓ improved health and safety environment
✓ lower cost of storage

FAB 2 – High performance seals

FEATURE
The gland seals comprise a double lip wiperseal and a ‘serrated’ lipseal which features a series of sealing edges. Seals are available in a wide range of materials, to suit different temperature ranges and fluids. Gland kits include seals pre-fitted.

ADVANTAGES
+ ‘dry rod’ performance – the lipseal’s series of sealing edges act progressively as pressure increases on extension, while permitting trapped oil to re-enter the cylinder on the return stroke
+ double lip wiperseal prevents dirt from entering the cylinder, and fluid escaping
+ polyurethane seal compounds, supplied as standard, offer up to five times the working life of nitrile seals

BENEFITS
✓ longer system and component life
✓ hazardous fluid leakage is avoided
✓ lower maintenance costs
PISTON ROD

The piston rod has a dual function. It transmits the force generated by the fluid acting against the piston, and it guides the direction in which that force is applied. This second function leads to one of the commonest causes of early seal failure: if the piston rod and the machine member to which it is attached are not precisely aligned, side loading of the piston rod will cause rapid wear to one side of the gland and seal assembly. The result: contaminated fluid, leakage and, potentially, rod breakage.

FAB 3 – Rod material

FEATURE
High tensile, carbon alloy steel piston rods, induction case hardened, plated and polished to a 0.2µm finish. *Note – some competitors, eg: Rexroth, offer non-hardened rod as standard. Hardened rod, standard on Parker tie rod cylinders, is an extra-cost option*

ADVANTAGES
Exceptional resistance to denting, scoring and external damage results in:

- efficient fluid retention
- long seal life
- sustained high performance
- reduced maintenance requirement
- minimal downtime

BENEFITS
✓ higher productivity
✓ improved health and safety environment

FAB 4 – Design and construction

FEATURE
One-piece steel piston with wide bearing surfaces, secured to the piston rod by long thread engagement, threadlock adhesive and a locking pin.

ADVANTAGE

- effective distribution of load
- maximum stability when extended
- reduced machine stress
- secure attachment reduces risk of machine failure

BENEFITS
✓ higher productivity
✓ longer cylinder life
✓ minimal downtime
✓ lower cost and frequency of maintenance

PISTON ASSEMBLY

The piston is the key component of a hydraulic cylinder. It converts fluid power into controlled linear force and, in a double-acting cylinder, is subject to full system pressure in both directions. The design of the piston and the integrity of the piston-to-rod joint are, therefore, critical to the long life and efficient performance of the cylinder.

Hardened and unhardened rod – the softer surface of the rod on the left is easily damaged, letting fluid out and dirt in

Piston is threadlocked and torque-tightened to rod, then pinned for ultimate security
FAB 5 – Spiral piston grooves

**FEATURE**
Spiral grooves machined into the faces of the piston distribute oil rapidly across the face at the start of the pressure stroke.

**ADVANTAGES**
- improved breakaway performance
- smoother power delivery
- faster *cycling*

**BENEFITS**
- higher productivity
- longer cylinder life
- lower whole-life costs

FAB 6 – Standard piston seal (HMI range)

**FEATURE**
Standard seals combine an energised elastomeric seal element with twin *wear rings*.

**ADVANTAGES**
- durable, cost-effective sealing
- long service life
- good load-holding properties
- metal-to-metal contact prevented by wear rings
- high piston speeds – up to 1m/s
- wide range of seal materials

**BENEFITS**
- sustained high productivity
- lower cost and frequency of maintenance
- minimal downtime
- safe load holding performance

**PISTON SEALS**
A hydraulic cylinder is at its most efficient when 100% of the available hydraulic pressure is applied to the surface of the piston. Any leakage of pressurised fluid past the *piston seals* will result in a rapid drop in performance. Leakage past the piston seals also means that the cylinder will not support a suspended load, which may be a safety critical requirement for applications such as presses.

*Spiral grooves permit rapid distribution of oil across the piston face*
FAB 7 – LoadMaster piston seal (HMI range)

**FEATURE**
LoadMaster seals are similar to Standard seals but feature heavy-duty wear rings.

**ADVANTAGES**
As for Standard seals, plus:
- superior resistance to side loads
- high performance in long stroke applications
- tolerant of alignment variations found in pivot-mounted cylinders

**BENEFITS**
As for Standard seals, plus:
- ✓ long service life in applications subject to variations in alignment

FAB 8 – Low Friction piston seal (HMI range)

**FEATURE**
Low Friction seals feature an energised PTFE seal and PTFE wear rings.

**ADVANTAGES**
- high performance in low pressure systems
- low break-out pressures for controlled low speed performance, electro-hydraulic feedback and servo control applications
- high piston speeds – up to 1m/s

**BENEFITS**
- ✓ high productivity
- ✓ lower cost and frequency of maintenance
- ✓ minimal downtime

FAB 9 – Cast iron piston rings (2H & 3L ranges)

**FEATURE**
The steel piston carries three or four cast iron rings, depending on size and operating pressure.

**ADVANTAGES**
- exceptional service life in general industrial applications
- ✓ low maintenance requirement
- ✓ suitable for high temperature applications
- ✓ high resistance to chemical attack

**BENEFITS**
- ✓ high productivity
- ✓ low cost of ownership
- ✓ minimal downtime
FAB 10 – Lipseal piston seal (2H, 3L & 2A ranges)

**FEATURE**
Lipseal pistons feature a pair of pressure-energised elastomeric lipped seals fitted to a steel piston.

**ADVANTAGES**
- secure load holding performance in both directions
- durable, cost-effective seal
- long service life
- wide range of seal materials
- suitable for hydraulic and pneumatic applications

**BENEFITS**
- safe operating environment
- high productivity
- low cost of ownership
- minimal downtime

FAB 11 – Hi-Load piston seals (2H & 3L ranges)

**FEATURE**
Hi-Load pistons combine two energised elastomeric seals with twin wear rings on a steel piston.

**ADVANTAGES**
- superior resistance to side loads
- high performance in long stroke applications
- tolerant of alignment variations found in pivot-mounted cylinders
- metal-to-metal contact prevented by wear rings

**BENEFITS**
- long service life in applications subject to variations in alignment
- high productivity
- low cost and frequency of maintenance
- minimal downtime

FAB 12 – Materials and construction

**FEATURE**
Steel head and cap, machined from solid billet.

**ADVANTAGES**
- Solid steel heads and caps offer exceptional fatigue resistance and zero porosity, resulting in:
  - greater machine reliability
  - greater operator safety
  - effective heat dissipation
  - long working life

**BENEFITS**
- high productivity
- minimal downtime

FAB 13 – Specification

**FEATURE**
High grade steel tube, subject to strict quality control of straightness, roundness and surface finish, with chamfers to internal body diameters.

**ADVANTAGES**
- long seal life
- resistance to wear from side loading
- chamfers ensure concentricity for accurate alignment
- simplified assembly, reducing risk of damage to seals
- faster maintenance

**BENEFITS**
- long service life
- high productivity
- low cost of ownership

BODY AND END CAPS

The cylinder body and end caps together contain the full hydraulic pressure created by both the hydraulic system and the load under dynamic conditions. They are designed to withstand peak pressures which, in the cushioning bore for example, can exceed twice the maximum operating system pressure. To ensure the safety of personnel and the long working life of the cylinder, Parker’s tie rod cylinders are designed to be fatigue-free at the maximum rated pressure, and have a 4:1 factor of safety.
FAB 14 – Torque-loaded tie rods

FEATURE
Tie rods are torque-loaded on assembly. Rolled threads and high strength tie rod nuts are used on all cylinders.

ADVANTAGES
Pre-loading of the tie rods imposes a compressive force on the cylinder tube which counters the tensile forces generated by system pressure.

+ fatigue-free construction ensures long service life
+ exceptionally compact dimensions
+ inherent rigidity simplifies mounting

BENEFITS
✓ high productivity
✓ low cost of ownership
✓ easier machine design

FAB 15 – Pressure-energised body seals

FEATURE
Body end seals act against the tube’s internal bore rather than on the end face, as on some competitor products.
Radial seals bearing against the tube’s end face are subject to pressure variations as the cylinder cycles, leading to leakage. Parker uses pressure-energised seals, bearing on the tube’s internal bore. All seals are available in a range of materials, to suit different fluids and operating temperatures.

ADVANTAGES
+ stronger seal under pressure
+ sealing effect increases as pressure rises
+ leak-resistant – no damaging movement occurs

BENEFITS
✓ high productivity
✓ low cost of ownership
✓ minimal downtime

Tie rod design achieves equilibrium between compressive and tensile forces
MOUNTINGS

Cylinder mountings transmit the force applied by the cylinder to the surface on which it is mounted. They are responsible for controlling alignment and resisting movement which would result in fatigue failure. The most efficient transmission of force occurs along the cylinder’s centre line, as with flange-mounted cylinders. Trunnion mounted cylinders also absorb force on their centreline, but lack the rigidity of a fixed mounting. Foot-mounted cylinders do not absorb force on their centrelines and should be firmly secured, using a thrust key for positive location where necessary.

FAB 16 – Wide standard range

FEATURE
Wide range of mounting styles – head, cap and mid-tube styles, fixed and pivoting, foot mounts.

ADVANTAGES
Different mounting options give freedom to the designer when building a hydraulic cylinder into a machine. A correctly specified mounting ensures a long service life with low maintenance demands.

- push applications suit cap end mountings
- pull forces suit head end mountings
- fixed mountings offer the greatest rigidity
- pivot mountings should be used where the load travels in an arc on either side of the true plane of motion

BENEFITS
✓ faster machine design
✓ reduced maintenance requirement
✓ greater machine and operator safety
✓ higher productivity
✓ reduced downtime

FAB 17 – Nitro-carburised trunnion pins

FEATURE
Steel trunnion pins with nitro-carburised bearing surfaces. (Note – Parker’s steel trunnions are tougher and have a longer fatigue life than the head end trunnions on the one-piece, cast iron head design used by Rexroth)

ADVANTAGES
Nitro-carburising improves the wear characteristics of the bearing surface, giving:

- double the resistance to fatigue of untreated steel
- longer service life
- a safer operating environment

BENEFITS
✓ higher productivity
✓ reduced whole life costs
✓ reduced downtime
✓ greater machine and operator safety
CUSHIONING

The load attached to an unregulated cylinder stops when it meets a physical obstacle or when the piston in the cylinder reaches the end of its travel – abruptly. The resulting shock is transmitted to the machine and/or cylinder, often with considerable force and noise. In some simple applications, this is acceptable; in others, e.g., assembly automation, more controlled acceleration and deceleration is required. By utilising the rising back pressure in the cylinder as it approaches the end of its stroke, system fluid can be used to create a progressive retarding effect as flow is reduced using a tapered ‘cushion’ valve.

FAB 18 – Self-aligning cushions

FEATURE
Optional cylinder cushions, available at one or both ends, employ a floating, self-aligning cushion sleeve at the head and a bush at the cap.

ADVANTAGES
- Optimised cycling speed maximises productivity
- Machine life is maximised by reduction in shock loads
- Operating environment is improved by reduced noise levels
- Floating designs give smooth, consistent cushioning performance
- Efficiency is optimised by computer-generated cushion profiles

BENEFITS
- Higher productivity
- Longer cylinder and component life
- Greater reliability
- Better operating environment

FAB 19 – Adjustable cushion valves

FEATURE
All cushions, where specified, feature an adjustable needle valve, recessed and retained securely within the head or cap. (Note – The performance of Rexroth and other competitors’ non-adjustable cushions varies with fluid temperature, viscosity and load)

ADVANTAGES
- Cycling speed can be set for optimum productivity
- Cylinder performance can be fine-tuned for temperature, viscosity and load
- Multiple cylinder installations can be adjusted to achieve matched performance
- Ease of mounting – cushion adjusters can be mounted in any unused face of the head or cap

BENEFITS
- Higher productivity from optimised cycling
- Simplified machine design
- Longer cylinder and component life
- Reduced shock loading
- Greater reliability
FAB 20 – High-flow check valves

FEATURE
A high-flow check valve action is provided by fluid passing under the cushion sleeve at the head end, and past a retained, floating bush at the cap end.

ADVANTAGES
Check valves allow fluid to pass in one direction but not the other. They provide fluid with an unobstructed route to the pressurised side of the piston on cushioned cylinders, permitting:
+ fast exit from cushioning
+ smooth, progressive acceleration of the load
+ optimised cycle times

BENEFITS
✓ higher productivity
✓ longer cylinder & component life
✓ greater reliability

✓ Ports – Parker's wide range permits high piston speeds and simplifies connection

✓ Air bleeds – shorten connection and commissioning times, so full production is achieved faster

✓ Gland drains – extend service life by preventing a build-up of oil between the gland seals in demanding high speed, long stroke or low pressure applications, and enable remote monitoring of gland seal condition on ‘hidden’ cylinders

✓ Transducers – turn a simple actuator into a sophisticated motion and control device, with programmable control over position, acceleration and velocity

✓ Position switches – a reliable, cost-effective and user-adjustable means of identifying piston position for system control and secondary processes

✓ Double-rod cylinders – provide the same force in both directions by equalizing the annular area on each side of the piston. The second rod can be used for switches, safety guards or associated processes
Annular – the circular area of the piston face subject to system pressure, less the area occupied by the piston rod.

Cycling – the repeated process of completing a full cycle of extension and retraction.

Cylinder, hydraulic – a machine which converts fluid pressure into controlled linear motion.

Fatigue-free – a rate of doing work at which the component is capable of delivering an unlimited number of cycles without suffering fatigue failure.

Gland – a bearing sleeve which supports the piston rod. Contains pressure and wiperseals and may include separate bearing rings.

Lipseal – design of inner gland seal, which prevents pressurised fluid escaping from the cylinder. Also used on some types of piston.

Piston – close fitting, sliding element within the cylinder tube, with circular faces against which the pressurised fluid bears. Converts this pressure into linear force.

Piston rod – steel connecting rod that transfers the force generated by the piston to the workpiece.

Piston seals – flexible or sprung sealing elements which prevent pressurised fluid from leaking past the piston.

Pressure-energised – a seal shaped in such a way that, as pressure against the seal rises, it bears more strongly against the surface to which it seals.

Rolled threads – threads formed by ‘squeezing’ steel rod with a rotary motion to form the peaks and troughs of the thread; stronger than a ‘cut’ thread.

System pressure – the operating pressure maintained in the hydraulic system by the power unit and associated components.

Torque-loaded – where a threaded component is tightened to a specified torque figure.

Trunnions – steel pivot pins mounted on either side of a cylinder, which allow it limited freedom to rotate in a fixed plane.

Viscosity – the ‘thickness’ of a fluid.

Wear ring – a flexible, wear-resistant element fitted to the piston or gland to prevent metal-to-metal contact.

Wiperseal – outer gland seal which ‘wipes’ oil from the piston rod. It prevents low-pressure fluid escaping from the cylinder and prevents dirt from entering.

**RANGE SUMMARY**

**HMI/HMD Series**
- Working pressure: 210 bar
- Bore sizes: 25 – 200mm
- Standards: ISO 6020/2 & DIN 24 554

**2H Series**
- Working pressure: 210 bar
- Bore sizes: 38.1 – 304.8mm
- Standards: NFPA, JIC, ANSI

**3L Series**
- Working pressure: 70 bar
- Bore sizes: 25.4 – 203.2mm
- Standards: NFPA, JIC, ANSI

**2A Series**
- Working pressure: 18 bar (pneumatic)
- Bore sizes: 25.4 – 335.6mm
- Standards: NFPA, JIC, ANSI

**Applications**
- Machine tools
- Automotive transfer lines
- Plastic injection moulding
- Die casting
- Presses
- Aggregate crushing
- Woodworking machinery
- Clamping
- Positioning
For further information please contact:

Andy Lindgren  
CLDE Product Development Manager  
Parker Hannifin plc  
Greycaine Road,  
Watford,  
Herts.  
WD24 7QA

Tel: 01923 492053  
Mob: 07974 237082  
email: alindgre@parker.com