

PFAS regulation and its potential impact on the machine tool industry

Sealing types and materials in machine tools

VDW Working Group 5 “Machine Tool Design”

Frankfurt am Main, July 2023

O-ring preloaded PTFE seals

Pneumatic applications

Public consultation:

Fluoropolymers such as PTFE and FKM generally have long chain “large molecules”

→ organised recycling at the end of life, closed loop, abrasion does not enter the environment ...

For prohibition:

Limitation lifetime, tightness, friction, energy consumption, sustainability, safety.
Spare parts in old constructions/machines
(Special spare parts require special shapes)

Kolbendichtungen,
doppeltwirkend

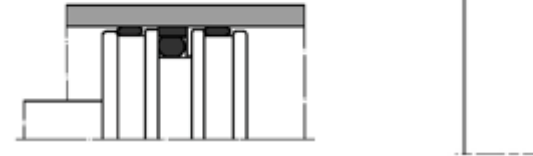


Image source: VDMA teaching material

Boundary conditions for alternatives:

-10°C to +50°C

up to 1m/s

Dry or oiled air

Influence of MWF and of CGLP lubricating oil, fluid grease xxx

Target same service life

Possible alternative material combinations

UHMW-PE / NBR → Temperature limit < 80°C

Polyurethane / NBR → Temperature limit < 100 °C

Note increased friction values

Pure elastomer seals → Temperature limitation

Support rings based on PTFE

for high-pressure hydraulic applications

Public consultation:

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For prohibition:

Limitation lifetime, tightness, friction, energy consumption, sustainability, safety.
Spare parts in old constructions/machines
(Special spare parts require special shapes)

Boundary conditions for alternatives:

+10°C to +70°C
static
High pressure up to 240 bar
Influence of HLP46, MWF and of CGLP lubricating oil, fluid grease xxx
Target same service life



Image source: VDMA teaching material

Possible alternatives:

UHMW-PE (< 80°C),
Elastomers, TPU (<100°C)
generally thermoplastics → more difficult assembly and observe assembly limits

Disadvantages:

Assembly
Universal resistance to operating materials is lost

PTFE-based guide elements for pistons

Public consultation:

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For prohibition:

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Spare parts in old constructions/machines
(Special spare parts require special shapes)

Boundary conditions for alternatives:

+10°C to +70°C

1 m/s

No pressure resistance, surrounded by pressure on all sides depending on the application,

Influence of HLP46, MWF and of CGLP lubricating oil, fluid grease xxx

Target same service life

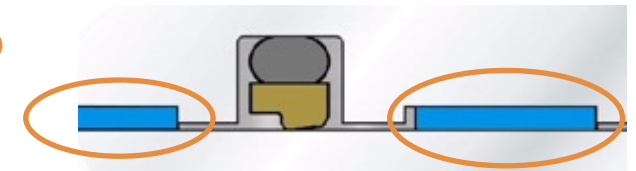
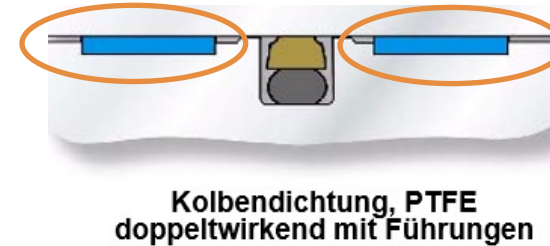


Image source: VDMA teaching material

Possible alternatives:

UHMW-PE (< 80°C) ,

Thermoset (fabric composites)

Thermoplastic materials such as POM, PA ...

Disadvantages:

Universal resistance to operating materials is lost

Increased friction values are to be expected
(higher energy input necessary)

O-rings on FKM and FFKM basis

Public consultation:

Fluoropolymers such as PTFE and FKM generally have long chain “large molecules”
→ organised recycling at the end of life, closed loop, abrasion does not enter the environment ...

For prohibition:

Limitation lifetime, tightness, friction, energy consumption, sustainability, safety.
Spare parts in old constructions/machines
(Special spare parts require special shapes)

Boundary conditions for alternatives:

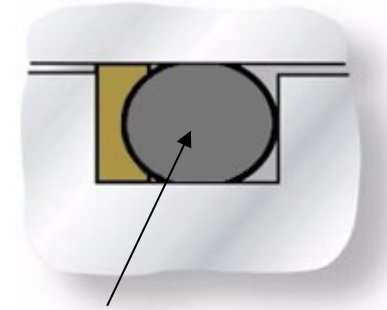
0°C to +70°C

static

High pressure up to 240 bar

Influence of HLP46, MWF and of CGLP lubricating oil, fluid grease xxx

Target same service life



O-Ring mit Stützring

Image source: VDMA teaching material

Possible alternative:

NBR, HNBR

The different additives in the cooling lubricants are usually critical, as they can sometimes cause critical changes in NBR and HNBR for the application.

In-depth studies are necessary for this

Max. application temperatures	NBR approx. 100°C
depending on the media to be sealed	HNBR approx. 140°C

X-rings on FKM and FFKM basis

Public consultation:

Fluoropolymers such as PTFE and FKM generally have long chain “large molecules”
→ organised recycling at the end of life, closed loop, abrasion does not enter the environment ...

For prohibition:

Limitation lifetime, tightness, friction, energy consumption, sustainability, safety.
Spare parts in old constructions/machines
(Special spare parts require special shapes)

Boundary conditions for alternatives:

0°C to +70°C

Static + quasistatic

High pressure up to 240 bar

Influence of MWF and of flowing grease xxx

Target same service life

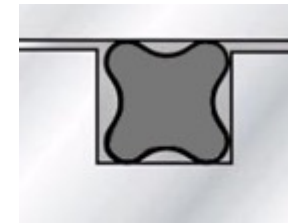


Image source: VDMA teaching material

Possible alternative:

NBR, HNBR

The different additives in the cooling lubricants are usually critical, as they can sometimes cause critical changes in NBR and HNBR for the application.

In-depth studies are necessary for this

Maximum application temperatures
depending on the media to be sealed

NBR approx. 100°C
HNBR approx. 140°C

O-ring preloaded translational hydraulic seals

Public consultation:

Fluoropolymers such as PTFE and FKM generally have long chain “large molecules”
→ organised recycling at the end of life, closed loop, abrasion does not enter the environment ...

For prohibition:

Limitation lifetime, tightness, friction, energy consumption, sustainability, safety.
Spare parts in old constructions/machines (Special spare parts require special shapes)

Boundary conditions for alternatives:

10°C to +70°C

1 m/s

High pressure up to 240 bar

Influence of HLP46, MWF and of CGLP lubricating oil, fluid grease xxx

Target same service life

Affected material combinations

PTFE filled / NBR

PTFE filled / FKM

UHMW-PE (Z80) / FKM

Polyurethane / FKM

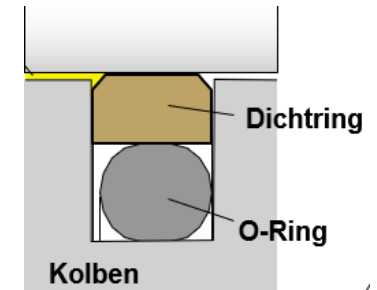


Image source: VDMA teaching material

Possible alternative material combinations

UHMW-PE / NBR → Temperature limitation up to 80°C and
pressure limitation up to 350 bar

Polyurethane / NBR → Temperature limitation up to 100 °C
Note increased friction values

Thermoplastics such as PEEK or similar / NBR → Temperature limitation up to 100°C

Friction and mounting possibility must be checked

The different additives in the cooling lubricants are usually critical, as they can cause changes in NBR and HNBR that are sometimes critical for the application.

In-depth investigations are necessary for this

O-ring preloaded rotary seals

Public consultation:

Fluoropolymers such as PTFE and FKM generally have long chain “large molecules”
→ organised recycling at the end of life, closed loop, abrasion does not enter the environment ...

For prohibition:

Limitation lifetime, tightness, friction, energy consumption, sustainability, safety.
Spare parts in old constructions/machines
(Special spare parts require special shapes)

Boundary conditions for alternatives:

10°C to +70°C

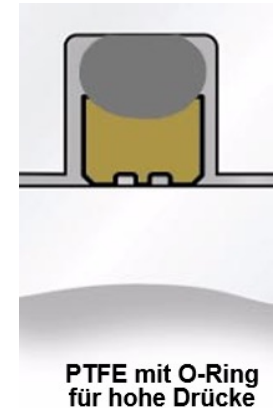
1 m/s

High pressure up to 240 bar

Influence of HLP46, MWF and of CGLP lubricating oil, fluid grease xxx

Target same service life

Image source: VDMA teaching material



Affected material combinations

PTFE filled / NBR

PTFE filled / FKM

UHMW-PE / FKM

Possible alternative material combinations

UHMW-PE / NBR → Temperature limitation up to 80°C and
pressure limitation up to 300 bar

Polyurethane / NBR → Temperature limitation up to 100 °C
Note increased friction values

Thermoplastics such as PEEK or similar / NBR → Temperature limitation up to 100°C

Friction and mounting possibility must be checked

The different additives in the cooling lubricants are usually critical, as they can cause changes in NBR and HNBR that are sometimes critical for the application.

In-depth investigations are necessary for this

Radial shaft seals

Public consultation:

Fluoropolymers such as PTFE and FKM generally have long chain “large molecules”

→ organised recycling at the end of life, closed loop, abrasion does not enter the environment ...

For prohibition:

Limitation lifetime, tightness, friction, energy consumption, sustainability, safety.
Spare parts in old constructions/machines
(Special spare parts require special shapes)

Boundary conditions for alternatives:

10°C to +70°C

Up to 30000 RPM

Almost pressureless

Influence of HLP46, MWF and of CGLP lubricating oil, fluid grease xxx

Target same service life

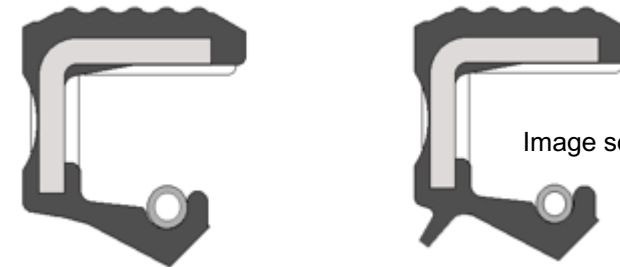


Image source: VDMA teaching material

Changeover to other elastomers possible, in which case the chemical resistance and also the circumferential speed must be taken into account. At high circumferential speeds, the frictional heat rises sharply, which makes the use of NBR and possibly also HNBR impossible.

The different additives in the cooling lubricants are usually critical, as they can cause changes in NBR and HNBR that are sometimes critical for the application.

In-depth investigations are necessary for this

Lip ring seals

Public consultation:

Fluoropolymers such as PTFE and FKM generally have long chain “large molecules”

→ organised recycling at the end of life, closed loop, abrasion does not enter the environment ...

For prohibition:

Limitation lifetime, tightness, friction, energy consumption, sustainability, safety.
Spare parts in old constructions/machines
(Special spare parts require special shapes)

Boundary conditions for alternatives:

10°C to +70°C

Circumferential speed up to 2 m/sec

Almost pressureless (1 bar overpressure)

Influence of MWF, lubricating oil and fluid grease xxx

Target same service life

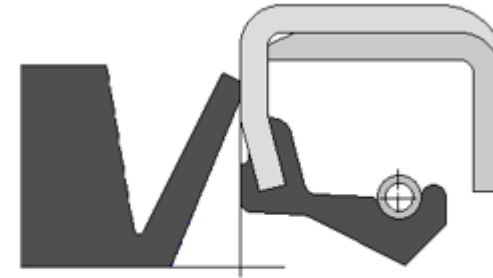


Image source: VDMA teaching material

V-Ring Standard

Changeover to other elastomers possible, in which case the chemical resistance and also the circumferential speed must be taken into account. At high circumferential speeds, the frictional heat rises sharply, which makes the use of NBR and possibly also HNBR impossible.

The different additives in the cooling lubricants are usually critical, as they can cause changes in NBR and HNBR that are sometimes critical for the application.

In-depth investigations are necessary for this

O-ring preloaded PTFE wipers

Public consultation:

Fluoropolymers such as PTFE and FKM generally have long chain “large molecules”

→ organised recycling at the end of life, closed loop, abrasion does not enter the environment ...

For prohibition:

Limitation lifetime, tightness, friction, energy consumption, sustainability, safety.
Spare parts in old constructions/machines
(Special spare parts require special shapes)

Boundary conditions for alternatives:

-10°C to +50°C

up to 1m/s

pressureless

Environmental influences

Influence of MWF and of CGLP lubricating oil, fluid grease xxx

Target same service life

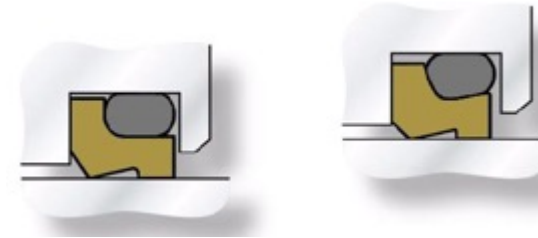


Image source: VDMA teaching material

Affected material combinations

PTFE filled / NBR

PTFE filled / FKM

Possible alternative material combinations

UHMW-PE / NBR → Temperature limitation up to 80°C and

Polyurethane / NBR → Temperature limit up to 100 °C,

observe increased friction values

Thermoplastics such as PEEK or similar / NBR → Temperature limitation up to 100°C

Friction and mounting possibility must be checked

The different additives in the cooling lubricants are usually critical, as they can cause changes in NBR and HNBR that are sometimes critical for the application.

In-depth investigations are necessary for this

O-ring preloaded hydraulic rod seals

Public consultation:

Fluoropolymers such as PTFE and FKM generally have long chain “large molecules”
→ organised recycling at the end of life, closed loop, abrasion does not enter the environment ...

For prohibition:

Limitation lifetime, tightness, friction, energy consumption, sustainability, safety.
Spare parts in old constructions/machines (Special spare parts require special shapes)

Boundary conditions for alternatives:

10°C to +70°C

1 m/s

High pressure up to 240 bar

Influence of HLP46, MWF and of CGLP lubricating oil, fluid grease xxx

Target same service life



Image source: VDMA teaching material

Affected material combinations

PTFE filled / NBR

PTFE filled / FKM

UHMW-PE (Z80) / FKM

Polyurethane / FKM

Possible alternative material combinations

UHMW-PE / NBR → Temperature limitation up to 80°C and
pressure limitation up to 350 bar

Polyurethane / NBR → Temperature limitation up to 100 °C

Note increased friction values

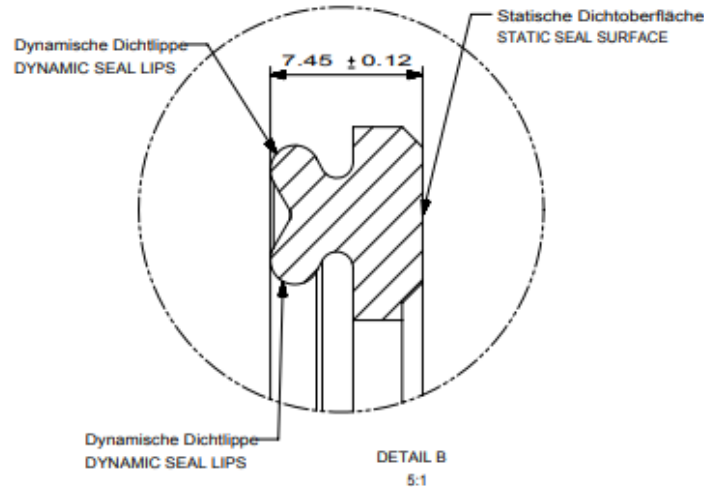
Thermoplastics such as PEEK or similar / NBR → Temperature limitation up to 100°C

Friction and mounting possibility must be checked

The different additives in the cooling lubricants are usually critical, as they can cause changes in NBR and HNBR that are sometimes critical for the application.

In-depth investigations are necessary for this

Special rotation seals



Public consultation:

Fluoropolymers such as PTFE and FKM generally have long chain “large molecules”
→ organised recycling at the end of life, closed loop, abrasion does not enter the environment ...

For prohibition:

Limitation lifetime, tightness, friction,
energy consumption, sustainability, safety.
Spare parts in old constructions/machines
(Special spare parts require special shapes)

Boundary conditions for alternatives:

10°C to +70°C

Circumferential speed up to 2 m/sec

Almost pressureless (1bar overpressure)

Influence of MWF, lubricating oil and fluid grease xxx

Target same service life

Changeover to other elastomers possible, in which case the chemical resistance and also the circumferential speed must be taken into account. At high circumferential speeds, the frictional heat rises sharply, which makes the use of NBR and possibly also HNBR impossible.

The different additives in the cooling lubricants are usually critical, as they can cause changes in NBR and HNBR that are sometimes critical for the application.

In-depth investigations are necessary for this

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