Description of the material polyurethane (TPU)

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Most of the Masterflex suction and conveying hoses for abrasiv solids are manufactured from the heavy-duty material polyurethane. Polyurethane is essentially created by the reaction of three components with each other:

1. Polyols (long-chain diols)
2. Diisocyanates
3. Short-chain diols

The type of raw materials, the reaction conditions and the proportions of the starting materials are responsible for the product characteristics. The polyols used have quite a significant effect on specific properties of the thermoplastic polyurethane. Either polyester polyols or polyether polyols are used as polyols.
Thermoplastic polyurethane elastomers, also known as TPU, have the quality and properties to meet the most varied requirements such as:

- flexibility in a wide range of temperatures
- high degree of resistance to wear
- resistance to buckling and tearing (high resistance to nicking and further tearing)
- good resilience
- good dynamic stability under load
- resistance to hydrolysis and microbes (for polyether types)
- good to very good resistance to atmospheric corrosion
- resistance to oil, grease and solvents

Colour

The inherent colour is between yellowish and whitish opaque or also translucent, although the wall thickness is also a factor here. With increasing ageing of the material the yellowish discoloration increases, without adversely affecting the mechanical, thermal and chemical properties. Colouring is possible.

Mechanical properties

Resistance to further tearing

Resistance to further tearing means the resistance of a notched test piece to further tearing. The test is carried out in accordance with DIN 53 515 on corner samples with a cut in one side. For hoses made of polyurethane, this means that it is much more difficult to tear hoses, even when damaged, than other thermoplastic hoses (e.g. PVC, TPV, PO, etc)

Resistance to abrasion

Abrasion in rubbers and elastomers is determined in accordance with DIN ISO 4649. Here, a test sample is brought to bear with a particular contact force on a rotating roller covered with a test emery sheet. The full friction length is approximately 40m. The loss of mass due to abrasive wear is measured with due consideration of the thickness of the test sample and the severity of the attack with the test emery sheet. This is indicated as a loss of volume in mm^3. The standard PUR raw material used has an abrasion of approximately 25 - 30 mm^3.

Comparative values of the raw materials used:

- rubber approx. 60 - 150 mm^3
- soft PVC approx. 100 mm^3
- TPV approx. 200 mm^3
- PUR-EL approx. 45mm^3

See here for further data
Field tests have produced even greater differences compared with the above materials, due to the increased damping and rebound elasticity of the polyurethane material. The standardised test methods do not fully reveal these differences.

Thermal properties

Like all materials, TPU is subject to temperature-dependent, reversible alterations in length. This is indicated by the coefficient of linear thermal expansion α [l/K] and calculated in accordance with DIN 53 752 as a function of the temperature. Shore hardness is also an influencing factor. It is therefore advisable in many applications to take account of the dependence on temperature when selecting PUR hoses. These hoses can be used in temperatures up to 125°C for

short periods but a temperature of 90°C should not be exceeded for longer periods. Soft polyether-based types are flexible in temperatures down to -40°C.
Long-term tests of our processed materials have shown that even with a permanent temperature load in the limit range of 90°C only insignificant effects on the mechanical properties (heat ageing) occur.

Electrical properties

Surface resistance

The polyurethane raw material processed has a surface resistance of 1010 ohms and can therefore be used as electrically insulating protective hosing.

Discharging electrostatic charges **see here**

Resistance to media

The suitability of a plastic for a particular application often depends on its resistance to chemicals. The reaction of thermoplastic polyurethanes to the effects of chemical substances can vary greatly. The resistance of TPU to certain materials, e.g. cooling and lubricating agents, depends on the additives in these agents. The mechanical properties can change when in contact with such agents. Swelling of the polyurethane material is often due to the effects of the media (see here). For TPU resistance to media see chemical resistance.

Resistance to atmospheric corrosion

The resistance of TPU to ozone and ultraviolet radiation is good. See also here for explanations. The resistance of TPU to high-energy radiation such as α, β and γ radiation is superior to that of most other plastics. The resistance to these kinds of radiation depends among other things on the dosage of the radiation, the form and dimensions of the product, and the climate and atmosphere in the location where used. Certain properties, e.g. resistance to thermoforming and chemical attack, can be positively influenced by deliberate addition of additives.

Fire resistance

Plastics, like all organic materials, are combustible. The standard TPU we use is also inherently classifiable as such. The fire

resistance of a material is not, however, a material property and it is influenced by different criteria. The complexity of the influencing factors makes it impossible to give a comprehensive and generally applicable description of the fire resistance of plastic because the risk of burning depends on, e.g. the thickness of the walling and the form, the number and layout of combustible objects and other circumstances of use.
For this reason, the fire resistance of plastics should not be described in words or phrases which could be misinterpreted, such as "self-extinguishing" or "non-flammable", but preferably by the relevant DIN standard. Hoses with flame-inhibiting additives are "flammable with difficulty" in accordance with DIN 4102-BI and unlike most of our competitors' hoses are manufactured from abrasion-resistant polyester TPU (not from polyether TPU).

Evaluation in terms of health risk

The raw material used to produce PUR hoses complies with the statutory requirements for foodstuffs (see here).

Hydrolysis resistance of PUR

The polyurethanes processed by Masterflex are permanently resistant to warm water up to a maximum of +40°C. At higher temperatures impairment of the mechanical material properties arises increasingly in the case of polyester polyurethanes. Polyether polyurethanes are generally permanently resistant to hydrolytic degradation.

Microbial resistance of PUR

As result of permanent product development, we have succeeded for the first time, unlike our competitors, in making our largely abrasion-resistant polyester polyurethane resistant to microbes with the use of special additives. Microbes can quickly develop where there is extended contact with earthlike substances or deposits of grass, foliage, sludge etc. Moisture together with heat accelerates this process. The enzymes released by the microbes result without appropriate treatment in the splitting of the ester compounds and the embrittlement of the plastic until it falls apart. Polyether hoses are also resistant to microbial attack, yet they show less mechanical strength as described elsewhere.