VAJRA

ENGINEERING ELASTOMERS & POLYMER SELECTION GUIDE

Polymer science • Compound engineering • Precision manufacturing

Engineering the Right Polymer for the Right Environment

Elastomer selection is governed by polymer chemistry, temperature, pressure, media, mechanical loading, dynamic conditions and required service life. Vajra approaches elastomers as engineered material systems rather than commodity materials.

Engineering principle: The polymer is the starting point — the compound is the engineering solution.

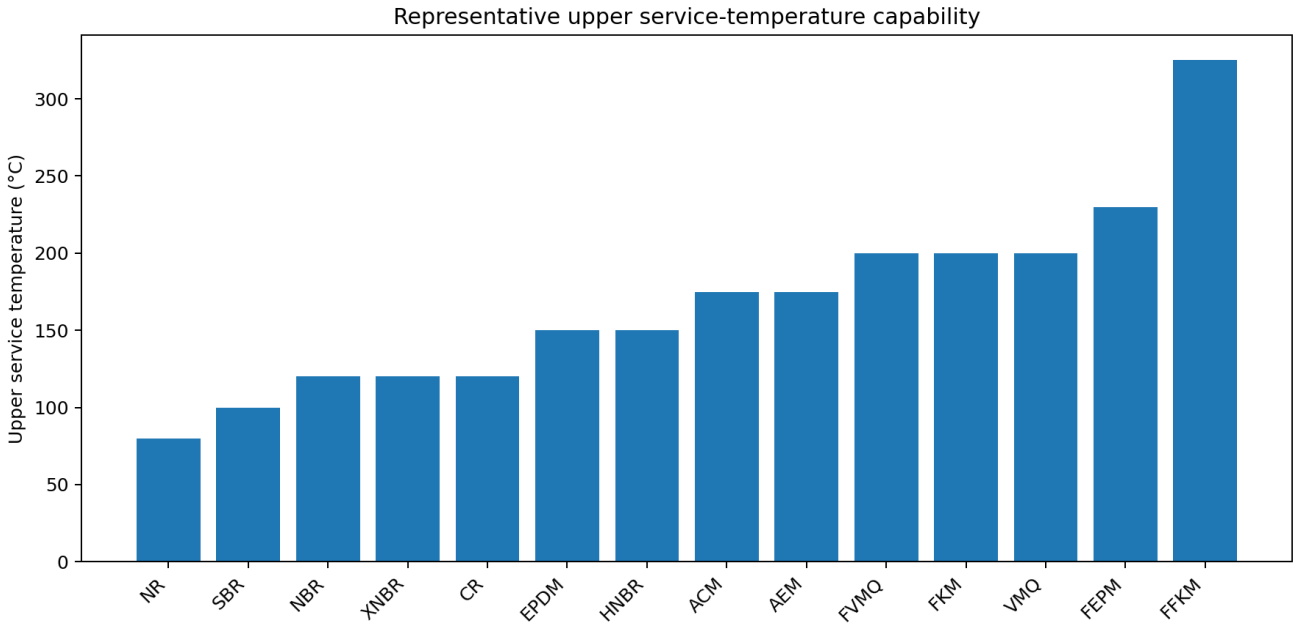
Representative values in this guide are for material screening only. Actual service limits depend on grade, formulation, cure system, media, pressure, exposure duration and component design.

1. ELASTOMER LANDSCAPE

Major elastomer families span general-purpose rubbers, oil-resistant nitriles, high-temperature fluoropolymers, silicone systems, polyurethane elastomers and thermoplastic elastomers.

Family	Primary advantage	Application space
NR / IR / SBR / BR	Dynamic performance, resilience, abrasion	Tyres, mounts, vibration and general engineering
NBR / XNBR / HNBR	Oil resistance; wear; heat/ageing	Hydraulic, oil and dynamic seals
EPDM / EPM	Water, steam, ozone, weather	Water, steam and outdoor sealing
FKM / FFKM / FEPM	Heat, fuel and chemical resistance	Aerospace, automotive and chemical
VMQ / FVMQ / PVMQ	Temperature flexibility; fuel	Aerospace, medical, electrical
ACM / AEM / ECO	Hot oil, air, fuel, gas barrier	Automotive and fuel systems
PU / TPU	Wear, tear, load capacity	Hydraulics, pneumatics, rollers
TPE / TPV	Thermoplastic elastomeric processing	Automotive and injection moulding

2. TEMPERATURE MAP



Temperature capability must be evaluated together with the actual fluid/media. A polymer may behave differently in air versus oils, fuels, steam or aggressive chemicals.

3. COMPREHENSIVE POLYMER LIBRARY

Polymer	Full name	Temp °C	Oil/Fuel	Water/Steam	Ozone	Wear	Key characteristic	Applications
NR	Natural Rubber / Polyisoprene	–50 to +80	Poor	Fair	Poor	Excellent	Fatigue, resilience, tear	Mounts, flex elements, tyres
IR	Synthetic Polyisoprene Rubber	–50 to +80	Poor	Fair	Poor	Very good	NR-like consistency	Technical mouldings
SBR	Styrene-Butadiene Rubber	–50 to +100	Poor	Fair	Fair	Excellent	Cost and abrasion	Tyres, mats, conveyors
BR	Polybutadiene Rubber	–70 to +100	Poor	Fair	Fair	Excellent	Resilience, low temperature	Tyres, impact products
NBR	Acrylonitrile-Butadiene Rubber	–30 to +100/120	Excellent	Good	Poor	Very good	Oil resistance	O-rings, oil/hydraulic seals
XNBR	Carboxylated Acrylonitrile-Butadiene Rubber	≈–30 to +120	Excellent	Good	Poor	Exceptional	Strength, tear, wear	Heavy-duty seals, wipers
HNBR	Hydrogenated Acrylonitrile-Butadiene Rubber	–30 to +150	Excellent	Good	Excellent	Excellent	Heat, oil, ageing	Automotive, aerospace seals
CR	Polychloroprene / Neoprene	–40 to +120	Good	Good	Excellent	Good	Balanced resistance	Bellows, hoses, mounts
EPDM	Ethylene-Propylene-Diene Rubber	–50 to +150	Poor*	Excellent	Excellent	Good	Water, steam, ozone	Water/steam and weather seals
IIR	Isobutylene-Isoprene / Butyl	–50 to +120	Fair	Excellent	Excellent	Fair	Very low gas permeability	Vacuum/gas seals
FKM	Fluoroelastomer / Fluorocarbon	–20 to +200/220	Exceptional	Moderate	Excellent	Good	Fuel, oil, heat, chemicals	Aerospace, automotive
FFKM	Perfluoroelastomer	–20 to +260/325	Exceptional	Excellent	Excellent	Fair	Extreme chemical/thermal	Chemical, semiconductor
FEPM	Tetrafluoroethylene-Propylene	≈–10 to +200/230	Excellent	Excellent	Excellent	Good	Steam and chemicals	Oil & gas, chemical
VMQ	Methyl-Vinyl Silicone	–60 to +200/230	Fair	Good	Excellent	Poor	Temperature flexibility	Aerospace, medical
FVMQ	Fluorosilicone	–60 to +175/200	Excellent	Fair	Excellent	Poor	Fuel + low temperature	Aerospace fuel systems
PVMQ	Phenyl-Methyl-Vinyl Silicone	≈–90 to +200	Fair	Good	Excellent	Poor	Extreme low-temperature	Aerospace/cryogenic
ACM	Polyacrylate Rubber	–20 to +150/175	Excellent	Fair	Excellent	Fair	Hot-oil resistance	Transmission/engine seals
AEM	Ethylene-Acrylic Rubber	–40 to +175	Very good	Fair	Excellent	Good	Hot air + oil	Turbo hoses, powertrain
ECO	Epichlorohydrin Copolymer	–40 to +135/150	Very good	Good	Excellent	Good	Oil + gas barrier	Fuel hoses, diaphragms
CSM	Chlorosulfonated Polyethylene	–40 to +120/150	Good	Good	Excellent	Good	Weather + chemicals	Cable jackets, linings
AU	Polyester Polyurethane	–30 to +100/120	Excellent	Fair	Good	Exceptional	Wear, tear, load	Hydraulic seals, rollers
EU	Polyether Polyurethane	–50 to +100/120	Very good	Excellent	Good	Exceptional	Wear + hydrolysis	Hydraulic/pneumatic seals
TPU	Thermoplastic Polyurethane	≈–50 to +100/120	Good	Good	Good	Excellent	Wear + thermoplastic	Seals, wheels, mouldings
TPV	Thermoplastic Vulcanizate	≈–50 to +135	Fair–Good	Good	Excellent	Good	EPDM-like + thermoplastic	Automotive weather seals

* EPDM is generally unsuitable for mineral oils and hydrocarbon fuels. Verify exact media and compound.

4. PROPERTY SCREENING

Relative screening scores are qualitative engineering indicators, not laboratory test data.

5. NBR vs XNBR vs HNBR

Characteristic	NBR	XNBR	HNBR
Chemistry	Acrylonitrile + butadiene	Carboxylated NBR	Hydrogenated NBR
Primary objective	Oil resistance + economics	Mechanical strength + wear	Heat + ageing + oil
Oil resistance	Excellent	Excellent	Excellent
Tensile / tear	Very good	Exceptional	Excellent
Abrasion	Very good	Exceptional	Excellent
Heat resistance	Good	Good	Excellent
Ozone/weather	Poor	Poor	Excellent
Dynamic sealing	Very good	Excellent	Excellent
Best reason to use	General oil sealing	High-wear/high-load sealing	High-temperature oil sealing

XNBR is especially valuable when abrasion, tear and mechanical loading dominate. HNBR is generally selected when oil resistance must be combined with higher heat, oxidation and ozone resistance.

6. APPLICATION-DRIVEN SELECTION

Requirement	Preferred families	Engineering note
Mineral oil	NBR / XNBR / HNBR / FKM	Temperature and pressure determine final selection
High-wear oil seal	XNBR / HNBR / PU	Prioritize abrasion, tear and extrusion resistance
Hot oil	HNBR / FKM / ACM / AEM	Check ageing and fluid additives
Water / hot water	EPDM	Excellent water and weather resistance
Steam	EPDM / FEPM / FFKM	Compound and steam conditions are critical
Aviation fuel	FVMQ / FKM	Aerospace qualification required
Extreme chemicals	FFKM / FEPM / FKM	Check exact concentration
Extreme low temperature	PVMQ / VMQ / FVMQ	Flexibility and Tg are critical
Gas / vacuum	IIR / CIIR / ECO / FKM	Permeability and outgassing matter
Heavy abrasion	PU / XNBR / NR	Wear mechanism and hardness matter
Hydraulic sealing	NBR / XNBR / HNBR / PU	Pressure, speed and fluid drive selection
Automotive powertrain	HNBR / FKM / ACM / AEM	Heat, oil and ageing dominate
Aerospace sealing	FVMQ / FKM / HNBR / FFKM	Application-specific qualification

7. AEROSPACE & DEFENCE SELECTION

Requirement	Candidate elastomers	Primary considerations
Aircraft fuel	FVMQ / FKM	Fuel compatibility, low temperature, qualification
Hydraulic systems	HNBR / FKM / XNBR	Pressure, temperature, wear, fluid compatibility
Engine oil	FKM / HNBR / ACM	High-temperature ageing
Extreme chemicals	FFKM	Maximum chemical resistance
Cryogenic / low temperature	PVMQ / VMQ / FVMQ	Low-temperature flexibility
Dynamic flex elements	NR / specialist systems	Fatigue and resilience
Rocket / missile actuator seals	NBR / HNBR / FKM / specialist	Mission-specific qualification
Rocket / missile flex seals	Specialist NR / elastomer systems	Fatigue, bonding, geometry and mission environment

A polymer family should never be represented as automatically qualified for aerospace or defence service. Qualification must be tied to the specific compound, geometry, process and mission environment.

8. VAJRA POLYMER-TO-PERFORMANCE WORKFLOW

01	Understand operating environment
02	Define temperature profile
03	Define pressure and mechanical loading
04	Identify fluids / chemicals
05	Determine static or dynamic operation
06	Determine required service life
07	Shortlist polymer families
08	Select polymer grade
09	Develop / select compound
10	Optimise cure system
11	Design component and tooling
12	Validate material and application performance
13	Establish production controls and traceability

9. COMPOUND ENGINEERING

The polymer is only the beginning.

Final elastomer performance depends on polymer grade, molecular characteristics, fillers, reinforcement, plasticizers, cure chemistry, crosslink density, antioxidants, antiozonants, hardness, processing and post-cure. Two components made from the same polymer family can therefore perform very differently.

Variable	Engineering effect
Polymer grade	Base chemical and physical behaviour
ACN content in NBR	Oil resistance versus low-temperature flexibility
Carbon black / reinforcement	Strength, hardness, wear and conductivity
Plasticizer	Flexibility and low-temperature behaviour
Cure system	Crosslink density, compression set and heat ageing
Peroxide vs sulphur cure	Heat resistance and dynamic behaviour
Antioxidants / antiozonants	Ageing and environmental resistance
Hardness	Sealing force, extrusion and wear
Surface treatment	Friction, stick-slip and assembly
Processing	Dimensional accuracy, bonding and consistency

10. VAJRA ENGINEERING POSITIONING

Polymer Science. Compound Engineering. Precision Manufacturing.

At Vajra, elastomers are treated as engineered material systems rather than commodity materials. We evaluate the application environment, identify the appropriate elastomer family, select the polymer grade, engineer the compound and manufacture the component to the required geometry and performance specification.

Material expertise: NR | IR | SBR | BR | NBR | XNBR | HNBR | CR | EPDM | IIR | CIIR | BIIR | FKM | FFKM | FEPM | VMQ | FVMQ | PVMQ | ACM | AEM | ECO | CSM | AU | EU | TPU | TPE | TPV

Our objective is not simply to select a rubber. It is to engineer the right material system for the application.

TECHNICAL DISCLAIMER

This guide is a general engineering reference and does not constitute a material qualification, specification or guarantee of service performance. Final selection should be validated through application-specific testing and applicable customer, ASTM, ISO, aerospace, defence or regulatory requirements.