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## Materials

# Materials

In the technology of sealing, mainly representatives of two groups of macromolecular (polymer) substances are used, i.e. substances of the group of elastomers and thermoplastics (plastomers).

Macromolecular substances are organic compounds whose molecules exist of several thousands, often even of millions, of atoms which are known as macro, giant, string or chain molecules. They can either be created by modification of highly molecular natural materials (e.g. natural rubber) or by depositing low-molecular elements (so-called monomers) through various chemical reactions (synthetic materials, "plastics").

## Elastomers

Elastomers are materials that can be highly expanded by exerting relatively little power. Because of their structure, elastomers have a high retractility, which means that the remaining deformation is very small. Basically there are two main groups of elastomers: chemically crosslinked and thermoplastic ones.

**Chemically crosslinked (vulcanized) elastomers** or rubber materials are polymers which are formed by crosslinking the macromolecules with various vulcanisation additives. Due to this chemical bonds they **do not melt** and they **begin to decompose at high temperatures.** In addition elastomers **swell more or less intensively**, depending on different media, and **do not dissolve**.

**Thermoplastic elastomers** have the significant properties of elastomers over a wide temperature range, but they are physically and not chemically crosslinked. Therefore they can be melted at high temperatures and can be processed with the traditional thermoplastic processing techniques. Thermoplastic elastomers **are soluble**; generally they **swell less** than their chemically crosslinked equivalents.

Elastomers are normally classified as "polar" and "nonpolar" and further as "saturated" and "unsaturated" types. To a certain extent, polarity allows statements about swelling and chemical resistance, and saturation about ozone and ageing resistance of the respective material.

## Saturation

Saturation of elastomers indicates whether there are free double bonds in the macromolecules of the material.

Saturated elastomers do not have double bonds in their macromolecules and are therefore significantly better resistant to ozone and ageing than unsaturated elastomers.

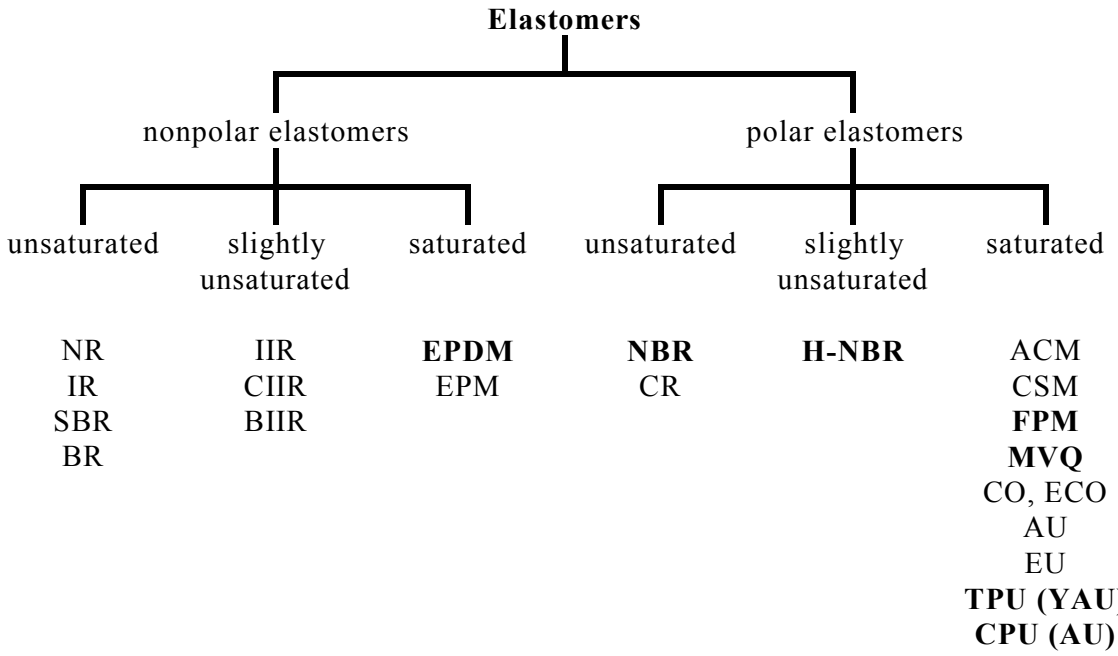
## Polarity

As mentioned above, the polarity of a synthetic material provides information on its swelling behaviour and chemical resistance in different media. A rule of thumb says that polar elastomers are incompatible with polar media and nonpolar elastomers with nonpolar media. In this context it must, however, be said that the chemical resistance of an elastomer cannot or only insufficiently be assessed by an amateur.

| | |
|---|---|
| **Polar media** are for instance: | water, detergents, alcohols, acids and bases, ketones, esters, etc. |
| **Nonpolar media** are for instance: | mineral oil, petrols, vegetable and animal oils and fats, silicone oils and grease and hydrocarbons. |

The following graphics shows the most important chemically and physically crosslinked elastomers used in sealing technology.

# The most important elastomers of sealing technology




*) Bold face printed elastomers are in the Economos standard program

Legend:

| | |
|---|---|
| NR | Natural rubber |
| IR | Isoprene rubber |
| SBR | Styrene-butadiene rubber |
| BR | Butadiene rubber |
| IIR | Isobutene-isoprene rubber |
| CIIR | Chloro-isobutene-isoprene rubber |
| BIIR | Bromo-isobutene-isoprene rubber |
| EPDM | Ethylene-propylene-diene rubber |
| EPM | Ehylene-propylene rubber |
| NBR | Acrylonitrile-butadiene rubber (Nitrile rubber) |
| CR | Chloroprene rubber |
| H-NBR | Hydrogenated nitrile rubber |
| ACM | Polyacrylate rubber |
| CSM | Chlorosulphonated polyethylene rubber |
| FPM | Fluorocarbon rubber |
| MVQ | Vinyl-methyl silicone rubber |
| CO, ECO | Epichlorohydrin rubber |
| AU | Polyester urethane |
| EU | Polyether urethane |
| TPU (YAU) | Thermoplastic polyurethane elastomer basing on polyester |
| CPU (AU) | Cast polyurethane elastomer basing on polyester |

## Shelf Life of Elastomers and Plastics

The following guidelines settle the storage conditions and the shelf life of semi-finished products and seals made from ECOPUR, H-ECOPUR, G-ECOPUR, S-ECOPUR, T-ECOPUR, ECORUBBER 1, ECORUBBER 2 and 3, ECORUBBER-H and ECOSIL.

The same recommendations are valid for the plastic products made from ECOTAL, ECOMID, ECOFLON 1 and ECOFLON 2 and also for ECORYT and ECOPAEK, because there exist no standards for these materials.

During storage, the characteristics of elastomeric products can on the one hand be damaged by chemical reactions wich are basically caused by the influence of heat, light, oxygen, ozone and various chemicals on the material, and on the other hand by physical processes. These physical processes, which are called physical ageing, are either due to the influence of external tensions leading to cracks and permanent deformation of the machined parts, or to the migration of plasticizers from the semi-finished products which makes the material more brittle and leads to deformation of the parts.

Therefore, rubber products will only maintain their characteristics without major changes for several years, if proper storage is ensured. In this context, it must be said that ageing and storage properties of rubber products depend considerably on their chemical structure. Unsaturated elastomers, such as nitrite rubber (ECORUBBER 1) age much quicker under improper storage conditions than saturated elastomers, such as fluororubbers (ECORUBBER 2). The ideal characteristics of these products can only be maintained for longer periods of time, if the products are stored in accordance with the following recommendations of DIN 7716.

## Storage conditions for elastomers and plastics

- Rubber and plastic products should be stored in a cool and dry environment. Storage temperature should be around 15°C and not exceed 25°C; relative humidity should be less than 65%.
- Rubber and plastic products should not be exposed to light above all direct sunlight and artificial light with a high UV content (bulbs to be preferred to neon lamps).
- The storage rooms must not contain any ozone-producing devices, such as electrics motors and high-voltage divices.
- Rubber products should not be exposed to draft. This can be ensured by using airtight packaging wich must not, however, contain plasticizers, Polyethylene is most suitable for such purposes.
- Contact between rubber products of different compositions is to be avoided.
- Contact between rubber and plastic products and chemicals and / or dangerous metals (e.g. copper, manganese) is to be avoided.

- Rubber and plastic products should be stored as tension-free as possible, i.e. the parts should not be subject to tensile, pressure or bending deformation. Rubber products, above all seals must not be hung on nails or tightly folded or rolled for reasons of space.

***Shelf life of semi-finished products:***

If all these recommendations are observed, semi-finished products can be stored for the periods of time indicated below without loosing their typical properties:

ECORUBBER 1 (NBR)
approx.5 years

ECOPUR and T-ECOPUR
approx.8 years

ECORUBBER 3 and ECORUBBER-H
approx.8 years

ECORUBBER 2, ECOSIL, ECOTAL and ECOMID
approx.10 years

H-ECOPUR, G-ECOPUR, S-ECOPUR, ECOFLON 1, ECOFLON 2
approx.12 years

ECORYT and ECOPAEK
approx. 12 years

S**helf life** of seals:

Normally the shelf life of seals is shorter compared to tubes/billets. The following recommendations are also valid for seals which are produced out of a material which is at the end of its “tube“-shelf life.

ECORUBBER 1 (NBR)
approx. 2 years

ECOPUR und T-ECOPUR
approx. 4 years

ECORUBBER 3 und ECORUBBER-H
approx. 4 years

ECORUBBER 2, ECOSIL, ECOTAL und ECOMID
approx. 6 years

H-ECOPUR, G-ECOPUR, S-ECOPUR, ECOFLON 1, ECOFLON 2
approx. 8 years

ECORYT und ECOPAEK
approx. 8 years

The aforementioned instructions, recommendations and guidelines are according to our best knowledge. We can, however, not accept any guarantee and / or liability in this respect.

# ECOPUR (TPU) - green

ECOPUR is a thermoplastic polyurethane-elastomer (TPU) on the basis of polyester developed by ECONOMOS. It belongs to the group of the polar and saturated elastomers. The use of special raw materials makes this material especially suitable for sealing purposes. ECOPUR has a green colour.

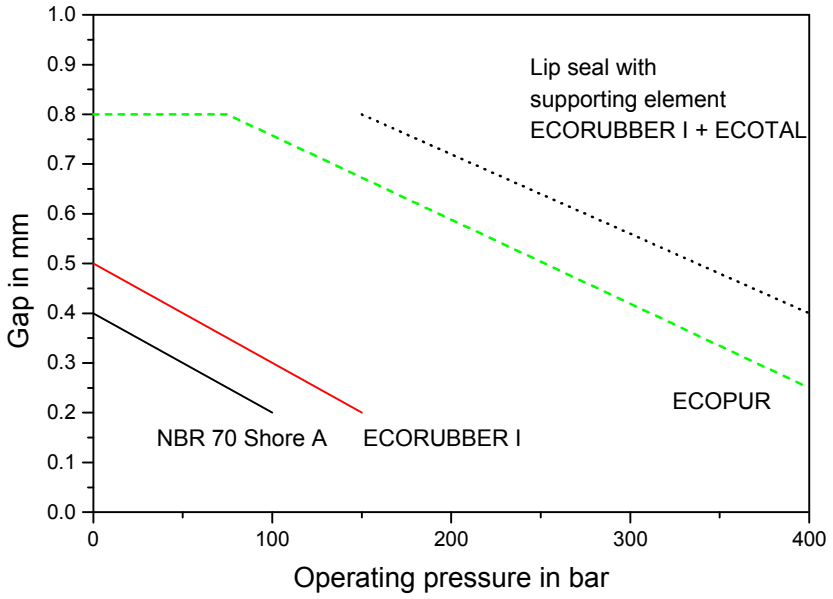
**Characteristics:**

As compared to chemically crosslinked elastomers (ECORUBBER 1 - NBR, ECORUBBER 2 - FPM, ECORUBBER 3 - EPDM) ECOPUR has superior mechanical qualities (see table).

**Typical properties of ECOPUR and ECORUBBER I:**

| **Designation** | **Tensile strength** *DIN 53504* | **Elongation at break** *DIN 53504* | **Tear strength** *DIN 53515* | **Abrasion** *DIN 53516* |
|---|---|---|---|---|
| **ECOPUR** | 50 N/mm$^2$ | 480 % | 120 N/mm | 18 mm$^3$ |
| **ECORUBBER I** | 17 N/mm$^2$ | 150 % | 20 N/mm | 90 mm$^3$ |

ECOPUR has a much higher extrusion-resistance than rubber elastomers. The diagram below shows the tolerated gaps in dependence on pressure for various materials and/or material combinations.




This comparison underlines the special suitability of ECOPUR for sealing purposes. In addition, ECOPUR excels with an extreme low compression set (20% at 70°C/70h). Service temperatures range from -30°C to +110°C.

Due to its saturated structure ECOPUR has good ozone, weather and temperature resistance. Swelling in mineral oils is relatively low in comparison to many chemically crosslinked elastomers. Gas permeability of ECOPUR is very low (inclination to explosive decompression is not relevant).

Just like most polyurethane elastomers, ECOPUR is more radiation-resistant than chemically crosslinked elastomers.

## Resistance:

| **good resistance** | **medium resistance** | **little to no resistance** |
|---|---|---|
| Hydraulic fluids basing on mineral oil | Non-alcoholic fuels | Aromatic hydrocarbons chlorinated hydrocarbons |
| Mineral oils and grease (certain additives may be destructive) | Biologically degradable hydraulic oils (HEES, HETG) | Ketones, alcohols, glycols |
| Water up to 40°C | Fire resistant pressure fluids, HFA and HFB up to max. +30°C | Fire resistant pressure fluids of the HFC and HFD groups |
| Aliphatic hydrocarbons (propane, butane) | Silicone oils and grease | Hot water, steam, alkalis, amines, acids, bases |
| Compressed air up to 110 °C | | Brake fluid basing on glycol |

## Application:

ECOPUR is mainly used where high demands are made on mechanical properties and wear-resistance in addition to good resistance to mineral oil.

e.g.: Seals that have to meet high demands on low friction, little wear, high extrusion strength, simple fitting (snap and/or slip-on installation), small size and long service life.

*Main use*: rod seals
piston seals
wipers
rotor seals
O-rings

**Encl.:** Data sheet

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# MATERIAL DATA SHEET

## ECOPUR (green)

**Thermoplastic polyurethane-elastomer (TPU)** **DIN** **ASTM**
**on the basis of polyester** **YAU** **YAU**

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 95 ± 2 | DIN 53505 |
| **Durometer hardness** | SHORE D | 48 ± 3 | DIN 53505 |
| **Density** | g/cm³ | 1,20 ± 0,01 | DIN 53479 |
| **Tensile strength** | N/mm² | ≥ 40 | DIN 53504 |
| **Elongation at break** | % | ≥ 430 | DIN 53504 |
| **100 % modulus** | N/mm² | ≥ 12 | DIN 53504 |
| **Compression set:** 70°C / 24h, 20 % compression | % | ≤ 30 | ---- |
| **Compression set:** 100°C / 24h, 20 % compression | % | ≤ 35 | --- |
| **Compression set:** 70°C/70h, 10 % compression | % | 20 | DIN ISO 815 |
| **Tear strength** | N/mm | ≥ 100 | DIN 53515 |
| **Rebound resilience** | % | 42 | DIN 53512 |
| **Abrasion** | mm³ | 18 | DIN 53516 |
| **Minimum service temperature** | °C | -30 | ---- |
| **Maximum service temperature** | °C | +110 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, July 1996
Dr. TS/He wdpure/werkstoffe

# H-ECOPUR (TPU) - red

H-ECOPUR is a thermoplastic polyurethane elastomer (TPU) developed by ECONOMOS. It is hydrolysis resistant and belongs to the group of polar and saturated elastomers. The use of special raw materials makes this material especially suitable for use in water, biologically degradable fluids, fire-resistant liquids (HFA, HFB) and mineral oils with additives. H-ECOPUR is red.

## Characteristics:

As compared to ECOPUR, H-ECOPUR has about the same mechanical properties. The compression set is extremely low (20% at 70°C/70h). Application temperatures range from -20°C to +110°C.

The main difference is the - in the case of polyurethane elastomers - unusually high hydrolysis stability and the high chemical resistance. Therefore it can be recommended for use in hot water and biologically degradable fluids. The high chemical resistance of H-ECOPUR can be seen in the following diagrams:

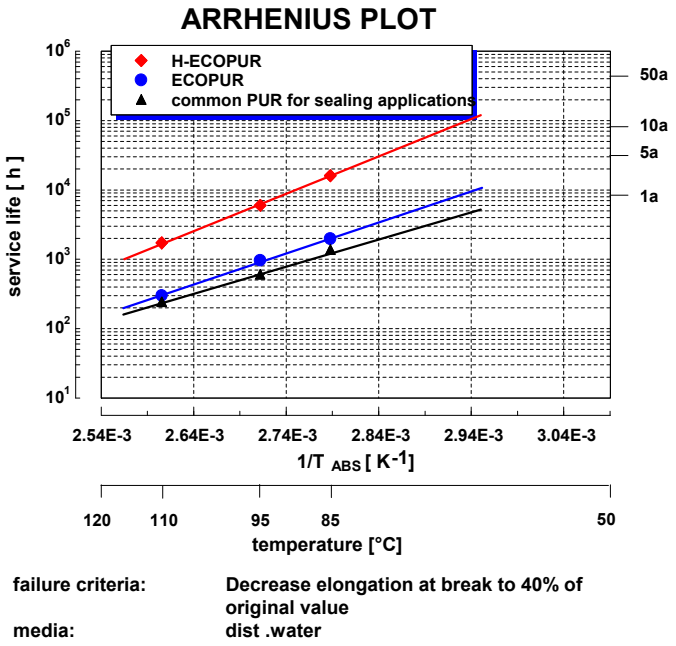


**Fig. 1 Arrhenius plot for ageing of various polyurethane elastomers in distilled water**

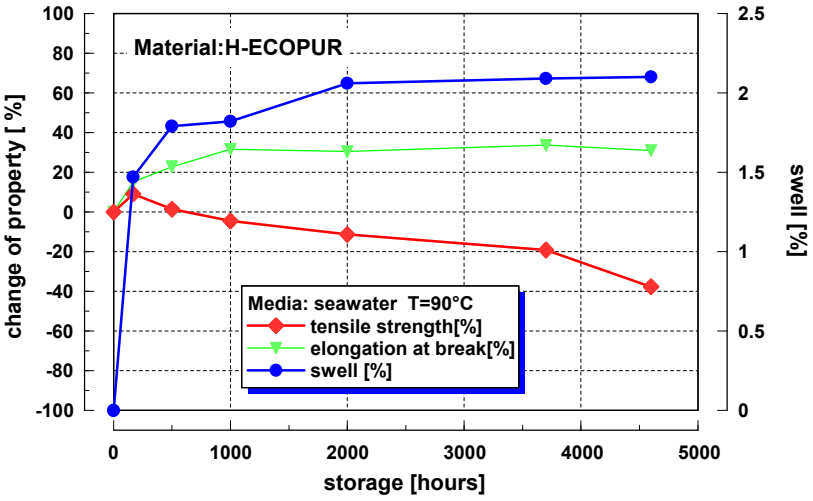


**Fig. 2** **Influence of hot sea water (90°C) on the properties of H-ECOPUR (tensile properties, volume change)**

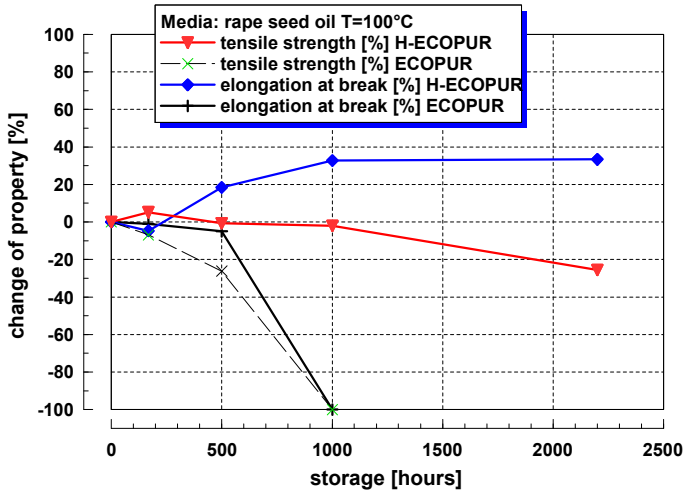


**Fig. 3** **Influence of a biologically degradable hydraulic fluid (rape seed oil, 100°C) on the tensile properties of H-ECOPUR and ECOPUR**

Because of its saturated nature and its chemical structure H-ECOPUR is highly ozone, weather and temperature resistant. Due to its high hydrolysis stability, it is especially recommended for use in tropical regions. As compared to chemically crosslinked elastomers the swelling in mineral oils is very small. Test results show that the gas permeability of H-ECOPUR is even lower than that of ECOPUR and therefore H-ECOPUR is especially recommended for the use in high pressure gases (piston-accumulator). Just like with ECOPUR, H-ECOPUR is highly radiation resistant.

## Resistance:

| good resistance | medium resistance | little to no resistance |
|---|---|---|
| Hydraulic fluids basing on mineral oil | Fire-resistant fluids of type HFC (water-glycol mixture) | Aromatic hydrocarbons |
| Biologically degradable hydraulic fluids | Some additives for power water (e.g. fungicides) can have destructive effects | Chlorinated hydrocarbons |
| Fire-restistant pressure fluids HFA and HFB | Alcohols | Ketones, glycols |
| Mineral oils and grease (certain additives can have destructive effects) | Fuels free of alcohol (except premium blend petrol and unleaded fuels) | Brake fluids basing on glycol |
| Silicone oils and grease | | Hot steam exceeding 100°C, alkalis, amines |
| Aliphatic hydrocarbons (for example propane, butane) | | Concentrated acids and bases |
| Hot water and sea water up to +90°C | | |
| Diluted acids and bases | | |

## Application:

H-ECOPUR is mainly used for applications where high hydrolysis stability and chemical resistance (also to many polar hydraulic fluids) are demanded in addition to good mineral oil resistance. Mechanical properties and wear resistance correspond approximately to that of ECOPUR.

e.g.: H-ECOPUR fulfils the sealing demands for
little friction,
little wear,
high extrusion-strength,
simple fitting (snap and/or slip-on installation),
small construction size.

as well as the additional demands for
hydrolysis stability (mining, water hydraulics) and
chemical resistance (biologically degradable hydraulic oils).

**ATTENTION!**

For use of pre-load elements for H-ECOPUR profiles in biologically degradable fluids, only FKM (ECORUBBER 2) is recommended.

*Main use:* rod seals
piston seals
wipers
O-rings for water hydraulic and in degradable oils

**Encl.:** Data sheet

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# MATERIAL DATA SHEET

## H - ECOPUR (red)

**Thermoplastic polyurethane-elastomer (TPU)** **DIN** **ASTM**
**on the basis of polyester (hydrolysis resistant)** **YAU** **YAU**

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 95 ± 2 | DIN 53505 |
| **Durometer hardness** | SHORE D | 48 ±3 | DIN 53505 |
| **Density** | g/cm³ | 1,20 ± 0,01 | DIN 53479 |
| **Tensile strength** | N/mm² | ≥ 50 | DIN 53504 |
| **Elongation at break** | % | ≥ 330 | DIN 53504 |
| **100 % modulus** | N/mm² | ≥ 13 | DIN 53504 |
| **Compression set:** 70°C / 24h, 20 % compression | % | ≤ 27 | ---- |
| **Compression set:** 100°C / 24h, 20 % compression | % | ≤ 33 | ---- |
| **Compression set:** 70°C/70h, 10 % compression | % | 20 | DIN ISO 815 |
| **Tear strength** | N/mm | ≥ 100 | DIN 53515 |
| **Rebound resilience** | % | 29 | DIN 53512 |
| **Abrasion** | mm³ | 17 | DIN 53516 |
| **Minimum service temperature** | °C | -20 | ---- |
| **Maximum service temperature** | °C | +110 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. These values are only tested on selected samples.

Judenburg, July 1996
Dr. TS/He wdhpure/werkstoffe

# S-ECOPUR

S-ECOPUR is a thermoplastic polyurethane elastomer (TPU) developed by ECONOMOS. The new brand has been optimised in regard of the tribological characteristics (friction and wear), achieved by an addition of a synergetic combination of solid lubricants.
The effect of this modification is a significantly improved sliding property compared to other sealing materials from the group of polyurethanes and elastomers. The better sliding properties directly resulting in a higher wear resistance at dry running conditions.
Because of its high chemical resistance and its low coefficient of friction, S-ECOPUR is best suited in tribological systems with lack of lubrication, as for example in clear water hydraulics, in water-based, fire resistant hydraulic fluids of the category HFA and HFB and in oil-free pneumatics.
Because of the incorporation of the solid lubricants S-ECOPUR has a grey-black colouring.

## Characteristics:

Compared to H-ECOPUR, S-ECOPUR has superior sliding properties. Figure 1 shows the sliding friction coefficient against a polished steel ball.

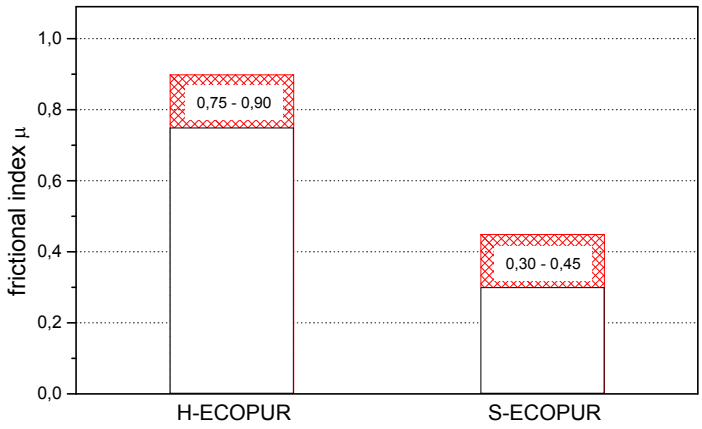


Fig.1: Friction coefficient μ of H-ECOPUR and S-ECOPUR against steel

This figure clearly shows the superior sliding properties of S-ECOPUR, which has a friction coefficient range of 0,30 to 0,45 against steel (without lubrication). The same test with

H-ECOPUR indicates a friction coefficient of 0,75 to 0,90 allowing the conclusion, that friction can be reduced by S-ECOPUR up to an extend of 50%.

The good chemical resistance of S-ECOPUR also permits its application in water-based hydraulic fluids (see to fig. 2 and 3).

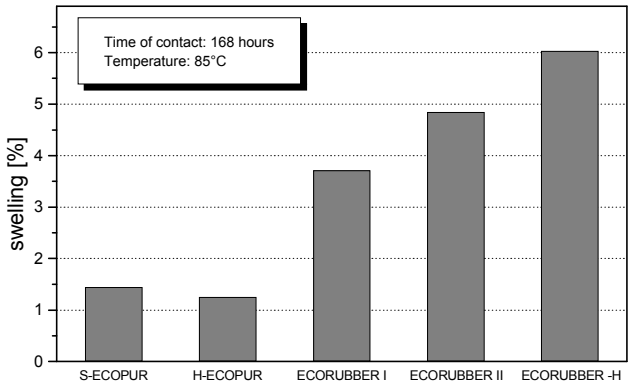


Fig.2: Swelling after 168 hr. at 85°C of S-ECOPUR and H-ECOPUR in a 5% HFA-fluid.

Shown in figure 2, the swelling of S-ECOPUR (1,4%) is only slightly above the value of H-ECOPUR, which can be considered as very low compared with other seal materials.

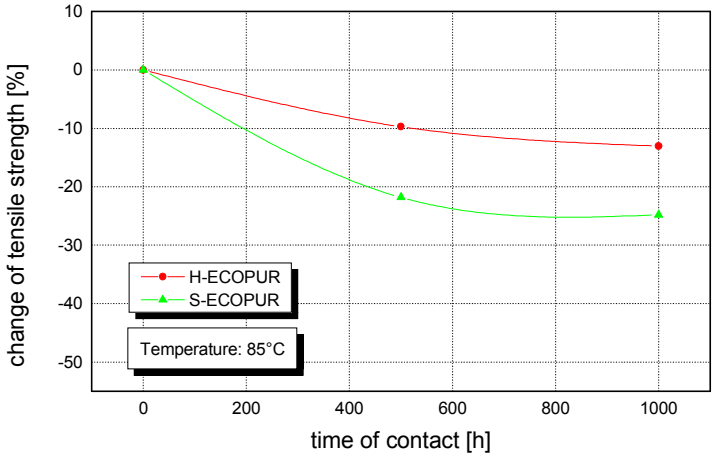


Fig.3: Tensile strength of H-ECOPUR and S-ECOPUR as a function of the storage period in a HFA-fluid at 85°C.

A long-term storage test in this HFA-fluid (fig.3) is furthermore suggesting that S-ECOPUR meets almost the high level of chemical resistance of H-ECOPUR.

After a storage time of 1000 hours at an extraordinary high temperature of 85°C the loss of the tensile strength amounts to only 25%. This loss is considered to be extremely low for polyurethane elastomers.
This high chemical resistance is obtained due to the fact that the same basic materials have been applied as for H-ECOPUR. In addition we consciously refrained to use molybdenum disulphide ($MoS_2$).

Similiar to ECOPUR and H-ECOPUR, S-ECOPUR has a very high extrusion resistance, a high tear strength and an extremely low compression set.

## Resistance:

| good resistance | medium resistance | little to no resistance |
|---|---|---|
| Hydraulic fluids basing on mineral oil | Fire-resistant fluids of type HFC (water-glycol mixture) | Aromatic hydrocarbons |
| Biologically degradable hydraulic fluids | Some additives for power water (e.g. fungicides) can have destructive effects | Chlorinated hydrocarbons |
| Fire-restistant pressure fluids HFA and HFB | Alcohols | Ketones, glycols |
| Mineral oils and grease (certain additives can have destructive effects) | Fuels free of alcohol (except premium blend petrol and unleaded fuels) | Brake fluids basing on glycol |
| Silicone oils and grease | | Hot steam exceeding 100°C, alkalis, amines |
| Aliphatic hydrocarbons (for example propane, butane) | | Concentrated acids and bases |
| Hot water and sea water up to +90°C | | |
| Diluted acids and bases | | |

## Application:

S-ECOPUR is mainly used where high demands are made to the tribological characters of the sealing material. The mechanical properties and the chemical resistance correspond to that of H-ECOPUR.

S-ECOPUR is especially suited for

- pneumatic applications
- particular operating conditions as dry running conditions, high sliding speeds, high pressure applikations and standstill under pressure
- special demands to friction limitation, head production, slip-stick-conditions, starting behavior and control movements
- working fluids with badly lubricating properties, as water, water-based fluids, gases and fluids with degreasing properties.

**Encl**.: Data sheet

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# MATERIAL DATA SHEET

## S - ECOPUR (grey/black)

**Self-lubricated thermoplastic polyurethane-elastomer (TPU) with lubricating agents for reduced friction applications**

| DIN | ASTM |
|---|---|
| YAU | YAU |

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 95 ± 2 | DIN 53505 |
| **Durometer hardness** | SHORE D | 48 ± 3 | DIN 53505 |
| **Density** | g/cm³ | 1,24 ± 0,02 | DIN 53479 |
| **Tensile strength** | N/mm² | 50 | DIN 53504 |
| **Elongation at break** | % | 380 | DIN 53504 |
| **100 % modulus** | N/mm² | 17 | DIN 53504 |
| **Compression set:** 70°C / 24h, 20 % compression | % | 25 | ---- |
| **Compression set:** 100°C / 24h, 20 % compression | % | 30 | ---- |
| **Compression set:** 70°C/70h, 10 % compression | % | ---- | DIN ISO 815 |
| **Tear strength** | N/mm | 120 | DIN 53515 |
| **Rebound resilience** | % | ---- | DIN 53512 |
| **Abrasion** | mm³ | 17 | DIN 53516 |
| **Minimum service temperature** | °C | -20 | ---- |
| **Maximum service temperature** | °C | +110 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. These values are only tested on selected samples.

Judenburg, October 1998
Dr. TS/He wdhpurgrey/werkstoffe

# T-ECOPUR (TPU) - blue

T-ECOPUR is a modified ECOPUR for the use at low temperatures. The difference to ECOPUR is a considerably lower brittleness point (glass temperature -42°C), greater elasticity and a compression set at -40°C of 45 % (better than silicone rubber). The lowest operating temperature is about -50°C.

## Application:

The same as with ECOPUR but for the use at low temperatures, mainly in cold regions and for deep freezing.

**Encl.:** Data sheet

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# MATERIAL DATA SHEET

## T-ECOPUR (blue)

**Thermoplastic polyurethane-elastomer (TPU)**
**for low temperature application**

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 95 ± 2 | DIN 53505 |
| **Durometer hardness** | SHORE D | 48 ± 2 | DIN 53505 |
| **Density** | g/cm³ | 1,17 ± 0,01 | DIN 53479 |
| **Tensile strength** | N/mm² | ≥ 50 | DIN 53504 |
| **Elongation at break** | % | ≥ 450 | DIN 53504 |
| **100 % modulus** | N/mm² | ≥ 12 | DIN 53504 |
| **Compression set:** 70°C/70h, 10 % compression | % | 20 | DIN ISO 815 |
| **Compression set** at - 40°C | % | 45 | DIN ISO 815 |
| **Tear strength** | N/mm | 80 | DIN 53515 |
| **Rebound resilience** | % | 50 | DIN 53512 |
| **Abrasion** | mm³ | 15 | DIN 53516 |
| **Glass temperature** | °C | - 42 | DIN 53445 |
| **Minimum service temperature** | °C | -50 | ---- |
| **Maximum service temperature** | °C | +110 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, July 1996
Dr. TS/He wdtpure/werkstoffe

# G-ECOPUR (CPU) - red

G-ECOPUR is a cast elastomer developed by ECONOMOS. It is made with a special casting procedure out of the same basic materials as H-ECOPUR, therefore the chemical characteristics can be compared with those of H-ECOPUR.

## Application:

The same as with H-ECOPUR and ECOPUR, but for material dimensions above 550mm up to 2500 mm and special dimensions with extreme wall thickness.

**Encl**. Data sheet

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# MATERIAL DATA SHEET

## G-ECOPUR (RED)

**Casting polyurethane-elastomer (CPU) on the basis of polyester (hydrolysis resistant)**

**DIN AU** **ASTM AU**

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 95 ± 2 | DIN 53505 |
| **Durometer hardness** | SHORE D | 47 ± 3 | DIN 53505 |
| **Density** | g/cm³ | 1,20 ± 0,01 | DIN 53479 |
| **Tensile strength** | N/mm² | ≥ 45 | DIN 53504 |
| **Elongation at break** | % | ≥ 280 | DIN 53504 |
| **100 % modulus** | N/mm² | ≥ 11 | DIN 53504 |
| **Compression set:** 70°C/24h, 20 % compression | % | ≤30 | ---- |
| **Compression set:** 100°C/24h, 20 % compression | % | ≤40 | ---- |
| **Compression set:** 70°C/70h, 10 % compression | % | 20 | DIN ISO 815 |
| **Tear strength** | N/mm | ≥40 | DIN 53515 |
| **Rebound resilience** | % | 43 | DIN 53512 |
| **Abrasion** | mm³ | 25 | DIN 53516 |
| **Minimum service temperature** | °C | -30 | ---- |
| **Maximum service temperature** | °C | +110 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, July 1996
Dr. TS/He wdgpure/werkstoffe

# ECORUBBER 1 (NBR) – black
# Improved Quality

The "new" grade of ECORUBBER 1 is a semifinished material made of sulphur-vulcanised acrylo-nitrile-butadiene rubber (NBR) produced by ECONOMOS. It belongs to the group of polar and unsaturated elastomers. Due to the unsatisfactory shrinkage behaviour of the "old" grade in slight swelling oils for which NBR elastomers are usually used, ECONOMOS have decided to improve the swelling behaviour in this kind of products. The result is this "new" grade of ECORUBBER 1 which replaces the former product from manufacturing date week 21/99; the tubes in the new quality are additionally signed with an "A" on the label.

## Characteristics:

The new material has – compared to the former quality – a little bit higher tensile strength, better tear strength and abrasion resistance (90mm$^3$). The service temperature ranges from -30°C to +100°C (short exposure to +120°C possible). At high temperatures, ageing is accelerated and the material becomes hard and brittle. In oxygen atmosphere (air) this effect starts at about 80° C, under exclusion of air ageing occurs slower (e.g. hot oil).
Due to its unsaturated structure, ozone, weather and ageing resistance of this elastomer is – compared to saturated elastomers - only **small** (caution at storage). Swelling in mineral oil is also small, but depends very much on the ingredients of the oil. Gas permeability is quite high and therefore there is an inclination to explosive decompression, through which parts of the material blast out.

Pictures 1 and 2 are showing the compatibility results of the two grades measured in some typical hydraulic fluids

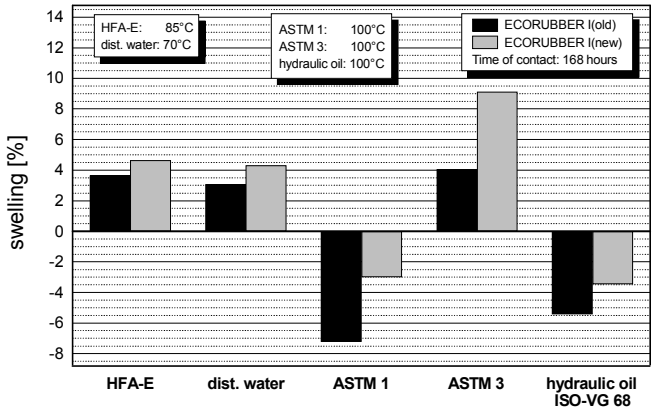


Fig.1: Volume change of ECORUBBER 1 "old" and "new" in various hydraulic fluids after an immersion period of 168 hours

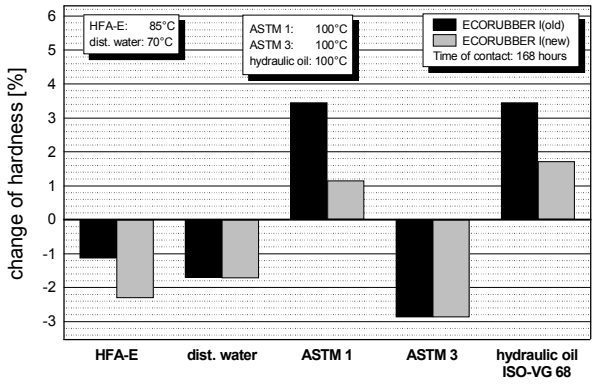


Fig. 2: Change of Shore A hardness of ECORUBBER 1 "old" and "new" in various hydraulic fluids after an immersion period of 168 hours.

The figures are clearly demonstrating that both grades have similar compatibility in aqeous fluids (e.g. distilled water and a fire-resistant pressure fluid of category HFA). The new grade has only slightly higher swelling values, but the volume change itself is only 5% and therefore very small for such applications.
In the reference oil for low swelling mineral oils, the ASTM oil No. 1 the new grade shows a clearly better compatibility with a shinkage of only –3% compared to more than –7% of the old grade. Therefore the increase of hardness is very small in comparison to more than +3% of the former grade.
Also the influence of a standard hydraulic oil of the viscosity class ISO-VG 68 is clearly lower. Only in the high swelling oils like ASTM reference oil No 3 the old grade of ECORUBBER 1 has a little better compatibility. Nevertheless in this kind of oils usually rubbers of the group of H-NBR and FPM are used.

## Resistance:

| good resistance | medium resistance | little to no resistance |
|---|---|---|
| Mineral oils and greases | Fuels with aromatic parts up to 40 % (leaded fuels) | Aromatic hydrocarbons (toluene, benzene) |
| Aliphatic hydrocarbons (propane, butane) | Biologically degradable hydraulic fluids (test necessary) | Chlorinated hydrocarbons (trichloro- and perchloroethylene) |
| Water | | Brake fluids basing on glycol |
| Fire-resistant pressure fluids of the HFA, HFB, HFC group | Silicone oils and greases (oils can cause shrinkage) | Fire-resistant pressure fluids of the HFD group (phosphate ester) |
| Vegetable and animal oils and fats | fire-resistant fluids category HFD-U | Polar solvents (acetone, ethyl-acetate) |
| Diesel fuel | | |
| Many diluted acids and bases, saline solutions at room temperature | | |

## Applications:

ECORUBBER 1 is mainly used in applications where high elasticity and extremely good compression set are called for in addition to good fuel and mineral oil resistance.

e.g.: in sealing technology where "soft seals" are essential, or as a pre-load element for less elastic materials.

*Main use:* rod seals for low pressure
piston seals for low pressure
wipers for special cases
rotor seals (oil seals, V-packings)
O-rings

**Encl.:** Data sheet

ECONOMOS®
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# MATERIAL DATA SHEET

## ECORUBBER 1 (black), „NEW“ valid from prod.-date 21/99
## Acrylonitrile - Butadiene- Rubber (NBR)

DIN / ISO NBR | ASTM NBR

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 85 ± 5 | DIN 53505 |
| **Density** | g/cm³ | 1,31 ± 0,02 | DIN 53479 |
| **Tensile strength** | N/mm² | ≥ 16 | DIN 53504 |
| **Elongation at break** | % | ≥ 130 | DIN 53504 |
| **100% Modulus** | N/mm² | ≥ 11,0 | DIN 53504 |
| **Compression set:** 100°C / 22h | % | ≤ 15 | DIN ISO 815 |
| **Tear strength** | N/mm | 20 | DIN 53515 |
| **Rebound resilience** | % | 28 | DIN 53512 |
| **Abrasion** | mm³ | 90 | DIN 53516 |
| **Minimum service temperature** | °C | -30 | ---- |
| **Maximum service temperature** | °C | +100 | ---- |
| **Glass transition temperature** | °C | -28 | DSC |
| **Swelling behavior in ASTM Oil No.1 acc. DIN 53521 168h/100°C:** | | | |
| Change in durometer hardness | Shore A | +1 | DIN 53505 |
| Volume change | % | -3,0 | DIN 53521 |
| **Swelling behavior in ASTM Oil No.3 acc. DIN 53521 168h/100°C:** | | | |
| Change in durometer hardness | Shore A | -3 | DIN 53505 |
| Volume change | % | +9,1 | DIN 53521 |
| **Heat resistance, air 168h/100°C:** | | | |
| Change in durometer hardness | Shore A | +2 | DIN 53505 |
| Volume change | % | -0,5 | DIN 53521 |
| **Swelling behavior, water 168h/70°C:** | | | |
| Change in durometer hardness | Shore A | -3 | DIN 53505 |
| Volume change | % | +4,0 | DIN 53521 |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, May 1999
Dr. TS/He wdrub1newe/werkstoffe

# ECORUBBER-H (H-NBR) - black

ECORUBBER-H is a semi-finished material consisting of peroxide-crosslinked hydrogenated acrylonitrile-butadiene-rubber produced by ECONOMOS. ECORUBBER-H belongs to the group of polar and saturated elastomers. ECORUBBER-H is **not** filled with carbon black, but it is coloured black.

## Characteristics:

As compared to ECORUBBER 1, ECORUBBER-H has better mechanical properties such as tensile strength, elongation at break and abrasion resistance. Due to its saturated structure, the temperature range is considerably wider (from -25°C up to +150°C; for a short time up to +170°C). Because of its saturated structure, excellent ozone, weather and ageing resistance are existing.
Swelling in mineral oil is very small, but depends very much on the composition of the oil. Compatibility with highly additivated oils is better than that of ECORUBBER 1. Gas permeability is relatively high leading to an inclination to explosive decompression, through which parts of the material blast out.

## Resistance:

| **good resistance** | **medium resistance** | **little to no resistance** |
|---|---|---|
| Mineral oils and grease | Fuels with aromatic parts up to 40 % (unleaded fuels)* | Aromatic hydrocarbons (toluene, benzene) |
| Aliphatic hydrocarbons (propane, butane) | Biologically degradable hydraulic fluids (shrinking,) additives may also cause swelling - test necessary) | Chlorinated hydrocarbons (trichloro- and perchloroethylene) |
| Water | | Brake fluids basing on glycol |
| Fire-resistant pressure fluids of type HFA, HFB, HFC | | Fire resistant pressure fluids of the HFD group (phosphate ester) |
| Vegetable and animal oils and fats | Silicone oils and grease (oils can cause shrinkage) | Polar solvents (acetone, ethyl-acetate) |
| Diesel fuel | | Hot steam |
| Highly additivated oils (transmission hypoid oils)* | | |
| Many diluted acids and bases, saline solutions at room temperature | | |
| Crude oils (also hydrogen sulfide and amine containing) | | |

*test recommended

## Application:

ECORUBBER-H is mainly used for applications where very good compression set together with high temperatures and highly additivated oils is called for in addition to good mineral oil resistance and high elasticity (substitute for fluororubber).

e.g. - Motor and transmission sealing for vehicles
- Sealing elements for oil-field application (also for sour gas)

*Main use:* rotor seals
O-rings
special seals

**Encl.:** Data sheet

ECONOMOS®
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# MATERIAL DATA SHEET

## ECORUBBER-H (black)

### Hydrogenated acrylonitrile-butadiene-rubber (HSN, H-NBR)

marked with green dye

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 85 ± 5 | DIN 53505 |
| **Density** | g/cm³ | 1,22 ± 0,02 | DIN 53479 |
| **Tensile strength** | N/mm² | ≥ 18 | DIN 53504 |
| **Elongation ab break** | % | ≥ 180 | DIN 53504 |
| **100 % modulus** | N/mm² | ≥ 10 | DIN 53504 |
| **Compression set:** 100°C / 22h | % | ≤ 22 | DIN ISO 815 |
| **Tear strength** | N/mm | 30 | DIN 53515 |
| **Rebound resilience** | % | 29 | DIN 53512 |
| **Abrasion** | mm³ | 90 | DIN 53516 |
| **Minimum service temperature** | °C | -25 | ---- |
| **Maximum service temperature** | °C | +150 | ---- |
| **Swelling behavior in ASTM Oil No.1 acc. DIN 53521 70h/100°C:** | | | |
| Change in durometer hardness | Shore A | +6 | DIN 53505 |
| Volume change | % | -8 | DIN 53521 |
| **Swelling behavior in ASTM Oil No.3 acc. DIN 53521 70h/100°C:** | | | |
| Change in durometer hardness | Shore A | -8 | DIN 53505 |
| Volume change | % | +11 | DIN 53521 |
| **Heat resistance, air 70h/100°C:** | | | |
| Change in durometer hardness | Shore A | +5 | DIN 53505 |
| Volume change | % | 0 | DIN 53521 |
| **Swelling behavior in water 70h/100°C:** | | | |
| Change in durometer hardness | Shore A | 0 | DIN 53505 |
| Volume change | % | +2,5 | DIN 53521 |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, July 1996
Dr. TS/He wdrubhe/werkstoffe

# *ECORUBBER 2 (FPM, FKM) – brown*
# *Improved Quality*

The "new" grade of ECORUBBER 2 is a semi-finished material made of a bisphenol-crosslinked fluorocarbon rubber based on VITON® of Du Pont. With this new, improved quality ECONOMOS has made another step in machining seals out of high-performance materials. The new material is based on a VITON terpolymer of vinylidene fluoride, hexa-fluoropropylene and tetrafluorethylene, which is showing a lot of advantages compared to the existing grade of ECORUBBER 2, which was based on a copolymer of vinylidene fluoride and hexafluoropropylene. The most important improvement of this material is the higher chemical resistance especially against low moleculare polar chemicals as for example alcohols and aromatic hydrocarbons.

The new grade of ECORUBBER 2 is also belonging to the group of polar and saturated special elastomers and is colored in the same brown as the previous grade.

The new grade will replace the former product effective with the manufacturing date "week 01/00". The new grade is additionally signed with an "A" on the label. All the test results have proved that there is no problem to apply the new product in the same applications / aggregates, etc. like the old product, so there should be no troubles to replace former seals with the new material. Anyhow, you should not use both qualities for a serial production of seals for one shipment, because on the one hand seals of the same size are differing in the weight and on the other hand there should not be used materials of different specification within the same shipment of serial seals.

**Characteristics:**

The new material has – compared to the former quality – a slightly smaller tensile strength, but a significantly improved elongation at break which leads to a better performance of the seals in critical applications and also lowers problems during the installation process. Futhermore the new elastomer shows an increased tear strength which protects the seals against cutting during the installation process. The compression set of the material is slightly higher than that of the former grade, which, anyhow, does not influence the performance of the seals.

Due to the chemical composition of the new material and the higher fluorine content, the chemical resistance of the new grade is significantly higher, especially against low molecular polar organic chemicals like alcohols and also against aromatic hydrocarbons. This improved chemical resistance is demonstrated in fig. 1 and 2.

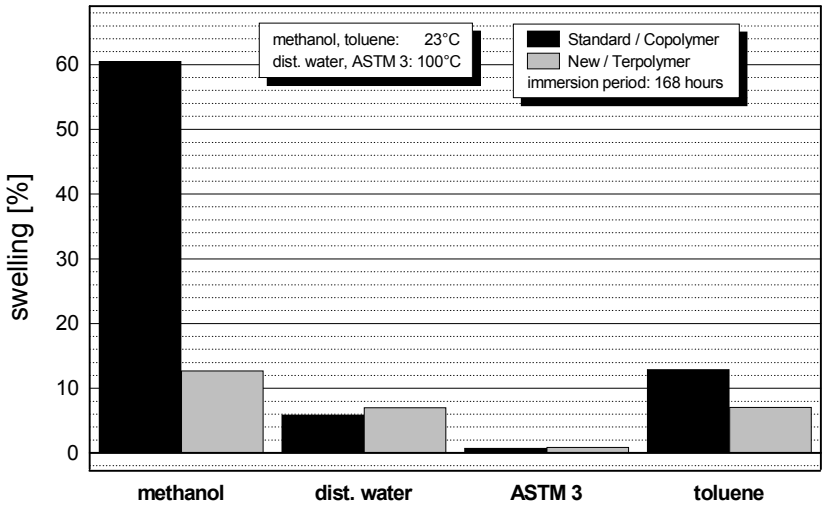


Fig. 1.: Volume change of ECORUBBER 2 “old“ and “new“ in various hydraulic fluids after an immersion period of 168 hours

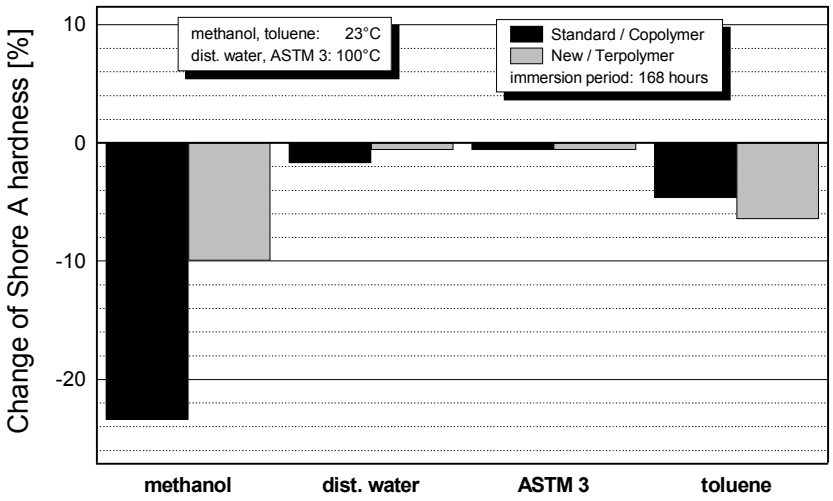


Fig. 2.: Change of Shore A hardness of ECORUBBER 2 “old“ and “new“ in various hydraulic fluids after an immersion period of 168 hours

Both pictures are clearly demonstrating the higher compatibility of the new grade, which has the same resistance in strongly affecting mineral oil like ASTM Oil No. 3 and water-based fluids and a significantly higher resistance in aromatic hydrocarbons and especially in low molecular polar medias like methanol, in which the volume change is only a fifth part of the old grade.

The new grade of ECORUBBER 2 is highly temperature and chemical resistant like the former grade. Operating temperatures range from -20°C up to + 200°C (short exposure to approx. +230°C possible). Due to its saturated nature and its chemical structure ECORUBBER 2 has extraordinary ozone, weather and ageing resistance. Swelling in different media is very small, also in aromatic hydrocarbons. Gas permeability is very low and therefore it can be used in high vacuum.

ECORUBBER 2 is not inflammable. Radiation resistance is low.

## Resistance:

| **good resistance** | **medium resistance** | **little to no resistance** |
|---|---|---|
| Mineral oils and grease | Hot water | |
| Aliphatic hydrocarbons (propane, butane) | alcohols | Skydrol 500 |
| Silicone oils and grease | | Ammonia, amines, alkali |
| Vegetable and animal oils and fats | | Overheated steam |
| Fuels, also premium blend petrol and unleaded petrol with aromatic parts up to 40% | Fire-resistant fluids of type HFA, HFB and HFC | Low molecular organic acids (formic and acetic acid) |
| Sulphured and high aromatic oils | | Hydrofluoric acid, chlorosulfonic acid |
| Fire-resistant pressure fluids of the HFD-S (chlorinated hydrocarbons) and HFD-R group (phosphate ester - certain types can have destructive effects) | | Polar solvents (acetone, methylethyl-ketone, ethyl-acetate, dioxane) |
| Biologically degradable hydraulic fluids | | Brake fluids basing on glycol |
| Aromatic hydrocarbons (benzene, toluene) | | |
| Chlorinated hydrocarbons | | |
| Diluted solutions and nonorganic acids | | |

## Application:

ECORUBBER 2 is mainly used for applications where high temperatures and chemical stress can be expected. In addition to that, ECORUBBER 2 is used in hydraulic systems working with fire-resistant hydraulic fluids of the HFD group (except some phosphate esters) and as a preload element for H-ECOPUR seals in biologically degradable hydraulic fluids.

*Main use:* Special seals for the chemical industry and in heat engineering
Shaft seals for high speed
O-rings
Hydraulic seals for HFD-fluids

ECONOMOS®
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# MATERIAL DATA SHEET

## ECORUBBER 2 (brown), "new grade", valid from prod-date 01/00

**Fluoro-Rubber** — **DIN / ISO** **FPM** — **ASTM** **FKM**
(Viton = Trade mark of DuPont)

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 83 ± 5 | DIN 53505 |
| **Density** | g/cm³ | 2,30 ± 0,03 | DIN 53479 |
| **Tensile strength** | N/mm² | ≥ 8,0 | DIN 53504 |
| **Elongation at break** | % | ≥ 200 | DIN 53504 |
| **100 % modulus** | N/mm² | ≥ 5,0 | DIN 53504 |
| **Compression set:** 175°C / 22h | % | ≤ 20 | DIN ISO 815 |
| **Tear strength** | N/mm | 21 | DIN 53515 |
| **Rebound resilience** | % | 7 | DIN 53512 |
| **Abrasion** | mm³ | 150 | DIN 53516 |
| **Minimum service temperature** | °C | -20 | ---- |
| **Maximum service temperature** | °C | +200 | ---- |
| **Heat resistance 168h / 225°C:** | | | |
| Change in durometer hardness | Shore A | +3 | DIN 53505 |
| Change in tensile strength | % | +24 | DIN 53504 |
| Change in elongation at break | % | -24 | DIN 53504 |
| **Swelling behavior in ASTM Oil No.3 acc. DIN 53521 168h/100°C:** | | | |
| Change in durometer hardness | Shore A | -1 | DIN 53505 |
| Volume change | % | +0,9 | DIN 53521 |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, Dec. 1999
Dr. TS/Fi wdrub2e/werkstoffe

# ECORUBBER 3 (EPDM) - black

ECORUBBER 3 is a semi-finished product produced by ECONOMOS, made from peroxide crosslinked ethylen-propylene-diene rubber. This material belongs to the the nonpolar and saturated elastomers. ECORUBBER 3 is filled with carbon black and therefore **not** suitable for electric insulation.

## Characteristics:

ECORUBBER 3 has good mechanical properties and can be used at a very wide temperature range of -50°C up to +150°C (hot steam up to 180°C). Due to its saturated structure ECORUBBER 3 is highly ozone, weather and ageing resistant. Because of its nonpolarity, ECORUBBER 3 is **not** resistant to mineral oils. Mineral oils and grease as well as animal and vegetable oils and fats cause intolerable swelling. Special use of plasticizers allows use in brake fluids basing on glycol (SL-DOT4). For this application, regional permission regulations have to be observed and the corresponding release is to be obtained (ECONOMOS is **not** in the position **to supply** them). Gas permeability is relatively high; radiation resistance is high.

## Resistance:

| **good resistance** | **medium resistance** | **little to no resistance** |
|---|---|---|
| Hot water and hot steam up to 180°C | Silicone oils and grease (oils can cause shrinkage, test recommended) | Mineral oils and grease |
| Fire-resistant pressure fluids of the HFD-R group without mineral oil addition (phosphate ester) | | Fire-resistant pressure fluids of the HFA, HFB and HFD-S (chlorinated hydrocarbons) group |
| Detergents, soda lye, potash lye | | |
| Many organic and anorganic bases and acids | | Aromatic and chlorinated hydrocarbons |
| Saline solutions and oxidation causing media | | Aliphatic hydrocarbons (propane, butane) |
| Fire-resistant pressure fluids of the HFC group (glycol-water, if it is ensured that the fluid is free of mineral oil) | | Vegetable and animal oils and fats |
| Many polar solvents (e.g. alcohols, ketones, esters, etc.) | | Biologically degradable hydraulic fluids |
| Skydrol 500 und 7000 | | |
| Brake fluids basing on glycol | | |

## Application:

ECORUBBER 3 is mainly used for cleaning and washing technology where polar media are used (household detergents, soda lye, etc.) ECORUBBER 3 is the best suitable material for use in hot water and/or hot steam (lubrication with silicone grease).

*Main use:* special parts for washers
piston and rod seals
O-rings
rotor seals (parts for motor vehicles)

**Encl.:** Data sheets

ECONOMOS®
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# MATERIAL DATA SHEET

## ECORUBBER 3 (black)

**Ethylene-Propylene-Rubber (EPDM)** **DIN/ISO** **ASTM**
**peroxide-cured** **EPDM** **EPM**
marked with blue dye

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 85 ± 5 | DIN 53505 |
| **Density** | g/cm³ | 1,22 ± 0,02 | DIN 53479 |
| **Tensile strength** | N/mm² | ≥ 12 | DIN 53504 |
| **Elongation at break** | % | ≥ 110 | DIN 53504 |
| **100 % modulus** | N/mm² | ≥ 9 | DIN 53504 |
| **Compression set:** 100°C / 22h | % | ≤ 15 | DIN ISO 815 |
| **Tear strength** | N/mm | 15 | DIN 53515 |
| **Rebound resilience** | % | 38 | DIN 53512 |
| **Abrasion** | mm³ | 120 | DIN 53516 |
| **Minimum service temperature** | °C | -50 | ---- |
| **Maximum service temperature** | °C | +150 | ---- |
| **Heat resistance, air 70h/150°C:** | | | |
| Change in durometer hardness | Shore A | +4 | DIN 53505 |
| Change in tensile strength | % | -15 | DIN 53504 |
| Change in elongation at break | % | -22 | DIN 53504 |
| **Compatibility with SL-DOT 4 - 168h/100°C** | | | |
| Change in durometer hardness | Shore A | 0/-1 | DIN 53505 |
| Volume change | % | +2,1 | DIN 53521 |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.
Valid from the manufacturing date week 45/1998

Judenburg, November 1998
Dr. TS/He wdrub3e/werkstoffe

# ECOSIL (MVQ) - reddish brown

ECOSIL is a semi-finished material from peroxide crosslinked silicone rubber produced by ECONOMOS. ECOSIL belongs to the group of polar and saturated special elastomers. ECOSIL is not filled with carbon black and suitable for electric insulation.

## Characteristics:

As compared to other elastomers ECOSIL has lower regidity properties. It can be used at temperatures between -60°C and +200°C. Due to its saturated structure ECOSIL has excellent ozone, weather and ageing resistance.

Swelling in mineral oils is very low, but depends very much on the composition of the oil. Compatibility with high additivated oils is better than with ECORUBBER 1. Gas permeability is very high. ECOSIL is used as a sealing material in the pharmaceutical and food industry.

## Resistance:

| **good resistance** | **medium resistance** | **little to no resistance** |
|---|---|---|
| Motor and transmission oil of aliphatic nature, also sulphured oils | | Aromatic mineral oils |
| Brake fluids basing on glycol | | Fuels |
| Vegetable and animal oils and fats | | Silicone oils and grease |
| Water up to 100°C | | Aromatic hydrocarbons (toluene, benzene) |
| Fire-resistant pressure fluids of the HFD-R, HFD-S groups (phosphate esters and chlorinated hydrocarbons) | | Low molecular chlorinated hydrocarbons (trichloroethylene) |
| Diluted saline solutions | | Low-molecular esters and ethers |
| | | Overheated steam above 120°C (short time steam sterilisation possible) |
| | | Acids and alkalis |

## Application:

Ecosil is mainly used in cases where are no other alternatives because of high temperatures and chemical stress. Due to its low mechanical properties use should be reduced to static application.

*Main use:* special seals in the chemical and food industry
rotor-seals for special use
O-rings
flange seals

**Encl.:** Data sheet

ECONOMOS®
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# MATERIAL DATA SHEET

## ECOSIL (reddish brown)

**Silicone Rubber**

| **DIN** | **ASTM** |
|---|---|
| **MVQ** | **VMQ** |

| **Property** | **Unit** | **Value** | **Standard** |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 85 ± 5 | DIN 53505 |
| **Density** | g/cm³ | 1,52 ± 0,03 | DIN 53479 |
| **Tensile strength** | N/mm² | ≥7 | DIN 53504 |
| **Elongation at break** | % | ≥ 130 | DIN 53504 |
| **100 % modulus** | N/mm² | ≥ 5 | DIN 53504 |
| **Compression set:** 175°C / 22h | % | ≤ 15 | DIN ISO 815 |
| **Tear strength** | N/mm | 8 | DIN 53515 |
| **Rebound resilience** | % | 44 | DIN 53512 |
| **Abrasion** | ---- | ---- | ---- |
| **Minimum service temperature** | °C | -60 | |
| **Maximum service temperature** | °C | +200 | |
| **Heat resistance, air 168h/225°C** | | | |
| Change in durometer hardness | Shore A | +3 | DIN 53505 |
| Change in tensile strength | % | -10 | DIN 53504 |
| Change in elongation at break | % | -40 | DIN 53504 |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, July 1996
Dr. TS/He wdsile/werkstoffe

# ECOTAL (POM) - black

ECOTAL is a semi-finished material made of polyacetal (polyoxymethylene) produced by ECONOMOS and belongs to the group of technical thermoplastics. ECOTAL is coloured in black.

## Characteristics:

ECOTAL is highly dimensionally stable, stiff and absorbs only little moisture. ECOTAL has a high creep resistance, i.e. the cold-flow tendency is low at temperatures below 80°C. ECOTAL shows excellent sliding and wear behaviour.

Sliding friction coefficient $\mu$ = 0.25 -0.32 (dry run against steel 16 MnCr5 - p = 0.5 kp/cm$^2$, V = 0.6 m/s/5h)

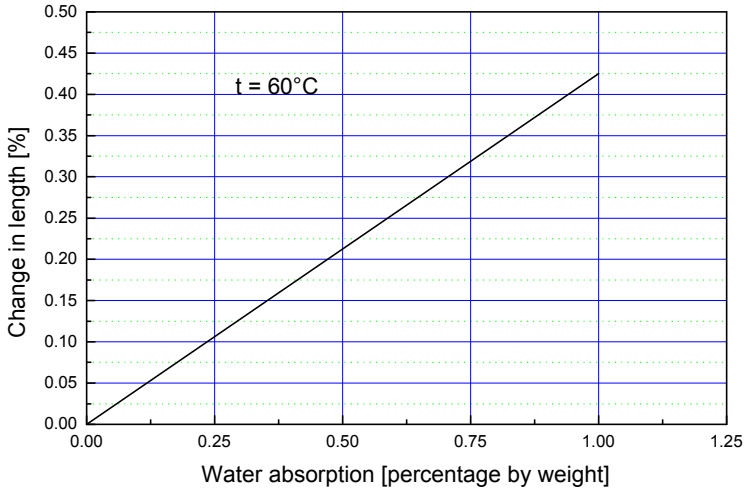
Standard value for pv-values (dry run):

| | |
|---|---|
| v = 0.05 m/s | pv = 0,11 (N.m/mm$^2$.s) |
| v = 0.5 m/s | pv = 0,1 (N.m/mm$^2$.s) |
| v = 5 m/s | pv = 0,07 (N.m/mm$^2$.s) |

It can be used at temperatures between -50° and +100°C (for short time up to + 130 °C). The use in cases where high stresses have to be maintained over long periods of time (retaining rings, clamping pieces, such as rotary shaft lip seals) the operationg temperature is to be limited to 80°C max. (stress relaxation, creeping).

ECOTAL has good electric properties and high resistance to chemicals and stress cracks. For linear change of dimensions due to water absorption see picture below.

**Change of length when water is absorbed**



## Resistance:

| **good resistance** | **medium resistance** | **little to no resistance** |
|---|---|---|
| Mineral oils and grease | Ketones | Strong acids and bases |
| Vegetable and animal fats and oils | | Oxidizing agents |
| Fuels | | |
| Alcohols | | |
| Water | | |
| Weak acids and bases | | |
| Aliphatic and aromatic hydrocarbons | | |

## Application:

ECOTAL is mainly used for applications where high hardness and low coefficients of friction are called for, i.e. guiding and support elements up to 100°C.

*Main use:* guide rings
back-up rings
special seal parts
wipers for special applications
valve parts/seats
construction parts
bearing shells/bushes

**Encl**.: Data sheet

ECONOMOS®
AUSTRIA

# MATERIAL DATA SHEET

## ECOTAL (black)
### Polyoxymethylene (POM)
### (also known under „Polyacetale“)

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Density** | g/cm³ | 1,40 | DIN 53479 |
| **Ball hardnessH 358/30** | N/mm² | 135 | DIN 53456 |
| **Durometer hardness** | Shore D | 82 | DIN 53505 |
| **Yield stress** | N/mm² | 62 | DIN 53455 |
| **Elongation at yield** | % | 8 - 10 | DIN 53455 |
| **Elongation at break** | % | 40 | DIN 53455 |
| **Tensile-modulus** | N/mm² | 2600 | DIN 53457 |
| **Izod-Impact resistance**<br>**at + 23°C**<br>**at - 30°C** | <br>kJ/m²<br>kJ/m² | <br>70<br>40 | <br>ISO 180<br>ISO 180 |
| **Water absorption, 23°C, satuation** | % | 0,8 | DIN 53495/L2 |
| **Coefficient of sliding** | µ | 0,17 bis 0,43 | ---- |
| **Minimum service temperature** | °C | - 50 | ---- |
| **Maximum service temperature** | °C | +100 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. These values are only tested on selected samples.

Judenburg, July 1996
Dr. TS/He wdtalewerkstoffe

# ECOMID (PA6) - black

ECOMID is a semi-finished material delivered by ECONOMOS, made from cast polyamide and belongs to the group of technical thermoplastics. ECOMID is coloured in black. ECOMID is used instead of ECOTAL for diameters above 250 mm.

## Characteristics:

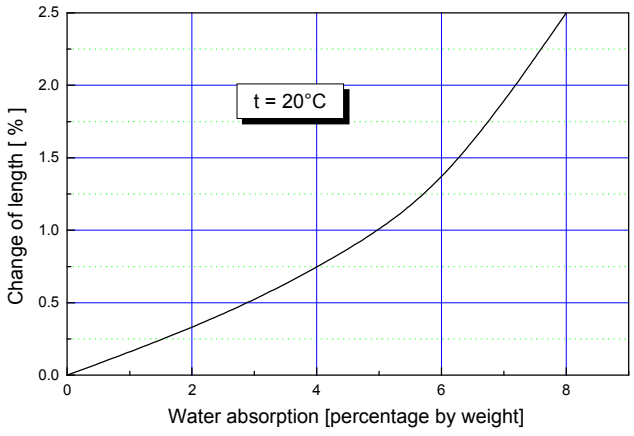
ECOMID has very good dimensional stability, stiffness and hardness values, but relatively high moisture absorption. Moisture absorption leads to decrease of stability and volume change. ECOMID has good sliding functions.

Sliding friction coefficient $\mu$ = 0.35 - 0.42 (dry run against steel 16 MnCr5-p = 0.5 kp/cm$^2$, V = 0.6 m/S/24h)

Standard values for pv - value (dry-run)

| | |
|---|---|
| v = 0.05 m /s | pv = 0.09 (N.m/mm$^2$.s) |
| v = 0.5 m/s | pv = 0.06 (N.m/mm$^2$.s) |
| v = 5 m/s | pv = 0.05 (N.m/mm$^2$.s) |

Suitable for temperatures between -40°C and +100°C (for short time up to 140°C). Good resistance to chemicals, poor electric properties due to high water absorption. The moisture content influences the mechanical characteristics. Hardness and stiffness decrease with increasing water content. Water absorption (8,5 % at saturation at 23°C) leads to dimensional changes. The dimensional change caused by water absorption cannot be exactly calculated, since influences of shape, production method and processing are very important (change in crystallisation). The Fig. below shows the values for changes of length when water is absorbed.



## Resistance:

| good resistance | medium resistance | little to no resistance |
|---|---|---|
| Mineral oils and grease | Chlorinated hydrocarbons | Acids and strong bases |
| Vegetable and animal oils and fats | | |
| Aliphatic and aromatic hydrocarbons | | |
| Esters | | |
| Ketones | | |
| Alcohols | | |
| Weak bases | | |
| Fuels | | |

## Application:

ECOMID is mainly used for applications where high hardness (hardness loss at water absorption), low coefficient of friction and excellent gliding and wear properties are called for, i.e. for guide and back-up elements up to approx. 100°C. The use in watery media is not recommended because of the high water absorption of ECOMID.

*Main use:* guide rings
back-up rings
special seal parts
valve parts/seats
construction parts
bearing shells/bushes

**Encl.:** Data sheet

ECONOMOS®
AUSTRIA

# MATERIAL DATA SHEET

## ECOMID (black)
**casting polyamide 6**

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Density** | g/cm³ | 1,15 | DIN 53479 |
| **Ball hardness, wet** | N/mm² | 125 | DIN 53456 |
| **Durometer hardness, wet** | Shore D | 77 | DIN 53505 |
| **Yield stress, wet** | N/mm² | 65 | DIN 53455 |
| **Elongation at break, wet** | % | 120 | DIN 53455 |
| **Tensile modulus, wet** | N/mm² | 1800 | DIN 53457 |
| **Impact resistance, Charpy, 23 °C, wet** | kJ/m² | no break | DIN 53453 |
| **Water absorption 23°C, Saturation** | % | 8,5 | DIN 53495/12 |
| **Moisture absorption 23°C, saturation** | % | 2,2 | DIN 53714 |
| **Coefficient of sliding** | P=0,05 N/mm² V=0,6 m/s | 0,35 - 0,42 | ---- |
| **Minimum service temperature** | °C | - 40 | ---- |
| **Maximum service temperature** | °C | +100 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. These values are only tested on selected samples.

Judenburg, July 1996
Dr. TS/He wdmide/werkstoffe

# ECOFLON 1 (PTFE, virgin) - white

ECOFLON 1 is a semi-finished material made from a semi-crystalline thermoplastic on the chemical basis of polytetrafluoro-ethylene. Because of its structure, PTFE cannot be processed with the usual thermoplastic methods. ECOFLON 1 is not coloured and therefore white.

## Characteristics:

ECOFLON 1 can be used at an extraordinarily wide temperature range (-200°C up to +260°C), excels with the lowest coefficient of friction ($\mu = 0.1$) of all plastics and is highly resistant to nearly all media. ECOFLON 1 has an antiadhesive surface, does not absorb moisture, and has very good electric properties. The plastic deformation depending on time (creeping) even under small stress (cold flow) has to be observed.

## Resistance:

To almost all chemicals with the exception of elementary fluor, chlortrifluoride and melted alkali metals.

PTFE has the lowest radiation resistance of all plastics.

Dynamic use in water is not recommended (high wear).

## Application:

ECOFLON 1 is mainly used in cases where no other material can be used because of thermal and chemical stress, and where antiadhesive surfaces and the lowest friction coefficients are called for. In seal engineering, the otherwise often unwanted cold flow is used (O-ring-back-up rings).

*Main use:* sealing elements for high and low temperature ranges
gliding and supporting elements
rotor seals
O-rings
construction parts for chemical and electrical purposes

**Encl.:** Data sheet

ECONOMOS®
AUSTRIA

# MATERIAL DATA SHEET

## ECOFLON 1 (white)
### Polytetrafluorethylene (Virgin PTFE)

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Density** | g/cm³ | 2,17 | DIN 53479 |
| **Durometer hardness** | Shore D | 57 | DIN 53505 |
| **Tensile strength** | N/mm² | 27 | DIN 53455 |
| **Elongation at break** | % | 300 | DIN 53455 |
| **Tensile modulus** | N/mm² | 750 | DIN 53457 |
| **Impact resistance, Charpy** | kJ/m² | no break | DIN 54453 |
| **Coefficient of thermal expansion (25°C)** | $K^{-1}$ | $16 . 10^{-5}$ | DIN 52328 |
| **Coefficient of sliding** | --- | 0,08 | ---- |
| **Coefficient of thermal conductivity** | W/m.K | 0,23 | ---- |
| **Minimum service temperature** | °C | - 200 | ---- |
| **Maximum service temperature** | °C | + 260 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. These values are only tested on selected samples.

Judenburg, July 1996
Dr. TS/He wdflon1e/werkstoffe

# ECOFLON 2 (PTFE with fillers) - grey

ECOFLON 2 is a semi-finished product made from filled semi-crystalline thermoplastic, on the chemical basis of polytetrafluoro ethylene. ECOFLON 2 is a PTFE filled with glass fibre and molybdenum sulfide. ECOFLON 2 is not coloured and its inherent colour is grey.

## Characteristics:

ECOFLON 2 can be used at an extraordinarily wide temperature range (-200°C up to +260°C), has a very low friction coefficient and is very highly resistant to chemicals. ECOFLON 2 has an antiadhesive surface and does not absorb moisture. Because of the fillers deformation dependent on time (creeping) is smaller than with ECOFLON 1 (reduction of cold flow, higher extrusion resistance).

## Resistance:

Basic material and glass fibres are resistant to most chemicals, only the $MoS_2$ can be attacked by several chemicals and a resistance test can be required. Not to be used for radiation application. Dynamic use in water is not recommended (high wear).

## Application:

ECOFLON 2 is mainly used in applications with high thermal and chemical stress and in cases where antiadhesive surfaces, little friction and high extrusion and deformation resistance are called for and pure PTFE cannot be used.

*Main use:* sealing elements for lowest friction at high stress
sliding and back-up elements
sealing elements with elastic support (elastomers, springs)

Critical pv-values (p = power, v = speed)

| | |
|---|---|
| v = 0,05 m/s | pv = 0,032 (N.m/mm².s) |
| v = 0,5 m/s | pv = 0,039 (N.m./mm².s)* |
| V = 5 m/s | pv = 0,05 (N.m./mm².s)* |

* Temperature rising beyond 150°C, steel counter surface turns blue

**Encl**.: Data sheet

ECONOMOS®
AUSTRIA

# MATERIAL DATA SHEET

## ECOFLON 2 (dark grey)
### PTFE filled with 15% glass-fibre and 5% molybdenum disulfide

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Density** | g/cm³ | 2,25 | ASTM D 1457 |
| **Durometer hardness** | Shore D | 60 | DIN 53505 |
| **Tensile strength** | N/mm² | 18 | ASTM D 1457 |
| **Elongation at break** | % | 200 | ASTM D 1457 |
| **Coefficient of thermal expansion (25°C)** | $K^{-1}$ | $11 . 10^{-5}$ | DIN 52328 |
| **Deformation unter load, unloaded (14 N/mm², 24 h, 25°C)** | % | 4,3 | ---- |
| **Coefficient of thermal conductivity** | W/m.K | 0,48 | DIN 62612 |
| **Minimum service temperature** | °C | - 200 | ---- |
| **Maximum service temperature** | °C | + 260 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, July 1996
Dr. TS/He wdflon2e/werkstoffe

ECONOMOS®
AUSTRIA

# MATERIAL DATA SHEET

## ECOFLON 3 (bronze-colored)
### PTFE filled with 40% bronze

| Property | Unit | Value: | Standard |
|---|---|---|---|
| **Density** | g/cm³ | 3,00 | ASTM D 1457 |
| **Durometer hardness** | Shore D | 64 | DIN 53505 |
| **Tensile strength** | N/mm² | 22 | ASTM D 1457 |
| **Elongation at break** | % | 280 | ASTM D 1457 |
| **Coefficient of thermal expansion (25°C)** | $K^{-1}$ | $6 . 10^{-5}$ | DIN 52328 |
| **Deformation unter load, unloaded (14 N/mm², 24 h, 25°C)** | % | 4,6 | ---- |
| **Coefficient of thermal conductivity** | W/m.K | ---- | DIN 62612 |
| **Minimum service temperature** | °C | - 200 | ---- |
| **Maximum service temperature** | °C | + 260 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, November 1998
Dr. TS/He wdflon3e/werkstoffe

ECONOMOS®
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# MATERIAL DATA SHEET

## ECOFLON 4 (black)
### PTFE filled with 25% carbon

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Density** | g/cm³ | 2,10 | ASTM D 1457 |
| **Durometer hardness** | Shore D | 65 | DIN 53505 |
| **Tensile strength** | N/mm² | 15 | ASTM D 1457 |
| **Elongation at break** | % | 180 | ASTM D 1457 |
| **Coefficient of thermal expansion (25°C)** | $K^{-1}$ | $9 . 10^{-5}$ | DIN 52328 |
| **Deformation unter load, unloaded (14 N/mm², 24 h, 25°C)** | % | ---- | ---- |
| **Coefficient of thermal conductivity** | W/m.K | 0,60 | DIN 62612 |
| **Minimum service temperature** | °C | - 200 | ---- |
| **Maximum service temperature** | °C | + 260 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, November 1998
Dr. TS/He wdflon4e/werkstoffe

ECONOMOS®
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# MATERIAL DATA SHEET

## ECOFLON 5 (white)

**Polytetrafluorethylene (PTFE modified, special material with superior extrusion resistance)**

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Density** | g/cm³ | 2,16 | DIN 53479 |
| **Durometer hardness** | Shore D | 59 | DIN 53505 |
| **Tensile strength** | N/mm² | 30 | DIN 53455 |
| **Elongation at break** | % | 360 | DIN 53455 |
| **Tensile modulus** | N/mm² | ---- | DIN 53457 |
| **Impact resistance, Charpy** | kJ/m² | no break | DIN 54453 |
| **Coefficient of thermal expansion (25°C)** | $K^{-1}$ | $12 . 10^{-5}$ | DIN 52328 |
| **Coefficient of sliding** | --- | 0,08 | ---- |
| **Coefficient of thermal conductivity** | W/m.K | 0,35 | ---- |
| **Minimum service temperature** | °C | - 200 | ---- |
| **Maximum service temperature** | °C | + 260 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. These values are only tested on selected samples.

Judenburg, March 1998
Dr. TS/He wdflon5e/werkstoffe

# Special materials
## ECOPAEK (Polyarylether ketone)

ECOPAEK is a semi-finished material produced by ECONOMOS. It is made from polyarylether ketone and belongs to the group of partly crystalline thermoplastics from the line of high temperature resistant plastics. Types of Victrex Sales Ltd. (Victrex) are used.

### Characteristics:

ECOPAEK is a polymer with high tensile strength, stiffness, high heat distortion temperature and good sliding and friction behaviour. As far as strength and stiffness are concerned, ECOPAEK exceeds most technical plastics especially at high temperatures. The torsional vibration test (see Fig. 1) provides a good insight to the mechanical and thermal behaviour of these materials.

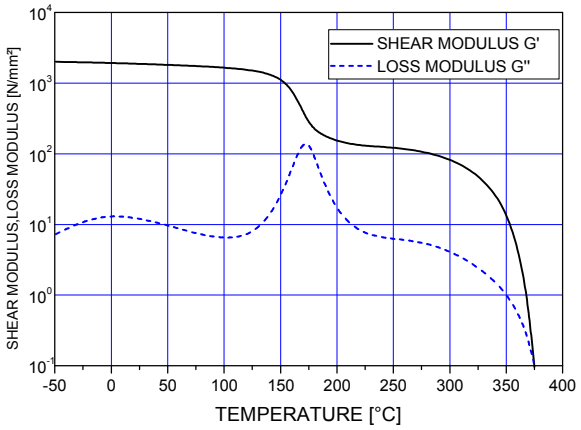


Fig. 1: Shear and loss modulus of ECOPAEK

The pronounced maximum of the loss modulus of ECOPAEK shows the glass transition temperature and thus the softening range of the amorphous parts, whereas the crystalline parts melt above 380°C, thereby ensuring dimensional stability and strength over a wide temperature range.Modulus data remain almost constant up to the glass transition temperature. Then, within a small range of temperature, modulus falls step by step to a new level, the value of which changes only slightly until melting temperature is reached.

The comparison of tensile strength data of ECOPAEK and ECOTAL underlines that these materials can still tolerate mechanical stress at high temperatures which could not be sustained by conventional plastics at room temperature. Figure 2 illustrates this comparision.

ECOPAEK has also a high impact resistance and ductility; just like the most thermoplastics it is sensitive to notches.

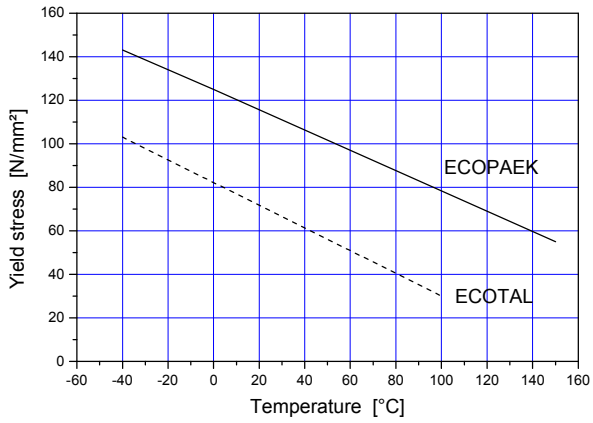


Fig. 2: Yield stress of ECOPAEK and ECOTAL as a function of temperature

ECOPAEK absorbs moisture from the air (0.25 % when stored at standard laboratory atmosphere according to DIN 50014-23/50-2). The maximum moisture absorption at storage in water of 23°C is 0.8 % after 90 days. Hydrolysis resistance is extraordinarily good (after 5000 hrs in water of 140°C no change of tensile strength and elongation at tear is found).
Heat distortion temperature of ECOPAEK measured according to DIN 53461 (ISO 75A) is at 170°C. Thermoxidative stability or thermal ageing resistance of ECOPAEK in air is excellent and one of the highest of all thermoplastics.
According to UL746B a temperature index of 250°C can be expected (temperature-time limit - tensile strength after 40 000 hours is still 50 % of the initial value). In many cases the limit can be seen as maximum application temperature.
The behaviour of parts made from ECOPAEK in heat and under the influence of various chemicals depends on time and kind of the temperature influence as well as on the design of the parts.

Figure 3 shows stress-strain diagrams and indicates the tensile properties over wide range of temperatures.

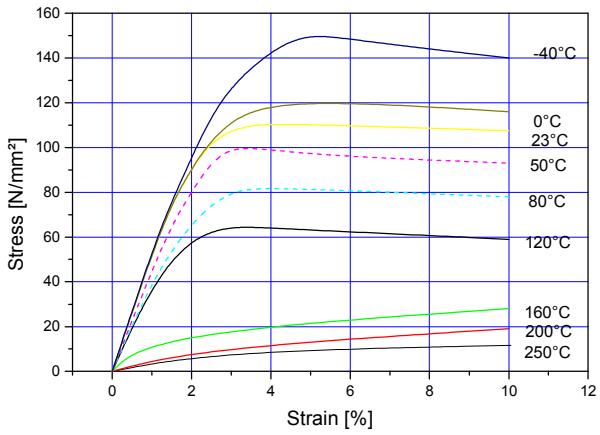


Fig. 3: Stress-strain diagram of ECOPAEK at different temperatures

Resistance of ECOPAEK against creeping is extraordinarily high. Behaviour under constant static loads is shown by creep curves at 23°C, 100°C and 200°C. Values in-between may be interpolated (see Fig. 4)

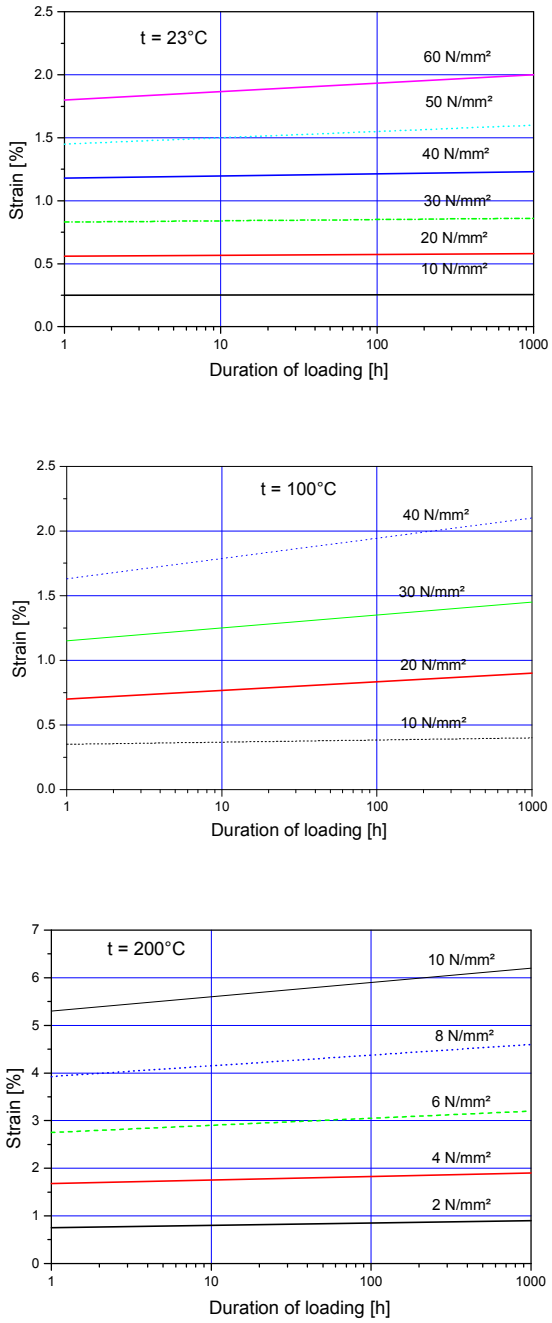


Fig. 4: Creep curves of ECOPAEK at various temperatures and loads

ECOPAEK is a good bearing material. Low friction coefficients and low wear rates make ECOPAEK interesting for tribiological applications. Figure 5 shows a comparision of the tribiological properties of ECOPAEK and ECOTAL determined with the peg- and disc-apparatus under defined conditions.

**Coefficient of sliding friction μ and rate of wear ΔS**

| | **Coefficient of sliding friction μ** | | **Rate of wear ΔS (μm / km)** | |
|---|---|---|---|---|
| | Surface temperature °C | | Surface temperature °C | |
| | **40** | **120** | **40** | **120** |
| ECOPAEK | 0,56 | 0,51 | 2,4 | 7,0 |
| Ecotal | 0,45 | | 30 | |

Pressure: 1 N/mm$^2$ Mating steel surface: 100 Cr6/800 HV
Rubbing velocity: 0.5 m/sec Surface roughness: 2.5 μ

Fig. 5: Tribiological properties of ECOPAEK and ECOTAL

The good electric properties combined with good mechanical properties and excellent heat resistance and fire behaviour allow a wide range of applications in electronics and electrical engineering.

## Resistance:

| **good resistance** | **medium resistance** | **little to no resistance** |
|---|---|---|
| Mineral oils and grease | Concentrated water-free acids | Concentrated sulphuric acid |
| Silicone oils and grease | Oxidizing acids | Concentrated nitric acid |
| Glycols | | Some halogenated hydrocarbons |
| Fuels | | |
| Chlorinated hydrocarbons | | |
| Brake fluids | | |
| Alcohols | | |
| Esters, ethers, ketones | | |

## Application:

ECOPAEK is mainly used where high temperatures, high chemical and mechanical requirements do not allow the use of traditional technical plastics.

*Main use:* special construction parts
guide and back-up elements
seals and parts for oil field applications

**Encl.:** Data sheet

ECONOMOS®
AUSTRIA

# MATERIAL DATA SHEET

## E C O P A E K - POLYARYLETHERKETONE
**(cream-colored)**

| Property | Unit | Value | Testspecification |
|---|---|---|---|
| **Density** | g/cm³ | 1,32 | ISO R 1183 |
| **Durometer hardness** | Shore D | 86 | DIN 53505 |
| **Yield stress** | N/mm² | 97 | ISO R 527 |
| **Elongation at yield stress** | % | 4,9 | ISO R 527 |
| **Elongation at break** | % | > 50 | ISO R 527 |
| **Tensile modulus** | N/mm² | 3600 | ISO R 527 |
| **Impact resistance, Charpy + 23°C, - 40°C** | kJ/m² | no break | DIN 53453 |
| **Impact resistance notched, Charpy + 23°C** | kJ/m² | 8,2 | ISO 179 |
| **Dimensional stability at high temperature HDT/A** | °C | 152 | ISO R 75 |
| **Dimensional stability at high temperature HDT/B** | °C | > 250 | ISO R 75 |
| **Maximum service temperature** | °C | 260 | --- |
| **Water absorption 24h / 23°C** | % | 0,5 | ISO R 262 A |

The values indicated are based on data determined for samples of the corresponding standards; when transfering these data to the corresponding semifinished product some restrictions should be observed.

Judenburg, August 1996
Dr.TS/He wdbpaeke / werkstoffe

ECONOMOS®
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# SPECIAL MATERIALS

## ECOFLAS (TFE/P, AFLAS®)

ECOFLAS is a semi-finished material produced by ECONOMOS. It is made on the chemical basis of tetrafluoroethylene-propylene-rubber (AFLAS®).

This material is chemical related to fluorocarbon-rubber. ECOFLAS has a lower fluorine content than ECORUBBER 2 but for certain applications it exhibits a better chemical resistance. The material is black coloured and can be manufactured in certain dimensions as a special material.

**Characteristics:**

Compared to FPM-elastomers ECOFLAS shows slightly higher tensile strength and a quite similar heat resistance. The restistance of ECOFLAS to mineral oils is not as high compared to ECORUBBER 2, but better than the mineral oil restistance of ECORUBBER 1 and ECORUBBER-H. Generally ECOFLAS can be seen as a combination of ECORUBBER 2 and 3. This results in an outstanding resistance to hot water and hot steam. The resistance to sour gas and amines, brake fluids (based on glycol, mineral oil or silicon oil) and fire-resistant hydraulic fluids is excellent as well. ECOFLAS shows in contrast to ECORUBBER 2 a good radiation resistance.

**Resistance:**

| Good resistance | Medium resistance | Little to no resistance |
|---|---|---|
| Mineral oils and greases | | Aromatic hydrocarbons |
| Steam and hot water | | Chlorinated hydrocarbons |
| Sour gas | | Ethers |
| Alcohols, amines | | Low-molecular weight organic acids and acetates |
| Acids and bases | | Coolants |
| Fire-resistant hydraulic fluids (categories HFA, HFB, HFC and HFD) | | |
| Brake fluids on glycol basis | | |

**Applications:**

Generally for seals and construction parts, which have to withstand an extensive exposure to chemicals.

For a great number of applications which can be found in oil and gas exploration and chemical industry.

Judenburg, December 2000
Dr.S/Fi Werksto/ECOFLAS

ECONOMOS®
AUSTRIA

# MATERIAL DATA SHEET

## ECOFLAS (black)

### Tetrafluoroethylene-Propylene Rubber (TFE/P, ALFAS)

| | DIN / ISO | ASTM |
|---|---|---|
| | TFE/P | TFE/P |

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 83 ± 5 | DIN 53505 |
| **Density** | g/cm³ | 1,60 | DIN 53479 |
| **Tensile strength** | N/mm² | 13 | DIN 53504 |
| **Elongation at break** | % | 220 | DIN 53504 |
| **100 % modulus** | N/mm² | 8 | DIN 53504 |
| **Compression set:** 175°C / 22h | % | 29 | DIN ISO 815 |
| **Tear strength** | N/mm | 19 | DIN 53515 |
| **Rebound resilience** | % | -- | DIN 53512 |
| **Abrasion** | mm³ | 110 | DIN 53516 |
| **Minimum service temperature** | °C | -10 | ---- |
| **Maximum service temperature** | °C | +200 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, Dezember 2000
Dr. TS/He wdflas/werkstoffe

# *SPECIAL MATERIALS*

## *ECOTEX*

ECOTEX is a compound based on a thermosetting polyester resin and reinforced with fabric inlays. Due to the addition of graphite the material shows very good characteristics in respect to the tribological requirements of bearing materials in gliding systems.

### Characteristics:

ECOTEX shows high compressive strength and outstanding friction and wear properties. Therefore ECOTEX is very well suited for guide rings and bearing bushes. Due to the very low absorption of moisture, ECOTEX is particularly suitable for use in water and media containing water (swelling in water < 0,1 %).
Additional to its high form stability and damping characteristics ECOTEX shows very good sliding and emergency running properties in systems lacking in lubrication. The textured surface of the material provides a good embedding ability of dirt particles through which a scratching or damaging of the cylinder bore by system contamination is prevented.

### Dynamic coefficient of friction:

| Lubricant | Dry | water* | HFA fluids* | grease* | Oil* |
|---|---|---|---|---|---|
| $\mu$ | 0,18-0,21 | 0,01 | 0,019 | 0,013 | 0,02 |

(running against 18/8 stainless steel; bearing pressure p = 15,4 N/mm$^2$; speed v = 2,25 m/s)
* hydrodynamic conditions

### Guideline for load-bearing capacity:

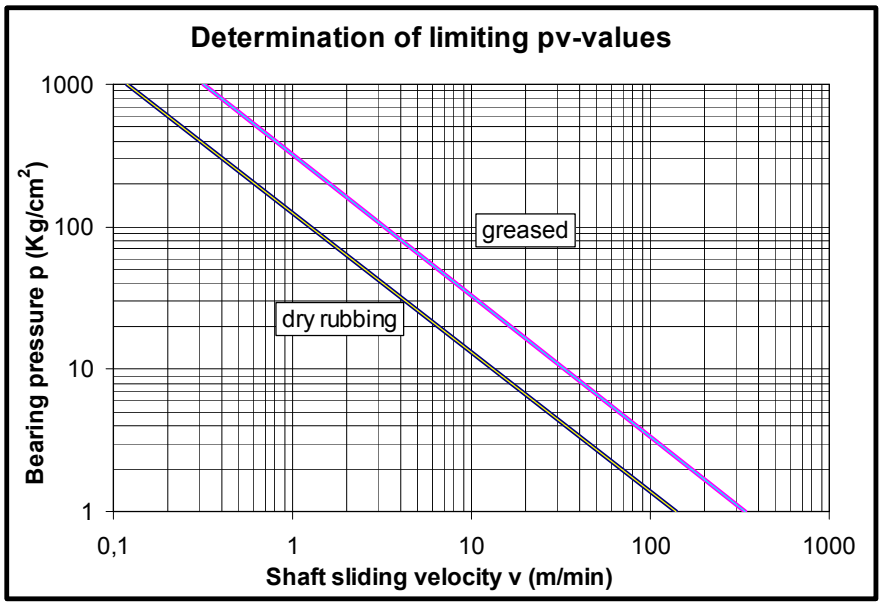
Use as guide ring/linear guidance:

permissible compressive strength under dynamic load (T = 60°C): **$p_{max}$= 90 N/mm$^2$**
permissible speed (linear movement): **v ≤ 1 m/s**

The nonlinear distribution of pressure between rod and guide ring is already considered at the indicated value for $p_{max}$. A safety factor of ν= 3 is recommended for the calculation of the guide ring width.

Use as a slide bearing for rotating applications:

The maximum load rating of a bearing in a rotary application is limited by the amount of heat generated, within the bearing. Many factors influence the amount of heat generated within a system, therefore the listed pv-values give only a rough guideline for the maximum bearing load.




In some cases the calculated pv-values might be exceeded. For special requirements please contact our technical department for support.

## Resistance:

| good resistance | medium resistance | Little or no resistance |
|---|---|---|
| Mineral oils and grease | | Strong acids and bases |
| Fuels | | Oxidising agents |
| Water | | Ketones |
| Many diluted acids and bases | | |
| | | |

## Application :

Due to its high compressive strength and outstanding friction and wear properties, ECOTEX will mainly used for guide rings and bearing bushes. Guide rings exceeding a diameter of 200mm can be cut to the required length from ECOTEX tape. ECOTEX is therefore a suitable substitute for ECOMID guide rings.

Main use:
- guide rings exceeding a diameter of 200mm
- special seal parts
- construction parts
- bearing shell / bushes

# MATERIAL DATA SHEET

## ECOTEX

polyester resin + polyester fabric + graphite filler

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Density** | $g/cm^3$ | 1,25 | -- |
| **Tensile strength** | $N/mm^2$ | 90 | -- |
| **Compressive strength**<br>static, normal to laminate,<br>fully comprehended<br><br>parallel to laminate | $N/mm^2$ | 345<br><br><br>97 | -- |
| **Tensile modulus**<br>(tensile test) | $N/mm^2$ | 3200 | -- |
| **Moisture absorption**<br>(saturation) | % | < 0,1 | -- |
| **Minimum service temperature** | °C | - 40 | -- |
| **Maximum service temperature**<br>(in water) | °C | 130<br>(100) | -- |
| **Hardness Rockwell M** | | 100 | -- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

# SPECIAL MATERIALS

## S-ECOPUR – 57 D

S-ECOPUR-57 D is a thermoplastic polyurethane elastomer (TPU), which has been optimised in regard of the tribological characteristics (friction and wear), achieved by an addition of a synergetic combination of solid lubricants.

Compared to the S-ECOPUR standard material S-ECOPUR-57 D has a higher hardness and therefore further improved sliding properties. Because of the higher hardness the material can be used for composite and glyd-ring seals (e.g. S09 and K08); sealing elements of these types are usually performing better than comparable PTFE seals in terms of wear and leakage.

**Characteristics:**

The material shows similar tensile strength and elongation at break but a clearly higher 100 %- modulus compared to the standard S-ECOPUR quality. Also it has a superior tear strength, whereas the compression set is on the same level.

Furthermore S-ECOPUR-57 D has a better extrusion resistance than the standard material and therefore sealing elements of this material can be used at higher pressures, assuming the same profiles are used.

**Chemical Resistance:**

Compatibility and swelling behaviour is similar to that of the standard grade.

Judenburg, Dezember 2000
Dr.S/Fi SECOPUR57D

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# MATERIAL DATA SHEET

## S-ECOPUR - 57 D (grey/black)

**Self-lubricated thermoplastic polyurethane-elastomer (TPU) with lubricating agents for friction-reduced applications**

| DIN | ASTM |
|---|---|
| YAU | YAU |

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 96 | DIN 53505 |
| **Durometer hardness** | SHORE D | 57 | DIN 53505 |
| **Density** | g/cm³ | 1,26 | DIN 53479 |
| **Tensile strength** | N/mm² | 45 | DIN 53504 |
| **Elongation at break** | % | 350 | DIN 53504 |
| **100 % modulus** | N/mm² | 24 | DIN 53504 |
| **Compression set:** 70°C / 24h, 20 % compression | % | 24 | ---- |
| **Compression set:** 100°C / 24h, 20 % compression | % | 30 | ---- |
| **Compression set:** 70°C/70h, 10 % compression | % | ---- | DIN ISO 815 |
| **Tear strength** | N/mm | 160 | DIN 53515 |
| **Rebound resilience** | % | ---- | DIN 53512 |
| **Abrasion** | mm³ | 20 | DIN 53516 |
| **Minimum service temperature** | °C | -20 | ---- |
| **Maximum service temperature** | °C | +110 | ---- |

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Judenburg, December 2000
Dr. TS/Fi wdspur57D/werkstoffe

# SPECIAL MATERIALS

## ECORUBBER 3 – 85 A – w – FG (white)

This material is made of a sulfur-cured ethylene-propylene-diene rubber which is suitable for applications in the food industry. It is white coloured and has the same range of hardness as ECORUBBER 3.

**Characteristics:**

Compared to the standard material this special material shows similar tensile strength and elongation at break, the 100 % modulus value is smaller and the compression set is on a slightly higher level. Its structure causes a slightly decreased processibility in machining. The material possesses the same chemical resistance as the standard material, but is not suitable for the use with brake fluids based on glycol.

This special material is designed according the FDA- and BGA-guidelines (see also enclosure) and therefore suitable for food applications.

**Resistance:**

| good resistance | medium resistance | little to no resistance |
|---|---|---|
| Hot water and hot steam up to 180° C | | |
| Fire-resistant pressure fluids of the HFD-R group without mineral oil addition (phosphate ester) | Silicone oils and greases (oils can cause shrinkage, test recommended) | Aliphatic hydrocarbons (propare, butane, benzine) |
| Detergents, soda lye, potash lye | | Mineral oils and greases |
| Many organic and anorganic bases and acids | | Aromatic and chlorinated hydrocarbons |
| Saline solutions and oxidation causing media | | Vegetable and animal oils and greases |
| Fire-resistant pressure fluids of the HFC group (glycol-water, if it is ensured that the fluid is free of mineral oil) | | Biodegradable hydraulic fluids |
| Many polar solvents (e.g. alcohols, ketones, esters, etc.) | | Fire-resistant hydraulic fluids of group HFA, HFB and HFD-S (chlorinated hydrocarbons) |
| Skydrol 500 and 7000 | | |
| | | Break fluids on glycol basis |

**Applications:**

Seals for the food industry free of greases and oils

Judenburg, Dezember 2000
Dr.S/Fi Werksto/Ecorubber3

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# MATERIAL DATA SHEET

## ECORUBBER 3 – 85A – w – FG (white)

### Ethylene-Propylene-Rubber (EPDM) for food applications

| | DIN/ISO<br>EPDM | ASTM<br>EPM |
|---|---|---|

| Property | Unit | Value: | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 85 ± 5 | DIN 53505 |
| **Density** | g/cm³ | 1,26 | DIN 53479 |
| **Tensile strength** | N/mm² | 12 | DIN 53504 |
| **Elongation at break** | % | 280 | DIN 53504 |
| **100 % modulus** | N/mm² | 5,5 | DIN 53504 |
| **Compression set:**<br>100°C / 22h | % | 33 | DIN ISO 815 |
| **Tear strength** | N/mm | 28 | DIN 53515 |
| **Rebound resilience** | % | -- | DIN 53512 |
| **Abrasion** | mm³ | 120 | DIN 53516 |
| **Minimum service temperature** | °C | -50 | ---- |
| **Maximum service temperature** | °C | +150 | ---- |

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Judenburg, Dezember 2000
Dr. TS/He wdrub3-85A-e/werkstoffe

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# SPECIAL MATERIALS

## ECORUBBER-H-85A-b-LT (HNBR) - black

ECORUBBER-H-85A-b-LT is a peroxide–cured hydrogenated nitrile rubber (HNBR) with outstanding properties at low temperatures. The material is produced by ECONOMOS in a hardness of 83 ± 5 Shore A and is colored black.

**Properties:**
The outstanding cold flexibility of this hydrogenated nitrile rubber makes it useful for applications down to minus 40°C e.g. as sealing elements for the oil-field exploration or in motors and other equipment working in arctic climate.
Tensile strength and elongation at break are nearly at the same level as our standard material ECORUBBER-H, 100%-modulus is on a lower level due to the reduced hardness; compression set is nearly on the same level.

The cold flexibility of the material was characterised by using thermoanalytical methods like DSC (differential scanning calorimetry) and DMA (dynamical mechanical analysis).
A comparison of the low temperature properties of ECORUBBER-H-85A-b-LT and two further HNBR grades, standard ECORUBBER-H and a competitor material for low temperature use, is shown in figure 1 and 2.
ECORUBBER-H-85A-b-LT shows an appr. 3 to 4°C lower dynamical glass temperature TG (the dynamical glass temperature measured as the peak maximum ot the loss modulus is the characteristic value for the lower working temperature for dynamical applications) and app. 10°C lower than the standard grade. This difference is more strongly developed by the glass temperature measured by differential scanning calorimetry (Fig. 2).

Regarding the fluid compatibility slight changes in swelling characteristics in mineral oil is to be expected; in water-based fluids the volume change seems to be similar to the standard grade (Fig. 3 and 4).

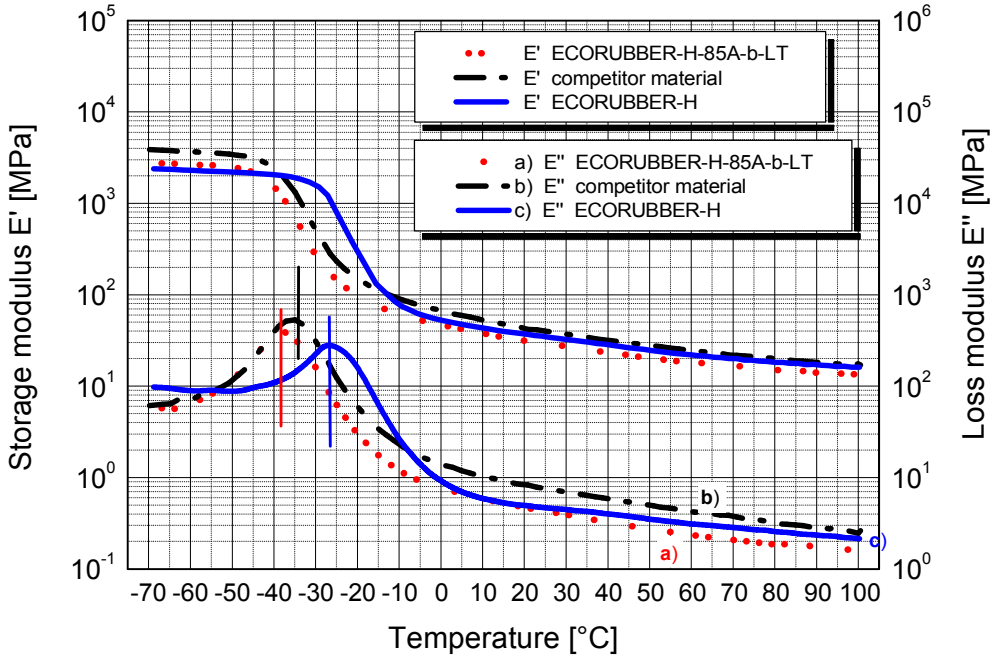


Fig. 1: Storage and loss modulus of various HNBR grades vs. temperature

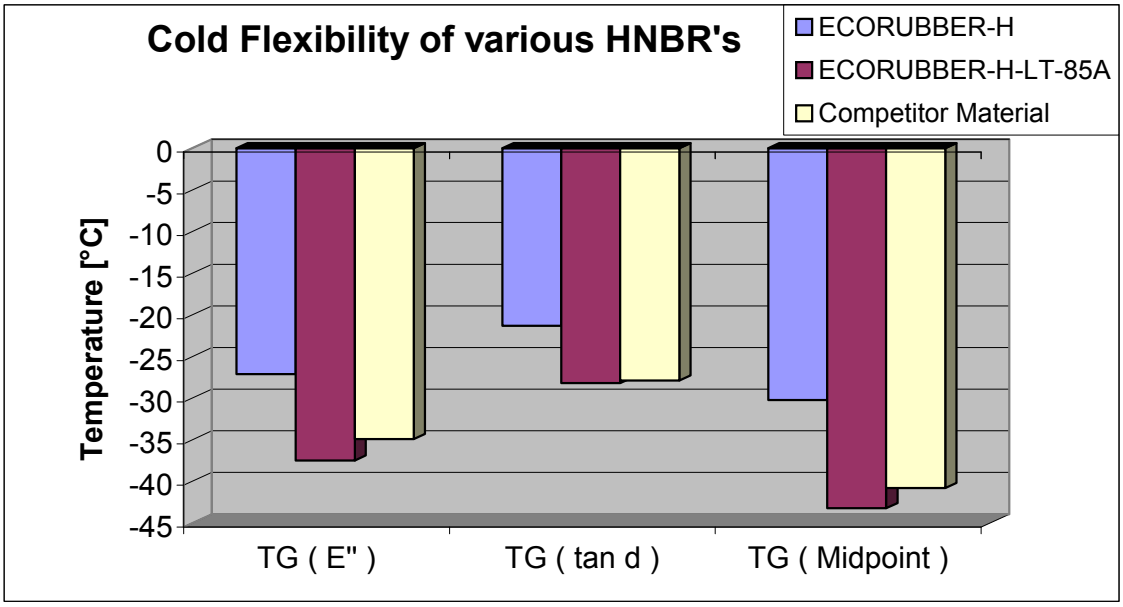


Fig. 2: Glass transition temperatures of HNBR grades characterised by different test methods

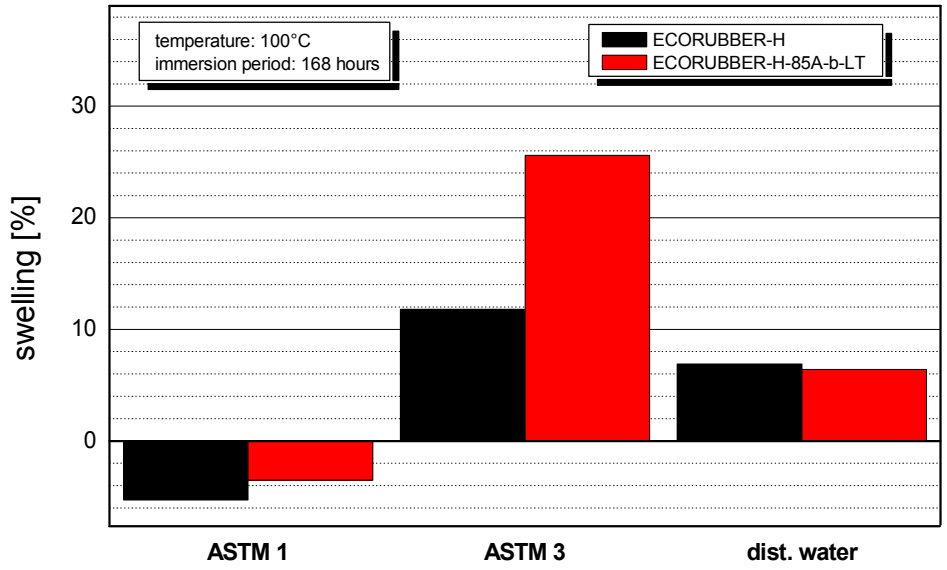


Fig. 3: Volume change of HNBR grades in various fluids

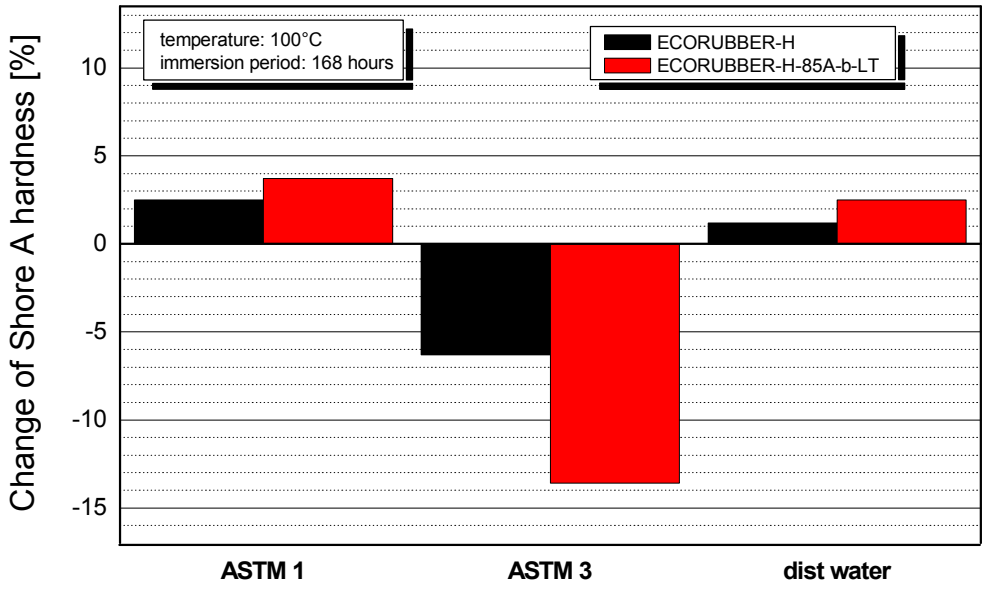


Fig. 4: Change of hardness of HNBR grades in various fluids

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# MATERIAL DATA SHEET

## ECORUBBER-H-85A-b-LT (black, low temperature grade)

### Hydrogenated acrylonitrile-butadiene-rubber (HSN, H-NBR)

| Property | Unit | Value | Standard |
|---|---|---|---|
| **Durometer hardness** | SHORE A | 83 ± 5 | DIN 53505 |
| **Density** | g/cm³ | 1,21 ± 0,02 | DIN 53479 |
| **Tensile strength** | N/mm² | 18 | DIN 53504 |
| **Elongation at break** | % | 180 | DIN 53504 |
| **100% Modulus** | N/mm² | 9,0 | DIN 53504 |
| **Compression set:** 100°C / 22h | % | 23 | DIN ISO 815 |
| **Tear strength** | N/mm | 15 | DIN 53515 |
| **Rebound resilience** | % | | DIN 53512 |
| **Abrasion** | mm³ | 94 | DIN 53516 |
| **Minimum service temperature** | °C | -40 | ---- |
| **Maximum service temperature** | °C | 150 | ---- |

The mentioned data are only valid for test pieces of the corresponding ISO, DIN and ASTM standards and cannot be directly related to gaskets and joints. The values which are marked with the symbols greater than (≥) and smaller than (≤) are nominal values and must be fulfilled of each batch. All values which are not marked are typical values which are only tested on selected samples.

Judenburg, July 2002
Dr. TS wdrubh-85A-b-LT./werkstof