The Buyers Guide To Industrial 'O' Rings

Which materials of 'O' Ring to choose for which applications. Understand common buying mistakes (and how to avoid them!) **Plus** all the technical information you need to know

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Introduction

The humble O-ring is used by tens of thousands of manufacturers each day in an extraordinary variety of different hydraulic systems. It is one of the most widely used and easily recognised engineering component, yet its sheer simplicity belies its usefulness. Many modern hydraulic or gas powered systems simply would not function without effective O-rings. They can effortlessly create sustainable vacuums and establish flawless seals under the most extreme pressures and temperatures. In regular use throughout the world since they were patented by Swedish engineer J. Lundberg in 1896, O-rings are now ubiquitous in almost all manufacturing sectors. In most countries of manufacture, O-rings have now been standardised. For instance, in the UK, O-rings are categorised according to BS references, each referring to the internal diameter of the O-ring. An O-ring can also be identified by outer dimensions and the thickness of its cross-section.

O-rings have been the subject of a lot of engineering literature over the past century, which have endlessly discussed their uses, chemical components, lubrication requirements and size.

The purpose of this e-book is quite different. Our goal is to provide a practical guide to selecting the right O-ring for your business, based on material, characteristics and function. We will be dipping into theory in some sections, but this is more a 'field guide' than an academic work. We are happy to recommend some more theoretical treatments of O-rings if you would like to know more – simply give us a call and have a chat with one of our engineers.

Who This Guide Is For

The audience we had in mind when writing this e-book are manufacturing businesses that want to find out more about O-rings and specify the correct components for their function. Many of the enquiries we have are from purchasing managers, as well as from design engineers working on specific projects.

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Introduction

About Birmingham Seals

The Birmingham Seals Company Ltd, or BSCL, are a specialist distributor of O-rings, hydraulic seals, fasteners, gaskets and turned parts. Established in 1998, our team combines decades of engineering and design experience to fabricate versatile and hard wearing parts for all manufacturing sectors.

Our customers include established companies from a variety of sectors, including:

» The aerospace industry
» Car manufacturers
» Pharmaceutical manufacturers
» Hydraulic engineers
» Plumbing contractors and distributors
» Shower, kitchen and bathroom manufacturers
» Engineering merchants.

Our stock includes more than 15,000 product lines, which can be dispatched on fast delivery anywhere in the world. We are also happy to take on bespoke orders of turned parts and seals, to give you access to the precise components you require. Our office in Walsall north of Birmingham is open for orders and enquiries on weekdays between 8 AM and 5 PM. Please give us a call at any time to discuss your requirements on **+44 (0) 1922 646 716.**

We will start this guide with a basic introduction to O-rings, which may be useful for readers who are new to the subject, or who would like a quick refresher course. Following this, we will discuss different types of O-rings according to their characteristics, their materials and their functions. Finally, we will explain the advantages we feel we offer our customers and why we would like you to consider turning to us for your O-ring requirements.

We would like to thank you for downloading this e-book and welcome any questions you may have while reading it. We hope to hear from you soon.

O-Rings & Other Seals

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O-Rings & Other Seals

As a purchasing manager or design engineer, you are probably already familiar with the basics of O-rings. Nevertheless, in the interests of clarity, we would like to start our guide with an explanation of what O-rings are, the advantages they offer and how they differ from other hydraulic seals. This lays the ground work for our later discussion of the different characteristics of various O-rings, their uses in manufacturing and the materials of which they are made. If this is already familiar material, please feel free to skip onto the next section.

What Are O-Rings?

By design, an O-ring is instantly recognisable as a doughnut shaped ring, usually made from thermoplastic materials such as elastomers or PTFE. Some are solid rings, while others are hollow. O-rings are fashioned to accommodate a wide variety of engineering purposes, as we will see below. Specific materials, internal structures and designs are fabricated for different tasks.

Despite the diversity, however, all O-rings are seals. They are used to insulate joints between two components so as to prevent leakage of liquids and gases from hydraulic systems. In some circumstances, they can also be used as mechanical drive belts, although for the purposes of this guide we will be dealing with O-rings purely as hydraulic seals.

How Are O-Rings Used?

As seals, O-rings are attached to a piston rod within a bore by means of a gland. The gland is a groove cut into a metallic piston that contains and supports the O-ring. When combined, the O-ring and gland make an effective and time-tested seal mechanism.

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O-Rings & Other Seals

Other Types Of Seal

O-rings aren't the only type of mechanical seal. Different engineering conditions may require alternative designs. In some systems you may need to use more than one type of seal, for instance a piston seal combined with backup rings and guide rings. The following are some of the most commonly used seals. If you'd like more information about the seals, we invite you to get in touch and chat with one of our engineering specialists.

» **Metal seals:** For use on smooth surface components such as metallic flanges, glass applications, heat exchangers etc.

» **Piston seals:** Heavy duty components that provide reliable sealing on moving pistons, while minimising the need for lubricants. Often used in conjunction with other types of seal.

» **Square rings / X rings /Quad rings:** can be used for both dynamic and static sealing operations. These seals have a better sealing capacity than O-rings but are less tolerant of friction.

» **Wiper seals:** help prevent contaminants infiltrating a hydraulic system, preventing degradation of other seals and maintaining a higher overall level of sealing.

» **Radial shaft seals:** For effective seals between rotating and non-rotating parts.

» **Rod seal:** An essential component that prevents the escape of fluids from a hydraulic system to the outside.

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O-Rings & Other Seals

Advantages Of O-Rings

With alternatives available, in what circumstances are O-rings the most advantageous choice, and what benefits do they offer to engineers?

High Tolerance: O-rings can create an effective seal over the widest range of temperature and pressure.

Easy to use: Once installed, an O-ring does not need to be tightened or serviced.

No risk of structural damage: As O-rings do not need to be tightened there is no risk of critical torque, meaning you are unlikely to experience structural damage through over-tightening.

Space efficient: O-rings are small, discreet and take up very little room.

Cheap: O-rings are very cost effective to manufacture and to purchase!

Long working life: O-rings have an impressive durability that gives them a long working life. They can normally be reused, giving them an advantage over different types of gasket. They are also not prone to sudden failure. Degradation is progressive and can easily be identified, allowing for phased replacement of O-rings without disruption or critical failures.

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Characteristics Of O-Rings

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Characteristics Of O-Rings

In the following section we will examine the performance characteristics of O-rings, information that will indicate the conditions under which they can be used. The ability of O-rings to seal over a wide range of tolerances, temperatures and pressures make them a critical component of hydraulic systems. These cost-effective components offer a low likelihood of structural damage, ease of servicing and the ability to be reused.

Several general characteristics contribute to the versatility and usefulness of O-rings; all of which continue to be of interest to seal designers.

Cost And Flexibility

O-rings require the same amount of money and machining expense to incorporate into hydraulic system designs as other seals do. The materials from which O-rings are constructed allow them to be easily stretched over large diameters. As well, there are no special tools required to assemble them.

Sealing Capability

The O-ring is capable of sealing between cylinders and reciprocating pistons at fluid pressures reaching up to 5,000 psi, although the ability of the hydraulic fluid to form film may result in a few drops of fluid per hundred strokes being lost. O-rings can function well when placed between rotating components, providing a reliable seal. However, in order to achieve this, low surface rubbing speeds are necessary.

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Characteristics Of O-Rings

Seal Durability And Life

Due to their rugged construction and simple design, O-rings offer extremely high dependability. When static, an O-ring can provide a seal at high pressure, even when the sealing surface is slightly irregular or a seal has slight chips and cuts. Indeed, even when a seal has broken or exhibits excessive wear, it can still provide flow restriction in emergency situations.

When pressure is applied to one side of an O-ring and then the other, an effective seal will result. The life of a seal can be extended when it needs to operate under a severe load or unfavourable conditions by ensuring that pressure is only applied on the seal in one direction. Dynamic seals under threat of failure from abrasion against the piston walls or cylinders can be given longer life by first ensuring that contacting surfaces are polished.

Friction

The friction applied to a moving O-ring is determined by the projected seal area, as well as fluid pressure and seal compression. Speeds of motion, fluids, surfaces and materials may also have an effect on the amount of friction applied. Under low pressure, an O-ring seal's friction may exceed that of lip seals. At higher pressures, however, the friction placed on an O-ring is often less than that placed on a lip seal.

Temperature

Temperature can have various effects on O-ring seals, depending on the material from which they are made. Changes between +18°C and +121°C will not have a significant effect on the performance of synthetic rubber seals, as they are made for continued use at both low and high temperatures. Although a seal may become brittle at very low temperatures, once warmed it will resume normal flexibility. A seal will harden permanently when exposed to high temperatures, rendering it unusable. Synthetic rubber seals have a low enough coefficient of thermal expansion to avoid design difficulty during times of temperature change.

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Characteristics Of O-Rings

Chemicals

The life of a seal can be lengthened or shortened by the chemical interaction between it and hydraulic fluid. The impact will depend both on the material from which the seal is made and the chemical composition of the fluid itself. Regardless of the chemical composition of seal or fluid, any shrinkage, swelling, softening or excessive hardening of the seal should be avoided at all costs.

Compression And Extrusion

In order to provide proper sealing action, an O-ring must be compressed radially between the cylinder wall and the bottom of the seal groove. While this will cause a slight rolling of the seal in its grove in certain conditions of piston motion, rolling is not necessary in order for normal operation of the seal.
Both static and dynamic O-rings can fail under high pressure. This primary cause of seal failure – extrusion – occurs when the seal enters the space between piston and cylinder due to sufficient clearance between piston and cylinder. Strength and hardness of the seal and the pressure of hydraulic fluid are also factors.

Seal Groove

The seal groove's shape is unimportant; it is proper seal compression between the cylinder wall and bottom of the groove that matters most. There must be enough room for compressed material to flow, so as not to confine it solidly between metal surfaces. A seal may sit in a groove cut into the cylinder wall as opposed to on the piston's surface as well. This will not affect its performance or change its design limitations.

Despite its many benefits, the O-ring does have characteristics which can limit its performance. That being said, using them correctly and in the proper context will ensure long life and dependability.

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How O-Rings Are Used

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How O-Rings Are Used

High performance seals, like O-rings, are used in a variety of industries for a variety of applications. Used to seal the openings between static and rotating components, O-rings are crucial where the goal is the longevity and efficiency of equipment. The O-ring can have a wide variety of purposes, depending on the type of seal required.

For example, in the textile industry, O-rings can be used in machinery to help it cope with high pressure; the constant rotation of air rams and compact spinning. The construction industry requires seals for its earth-moving equipment: concrete is a heavy and viscous substance that must be kept moving to prevent it from solidifying. It can also contain pieces of hard rock which can block equipment unless specialised sealing is in place.

Automobile manufacture uses seals extensively to save compressed air and absorb sound. Agriculture and farming must meet the demands of busy harvest season, which requires its machinery to perform at its best, regardless of temperature and weather conditions. Seals allow farm owners to keep their costs low whilst ensuring high productivity rates.

Rod Wiper

In this instance, an O-ring is used for to keep the rod or reciprocating shaft clean to prevent damage to an in-board O-ring. The wiper ring may not seal, but if there is a possibility to trap fluid between wiper and seal rings, the space between must be vented. This is an effective use of O-rings, where actuating cylinders need to operate in dusty and dirty environments.

Crush Installation

A variation on the static seal, the O-ring is installed by crushing it into a space with a different cross-section than that of a gland of standard and specific shape. This will provide an effective seal, but will result in the permanent deforming of the seal, which will render it unable to be reused.

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Vacuum Seal

O-rings can be used as vacuum seals when used in multiples, as they will reduce the permeation of hydraulic fluid. However, when used as a pressure seal, an O-ring will trap pressure between multiple components, increasing the load on a single seal.

Cushion Installation

If the O-ring is being used as a cushion, it must be able to deform so it can absorb the force of shock or impact, thus preventing forcible and sudden contact between moving metal parts. When used in this manner, the O-ring becomes a mechanical device. In order to be successful in this application, the seal must be held properly in place. Otherwise shifting can occur, which can interfere with the proper operation of the mechanism.

Oscillating Seal

O-rings can be used as oscillating seals. The arc motion of the inner and outer member of the seal assembly in an oscillating seal tends to rotate one or the other member in relation to the O-ring. In cases where the arc of motion exceeds 360°C, the return arc in the opposite direction will distinguish an oscillating seal from a rotary seal.

Reciprocating Seal

The relative reciprocating motion between the inner and outer elements of a reciprocating seal allow the O-ring to slide or roll with the reciprocal motion. This makes the O-ring ideal for use in situations where a plunger enters a chamber, a piston moves within a cylinder or where a hydraulic actuator has an anchored piston rod. However, using an O-ring for reciprocating installations is not recommended if the speed is less than one foot per minute.

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How O-Rings Are Used

Static Seal

Although virtually all true static seals are accompanied by vibrational movement, an O-ring can be used in situations where a seal is required under a bolt head or rivet, at a tubing or pipe connection, under a cover plate, or in a plug or similar application. In general, an O-ring can be used as a flat gasket.

Pneumatic Seal

A pneumatic seal can be used to describe any seal, but what sets true pneumatic seals apart is the use of vapour or gas, which will significantly affect the O-ring's lubrication. This can influence all seal installations in an application. Gas temperature with compression can also affect pneumatic seals. In order to identify the seal properly, it should be defined as a pneumatic-rotary seal or similar.

Seat Seal

The O-ring can act as a seat seal to be one of the contact members that closes the flow passage. The closing motion will mechanically distort the O-ring to create a seal. Examples of this type of seal include using the O-ring on the cone of a floating check valve, as a washer on a spiral threaded valve face, and as a seal located on the end of a solenoid plunger.

Rotary Seal

The O-ring can be used as a rotary seal, where either an outer or inner part of the sealing element turns in a single direction around the shaft axis. This application works in reversible rotation situations and does not allow for stopping and starting of brief arcs of motion, which would otherwise classify it as an oscillating seal. Some applications of O-rings as rotary seals include seals in engine shafts and motors, and in wheels on fixed axles.

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O-Ring Materials

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O-Ring Materials

The O-ring is a common seal used in several industries, as we have seen above. Versatility of function is increased by the use of different O-ring materials. The majority of O-rings are made of elastomers. They are usually cured through vulcanisation, which increases their elasticity, strength and durability. Depending on the materials used to manufacture them, some O-rings may be more resistant to tearing or more elastic than others. In this section we will examine the most common O-ring materials and how they are used.

The diversity of O-ring materials are what can make it difficult to choose the right one for a project. Usually, the best way to choose the right O-ring for an application is to do so according to the materials from which it is made. Give our team a call if in any doubt as to the material you need for your project.

General O-Ring Materials

Polyurethane

O-rings made from polyurethane are best for applications such as firearms, pneumatic tools, cylinders, valves and hydraulic fittings. They are not suited to applications which require heat resistance and good compression.

Features and Temperature Range – Polyurethane O-rings are resistant to extrusion and abrasion, and offer high durability. Their temperature range falls between (-15 to +85).

Nitrile (Buna-N)

Nitrile O-rings are best suited for general purpose applications, having limited resistance and temperature requirements, such as those involving water, petroleum oils and some hydraulic fluids. They are not suitable for applications involving halogenated hydrocarbons, phosphate ester hydraulic fluids, ketones or automatic brake fluid.

Features and Temperature Range - Nitrile O-rings are tear resistant as well as being resistant to abrasion. They range in temperature tolerance from (-30 to +120).

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O-Ring Materials

Silicone
Applications deemed best for silicone O-rings include those involving high temperatures, such as fuel injection ports and automotive steering devices. The rigidity of O-rings made of PTFE make them best suited to static applications.

Features and Temperature Range – Silicone O-rings that are PTFE-encapsulated can handle surface wear well. They also offer resistance to abrasion and corrosion. They are also chemically inert and non-permeable, with low absorption. Temperature tolerances can range from (Standard Silicone -60 to +200).

Neoprene
Neoprene O-rings are most often used in applications involving refrigerants, petroleum oils and some silicate ester lubricants. O-rings made of neoprene are not very resistant to oxygen or petroleum lubricants. As well, they are often compounded using lead-based agents, which are hazardous to human health

Features and Temperature Range – Neoprene O-rings are most durable when used in applications not involving petroleum or oxygen. Their temperature resistance is between - (-40 to +120).

Ethylene Propylene Rubber (EPR)
Ideal applications for EPR O-rings include hydraulic pumps used in the aerospace industry. They are only suited to a small range of applications due to issues with wear and tear.

Features and Temperature Range – O-rings made from EPR work well with Skydrol and other hydraulic fluids, as well as being suited for alcohols, brake fluids, silicone oils, water and steam. Their temperature range falls between 45 to +120).

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High-Performance Materials

Fluorocarbon (Viton)

Applications ideal for fluorocarbon O-rings include those involving acids, gases, silicone fluids and petroleum oils. They are not suited to hot hydrofluoric acids, amines, Skydrol or ethers of low molecular weight.

Features and Temperature Range - Fluorocarbon O-rings offer high versatility and so are able to be used in a wide range of applications. They are especially suited to applications such as diverse sealing jobs involving movement. Their temperature capability ranges from - (-20 to +200).

Aflas

O-rings made from Aflas compounds are best suited to applications involving sour gas, high water or steam temperatures and amines. They do not have resistance to all lubricants and fuels, however.

Features and Temperature Range – Aflas O-rings do have resistance to some fuels and lubricants whose chemical composition approaches that of fluorocarbon dipolymers. Their high temperature tolerance can reach as much as 260°C when used in applications involving steam.

Kalrez

Kalrez O-rings are available in several grades and are suited to a wide range of applications, as they offer virtually universal chemical resistance.

Features and Temperature Range – Kalrez O-rings retain their durability and functionality in continuous operations of up to (-50 to +315).

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Hydrogenated Nitrile (HNBR)
O-rings constructed of hydrogenated nitrile possess superior mechanical properties, making some of them ideal for oilfield applications. The acrylonitrile content can range from low to high, and hardness can range from 60 to 90 IRHD.

Features and Temperature Range – HNBR O-rings are best suited for applications ranging in temperature between (-30 to +170).

General Purpose Fluoroelastomer
There are several grades of O-ring constructed from general purpose fluoroelastomer:

FR10 is a dipolymer-based range that meets DTD standards. Ideal for general applications, they have low compression set specifications and hardness between 50 and 90 IRHD.

FR17 is a terpolymer-based range which has enhanced chemical resistance. Its low-temperature flexibility exceeds that of the FR10 range.

FR44 is also a dipolymer-based range with hardness of 50 to 90 IRHD. However, these are not DTD rated for the Ministry of Defence as their FR 10 counterparts. The FR44 range is easily identified by their distinct green colour.

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O-Ring Materials

Specific-Duty Fluoroelastomer Grades
Several grades of fluoroelastomer are available in both FR and LR designations for specific duties.

FR68/90 is a low compression set elastomer which offers excellent resistance to rapid gas decompression, sour gas, amine, steam and hot water.

FR 58/90 & 98 elastomers are terpolymer-based to offer resistance to rapid gas decompression. They also possess good elastomeric properties overall, making them suitable for many applications.

FR25 elastomers are tetrapolymer-based and offer hardness's of 70 to 90 IRHD. This range is resistant to fluids and can sustain temperatures as low as -41°C.

FR64/70 & 80 are dipolymer-based compounds that offer enhanced performance in applications involving mineral acid, hot water and steam.

LR5853 are tetrapolymer-based compounds with a hardness of 80, 90 or 98 IRHD. These materials are especially resistant to fluids having methanol and gasoline-alcohol blends. They are not recommended for low temperatures, as they stiffen below temperatures of -5°C.

LR6316 elastomers can range in hardness from 75 to 90 IRHD and offer similar fluid resistance to LR5853. They also offer low temperature characteristics suitable for temperatures down to -29°C.

Why Choose Birmingham Seals?

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Why Choose Birmingham Seals?

A search of the internet will reveal a number of seal manufacturers, so what sets BSCL apart from our competitors? Since 1998 we have been one of the UK's leading providers of hydraulic seals and associated parts. Whether you need O-rings, turned parts, springs, nuts, bolts, rotary shaft seals or washers, we have a huge in-stock catalogue of components at competitive prices.

A one stop shop for all hydraulic seal components: As a specialist provider, our goal is to offer you all the components you require, under the same roof. Why go to multiple manufacturers to purchase the seals and parts you need for a single system? At Birmingham Seals we can supply the complete range, on one convenient invoice.

Fast shipping, worldwide: We serve engineering and manufacturing customers around the world, and guarantee fast, affordable shipping to wherever you need your components. The competitive value of the pound makes it a great time to purchase from us if you are a customer outside the UK. If you've previously been put off due to the prohibitively high value of sterling, now is the time to take a look through our catalogue. A growing number of international clients are coming to rely on our high-quality components and customer service. Take advantage of fantastic rates on market leading components when you order from Birmingham Seals.

Quality guarantee: At BSCL we strive to go the extra mile to ensure quality products every time. A lot of providers say this, but we take the practical steps to ensure it is borne out in fact. We employ an in-house Quality Manager, which is unusual in the industry, who ensures that your products exactly match your specifications. This has drastically cut our number of returns and increased overall customer satisfaction. For our customers, it gives peace of mind that your components are reliable and fit for purpose; and that you will not experience disruption or downtime due to substandard components.

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Why Choose Birmingham Seals?

Flexible delivery schedule: We aim to get your components to you on your schedule, so they can perform their task without delay. We are therefore flexible on delivery and offer a range of shipping options to suit your requirements. We guarantee on time delivery, so when we agree a delivery window you can rely on us to follow through as promised.

Stockholding service: If you have parts that you use regularly, we can hold stock on your behalf. We can use this stock to ship out orders either on request, or at regular intervals. Your dedicated account manager will monitor your stock to maintain adequate levels and ensure you never run short. It is a convenient and low-cost alternative to managing repeat orders yourself and having to store components on site.

Get a Free Quote

Thank you for downloading and reading this e-book. We hope you have found it useful. At Birmingham Seals we are proud to offer a full range of oil seals, O-rings, hydraulic seals and associated products. Over the past 17 years we have served customers in all different fields of engineering and manufacturing, from small workshops and distributors to large-scale automotive and aerospace clients.

So if you need O-rings for your project, or are an engineering merchant interested in stocking a high quality range of hydraulic seals, then please get in touch.

Please click the link below to request a free quote through our website. We accommodate all sorts of orders at the same competitive prices: from small batches to repeat orders of many thousands of components.

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