

O-Ring Design Handbook

A practical engineering reference for size selection, material choice, compatibility, and compression guidance.

Introduction

Choosing the correct O-ring size is critical for reliable sealing. Our size chart library covers the five most commonly used international standards, with full cross-reference tables, search-by-dimension tools, and downloadable PDFs for engineering documentation.

Material Selection Workflow

Selecting the wrong O-ring material is one of the most common causes of premature seal failure. This material selector guides engineers through a systematic four-step process to identify the correct compound based on temperature limits, chemical compatibility, mechanical requirements, and industry standards.

The selector covers the five most common industrial elastomers: NBR (Nitrile), FKM (Fluorocarbon), EPDM (Ethylene Propylene), VMQ (Silicone), and PTFE. Each material has a distinct temperature envelope and chemical resistance profile. Using the wrong compound in an incompatible fluid or above its thermal limit will result in compression set, swelling, or chemical degradation.

4-Step Material Selection

	Guidance
Temperature	Identify the minimum and maximum continuous service temperatures. Include startup cold-soak and thermal excursion limits. Temperature is usually the primary design constraint.
Media	List all fluids, gases, or chemicals the seal will contact. Include hydraulic fluids, fuels, solvents, cleaning agents, and process chemicals. Use the chemical compatibility chart for guidance.
Application Type	Determine whether the seal is static, dynamic reciprocating, rotary, or pneumatic. Dynamic applications require materials with low friction and good abrasion resistance.
Compliance	Verify if FDA, aerospace (AMS), automotive, or medical compliance is required. Some applications require certified batch records or specific cure systems.

Material Comparison

Material	Min Temp	Max Temp	Best For	Avoid
NBR	-40C	+120C	Petroleum oils, mineral hydraulic fluids, fuels	Ketones, ozone, high aromatics
FKM	-20C	+200C	High temperature, chemicals, aggressive fuels	Strong bases, steam, ketones
EPDM	-50C	+150C	Water, steam, brake fluid, polar solvents	Petroleum oils, hydrocarbon fuels
VMQ	-60C	+200C	Food grade, medical, dry heat, low temperature	Petroleum oils, acids, solvents
PTFE	-200C	+260C	Aggressive chemicals, high purity, low friction	Molten alkali metals, fluorine gas

Compression Basics

Compression rate (also called squeeze percentage) is the primary design variable that determines whether an O-ring will seal reliably without excessive stress or extrusion. This calculator computes compression rate from the O-ring cross-section and the groove depth, supporting both inch and metric inputs.

The correct squeeze percentage depends on whether the seal is static or dynamic, the system pressure, and the material hardness. Too little squeeze results in leakage, especially under low pressure or thermal contraction. Too much squeeze accelerates compression set, increases friction, and promotes spiral failure in reciprocating applications.

Recommended Compression

Application	Recommended Squeeze
Static seal (low pressure)	15-20%
Static seal (high pressure)	18-25%
Dynamic reciprocating	10-15%
Dynamic rotary	5-8%
Pneumatic (dry air)	12-18%

Groove Guidelines

Parameter	Guidance
Width Static	1.10-1.25 x CS
Width Dynamic	1.20-1.30 x CS
Surface Finish Groove	Ra 0.8-3.2 micrometers
Surface Finish Dynamic	Ra 0.1-0.4 micrometers
Edge Radius	Minimum 0.1 mm

Quick Compatibility Snapshot

Fluid	NBR	FKM	EPDM	VMQ	PTFE
Mineral Oil (HLP)	A	A	D	D	A
Hydraulic Oil (Phosphate Ester)	D	A	A	C	A
Gasoline (unleaded)	B	A	D	D	A
Diesel Fuel	B	A	D	D	A
Water (fresh)	B	A	A	A	A
Steam (>120C)	D	C	A	B	A
Concentrated Sulfuric Acid	D	A	C	D	A
Sodium Hydroxide (50%)	C	D	A	B	A
Acetone (Ketone)	D	D	A	C	A
Methyl Ethyl Ketone (MEK)	D	D	A	C	A