

# INFORMATION ABOUT MASTERDUCT HOSES

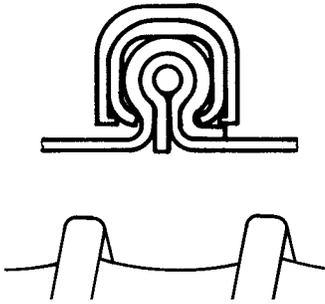
## HOSE CONSTRUCTIONS

### Hoses with an external helix

For example all MASTER-CLIP hoses, the hose-types CARFLEX 350 and CARFLEX 570.

#### Construction

High-tensile connection between hose material and external helix (CLIP) thanks to special clamping procedure.



#### Advantages

Universal possibilities of processing and combining hose material without using the manufacturing processes of adhesively bonding, vulcanising, welding or sewing.

- external steel helix protects against abrasion
- excellent flexibility
- small bend radius
- extreme compressibility
- easy installation when using CLIP-GRIP hose clamp
- continuously variable production diameters from 1.5" - 36"

### Extruded profile hoses

For example all MASTER-PUR and MASTER-PVC hoses.

#### Construction

Extruded plastic profile helical, lap-welded with immovable cast spring steel wire.



#### Advantages

Possibilities of producing hose qualities ranging from light and highly flexible to heavy and highly vacuum-proof.

- even, symmetrical bending thanks to the solid bonding between the plastic and spring steel wire.
- smooth inside, for optimum flow characteristics
- possibility of processing the most varied kind of thermo-plastic plastics
- production diameters from 2.0" - 16.00"

### Hoses of sheeting or coated fabric strips with set up support spiral

For example: MASTER PUR STEP- and CAR-FLEX SUPER - hose.

#### Construction

Sheeting or fabric strips, helical, lap-welded, with a plastic spiral.



#### Advantages

Variable possibility to produce hoses from different materials, films and fabric thickness.

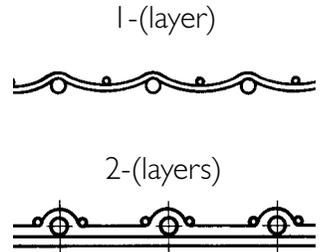
- highly flexible
- small bend radius
- cost-effective storage
- production diameters from 2.0" - 16.00"

### Single and multi-layer spiral hoses of vulcanised fabric strips

For example: the hose types MASTER-NEO 1, MASTER-NEO 2, MASTER-SIL 1, MASTER-SIL 2.

#### Construction

Vulcanised fabric strips wound and overlapping with internal free or embedded spring steel support spiral and additional external fibre string fixing.



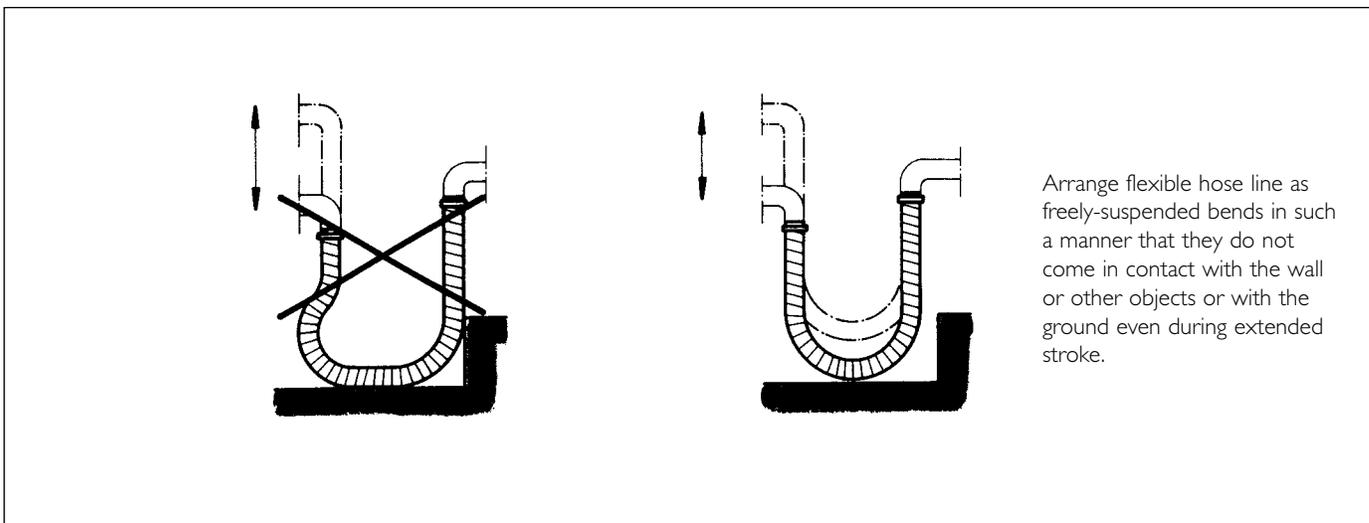
#### Advantages

- inner hose wall smooth
- extremely flexible
- small bend radius
- good pressure-resistance
- production diameters from 0.52" - 12.20"

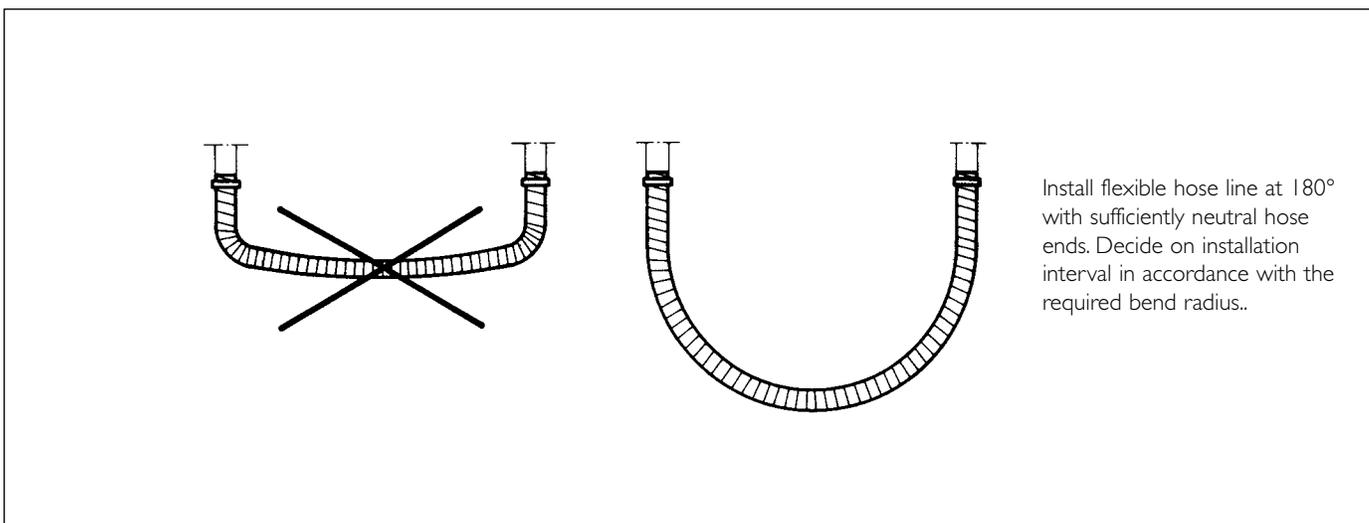
# POSITIONING OF MASTERDUCT HOSES

The length of individual hose types may be changed by the influencing variables of pressure, vacuum, media and ambient temperature. This must be taken into account when laying out flexible hose line in order to prevent mechanical damage occurring.

## example 1

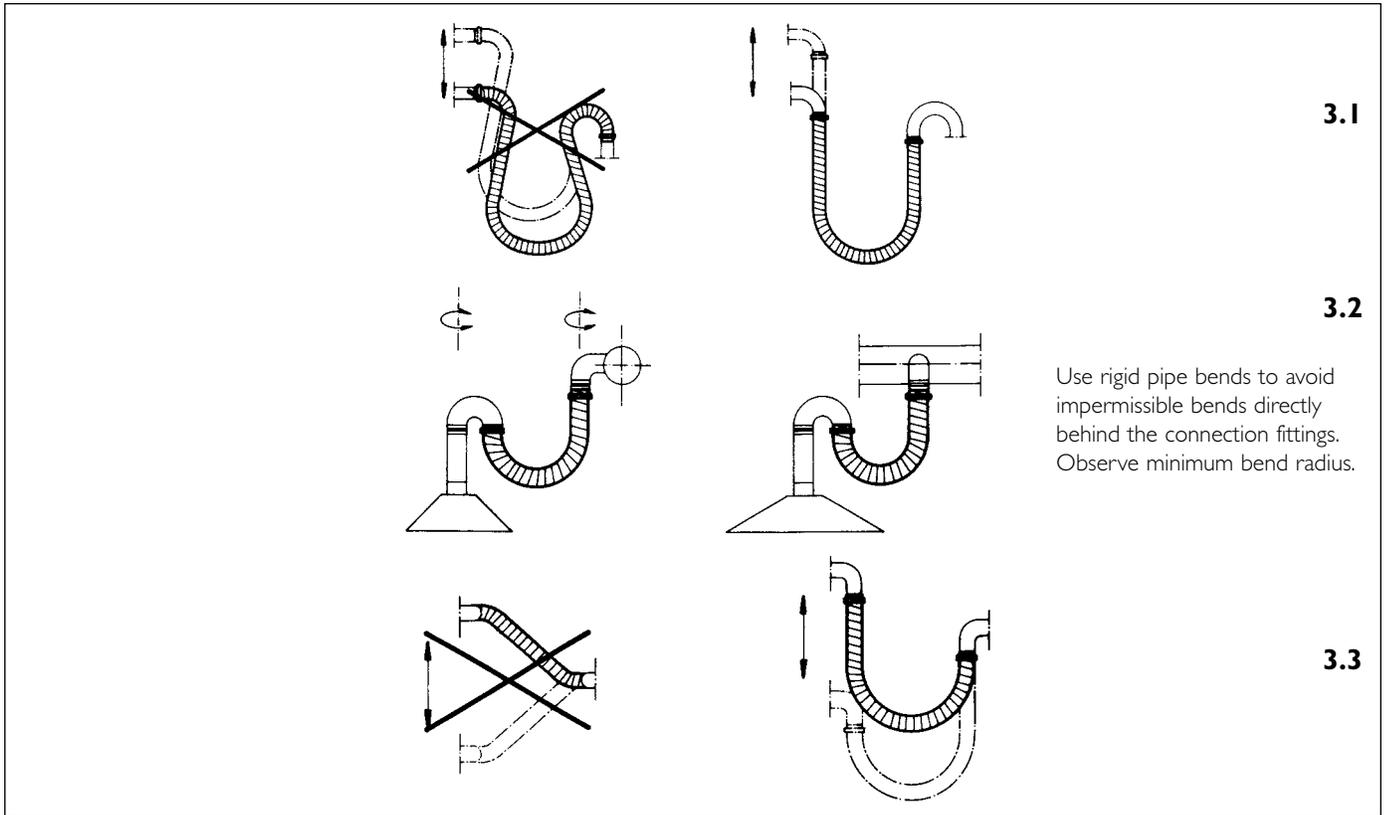


## example 2

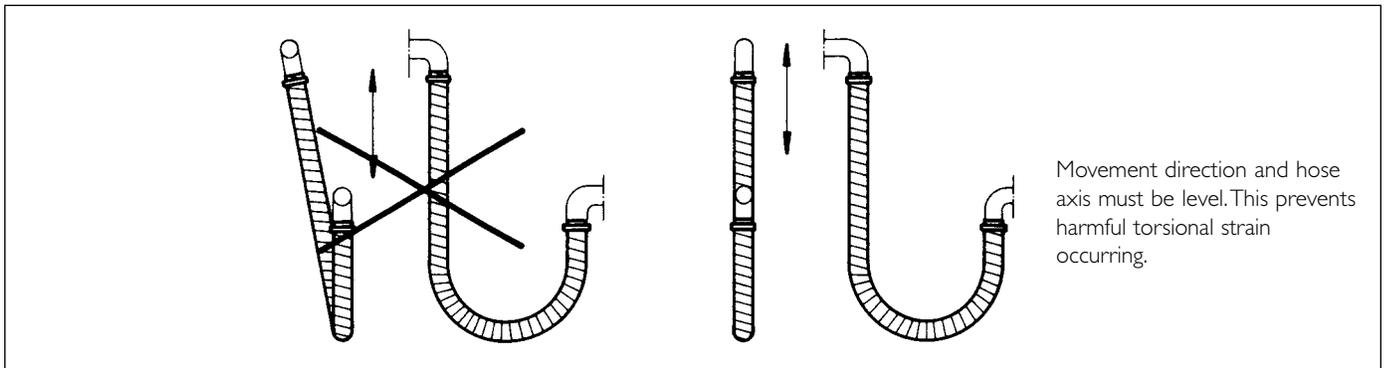


# POSITIONING OF MASTERDUCT HOSES

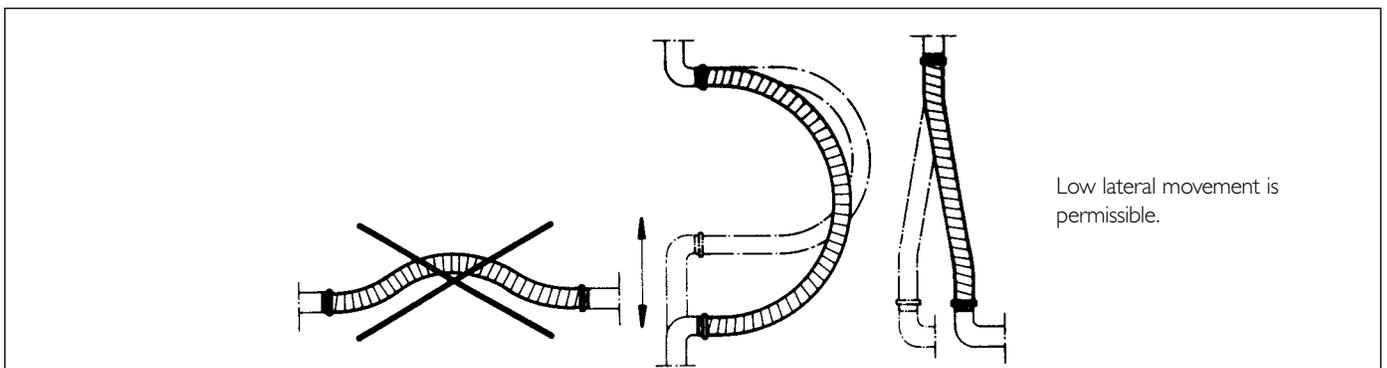
example 3



example 4



example 5

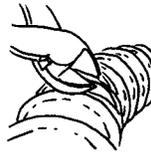


# INSTRUCTION FOR CUTTING LENGTH MASTERDUCT HOSES

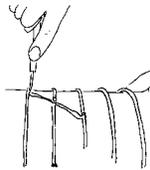
## How to cut hoses with an external helix

(all MASTER-CLIP, CARFLEX 350 and CARFLEX 570 hoses)

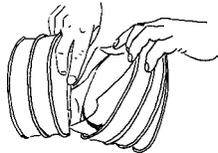
cut the helix at first with a side cutter



using a sharp knife, cut the hose material through to the both neighbouring helix

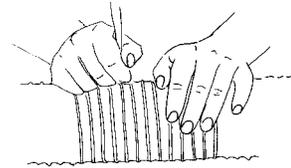


At last cut cleanly the hose material along the helix.

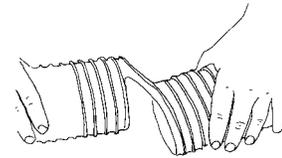


## How to cut hoses with integrated reinforce-spiral of spring steel wire or plastic

using a sharp knife, cut the hose material through to the reinforce-spiral



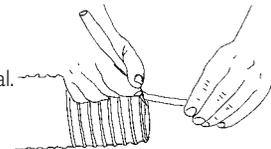
bend the both hose ends to separate the spirals



and cut the reinforce-spiral then with a side cutter



At last cut cleanly the hose material along the reinforce-spiral.



# PRESSURE RATING OF MASTERDUCT HOSES

## GENERAL TERMS

All catalog specifications are the result of internal tests and trials on internationally recommended standards and refer to a medium and ambient temperature of +68°F. Deviating temperatures can alter the pressure and vacuum specifications. Due to the construction, the length of individual hose types may be affected by the influencing variables of pressure, vacuum, medium and ambient temperature. This alteration in length must be taken into account by the user during operation. (see page: POSITIONING OF MASTERDUCT HOSES)

## OPERATING PRESSURE

The operating pressure is the maximum permitted overpressure at which a hose may be used.

## TEST PRESSURE

The test pressure is up to 50% above the operating pressure depending on the hose construction. At the test pressure the hose may not present any leaks or lasting deformation.

## BURSTING PRESSURE

Bursting pressure refers to the pressure at which the hose is destroyed. The bursting pressure serves to establish the operating pressure with due consideration to the normal safety factors.

## VACUUM

**Testing the vacuum withstand:**  
In the vacuum tests the hoses were laid in a 90° bend while maintaining the minimum bending radius and subjected to negative pressure until they showed signs of indentation or collapse. The permissible negative pressure in continuous operation is determined with due regard to the normal safety factors.

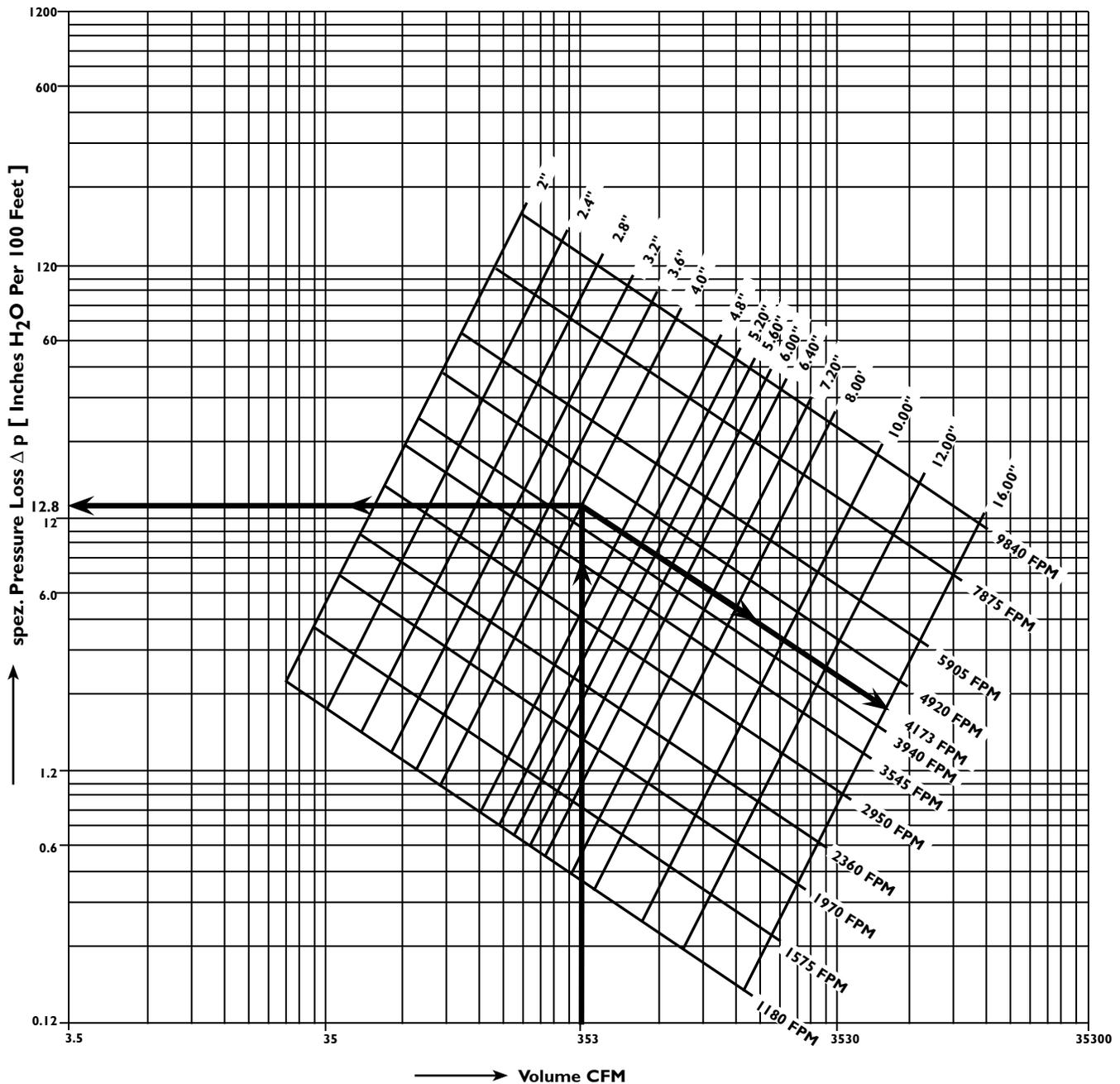
# PRESSURE LOSSES OF MASTERDUCT HOSES

## Pressure losses in hoses when stretched out

The pressure loss is the resistance to air in a hose or pipeline system. When planning a ventilation system, the air resistance which inevitably occurs must be taken into account. To simplify the determination of pressure loss, there are diagrams showing the specific pressure losses in Masterduct-hoses. The figures are average values for hoses which are stretched out straight and where the temperature is 68°F.

## Diagram I

2.00" - 16.00"  
smooth  
for following hose types:  
MASTER-PUR L  
MASTER-PUR H  
MASTER-PUR H-EC  
FLAMEX L  
FLAMEX H  
MASTER-PVC L  
MASTER-PVC H  
MASTER-NEO 2  
MASTER-SIL 2



# PRESSURE LOSSES OF MASTERDUCT HOSES

## Diagram 2

2.00" - 16.00"

wavy

for following hose types:

MASTER PUR SL

FLAMEX SL

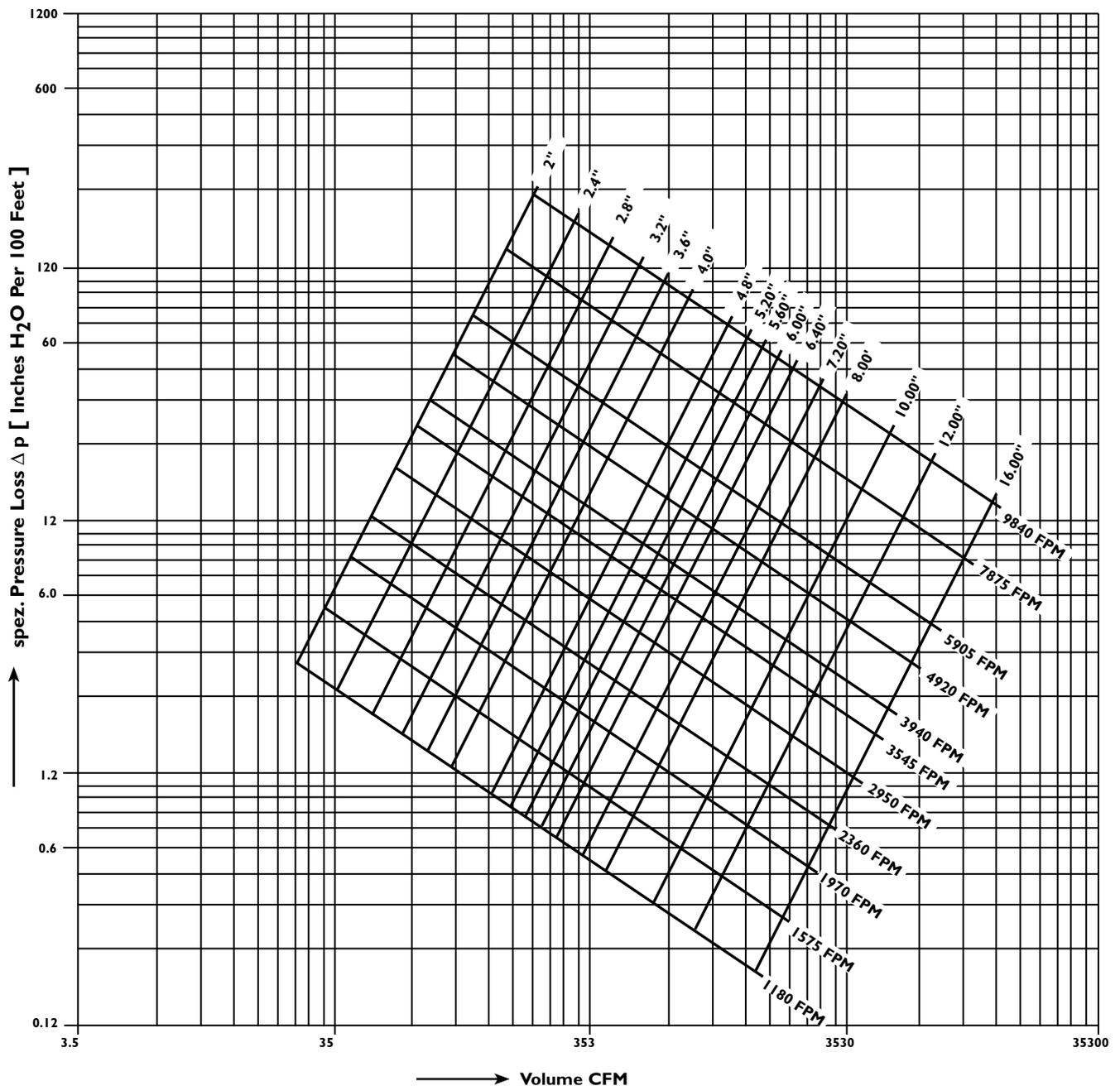
MASTER PVC SL

MASTER-NEO I

MASTER-SIL I

CARFLEX SUPER

MASTER-PUR STEP



# PRESSURE LOSSES OF MASTERDUCT HOSES

## Diagram 3

1.52" - 36.00"

for following hose types:

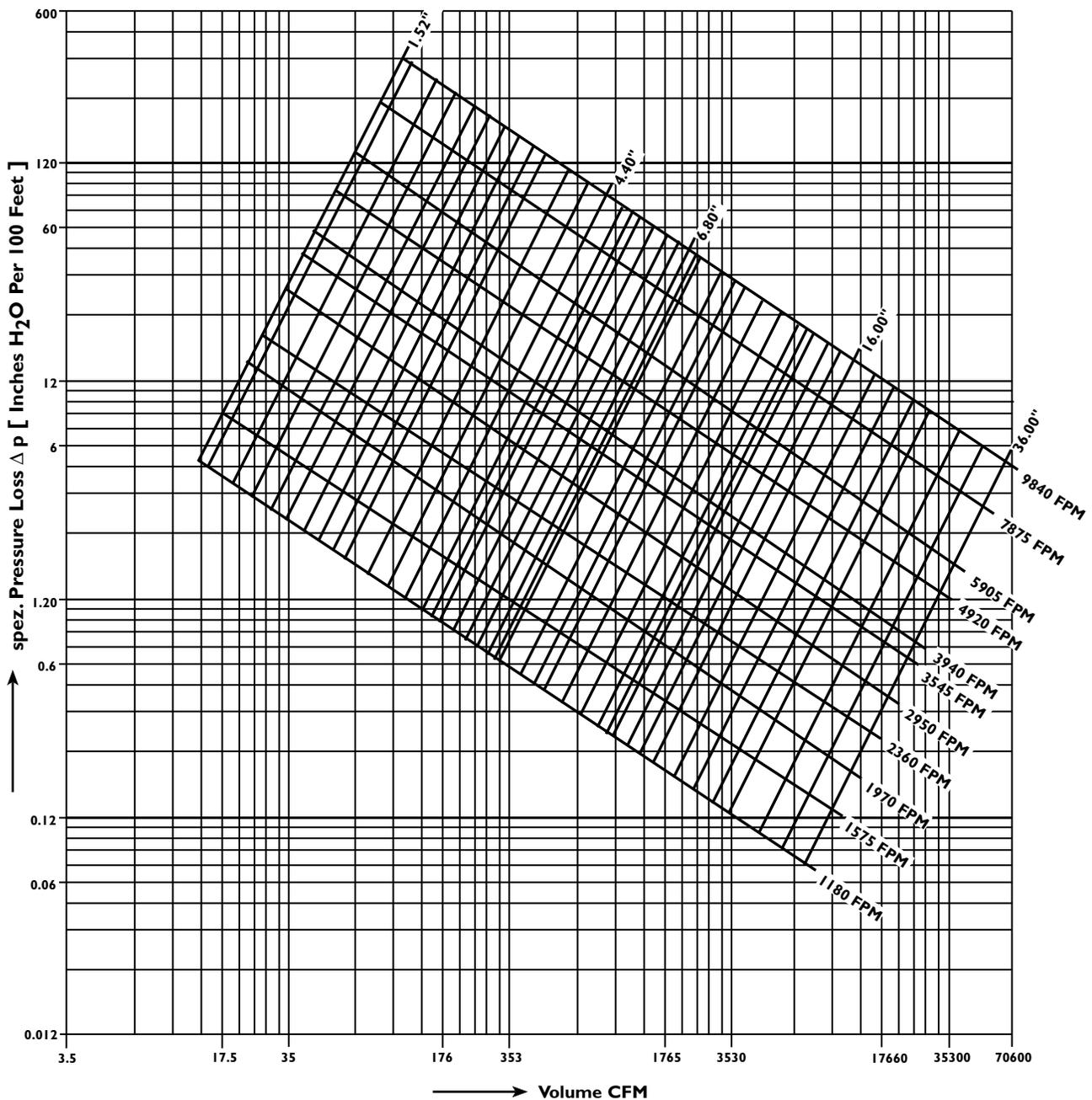
CARFLEX 350

CARFLEX 570

all MASTER-CLIP hoses except

hose constructions

loose lined



# DERIVATION OF ELECTRIC CHARGE AT MASTERDUCT-HOSES

## General points

Flexible hose lines can be a potential source of danger at pneumatic suction and conveying plants due to the building of electrostatic charges. The possibility of discharging is therefore mandatory in many areas of application to ensure safe operation. Hoses are used to transport solids, e.g. in the form of granular material, chips, dust, sand, cement etc. and also liquid and gaseous media. Electrostatic charges arise wherever solids which are non-conductive or of poor conductivity are brought into contact with other materials and separated again. As a result of the separating process one material has less electrons than the other which leads to one being positively and the other negatively charged. In the area of the common boundary surface the so-termed "interfacial potential" is formed which makes spark discharge possible. There are many ways of avoiding such discharge and these are described in more detail in the following.

## Regulations

There is a series of directives and regulations on evaluating and avoiding the risk of ignition and deciding on the safety precautions to be taken.

## Why electrostatic charge occurs

During the transport of solid, liquid or gaseous media, the "interfacial potential" described in the above is built up due to the friction on the insides of the hose lines. Depending on the degree of charge this leads to sparking, to electric breakdown or sometimes the ignition of flammable materials. In addition to the intensity of the contact (friction) between the medium and the inner sides of the hose, the "permittivity" of the hose and the medium flowing through is decisive for the degree of chargeability. This is considered a gauge of the polarisability. Even conductive materials can become charged if not grounded.

## Limit determination and definition

In general the following can become electrostatically charged:

- solids with a surface resistance  $> 10^9 \text{ Ohm}$
- liquids with a conductivity of  $< 10^{-8} \text{ s/m}$
- all objects of conductive material which are not grounded

In general the following **cannot** become electrostatically charged:

- all solid and liquid matter which fall short of the above critical resistance values
- all conductive materials which are grounded

# DERIVATION OF ELECTRIC CHARGE AT MASTERDUCT-HOSES

## Ways of connecting electrostatic charges

The surface resistance of the materials of the hose sides can be reduced to values between  $10^3 - 10^4$  Ohm by incorporating conductive additives. These conductive additives form in the plastic a network of conductive particles (volume conductivity) in contact with each other. Another possibility is incorporating antistatic agents. The effect results from the absorption of water from the atmospheric humidity at the surface of the sides of the hose. Surface resistance values of  $10^8$  Ohm can be attained (surface resistance). Also a risk of danger is not to be expected if the distances between the turns in hoses with metal, grounded support spirals do not exceed .75".

## Note

The addition of conductive additives or antistatic agents reduces the mechanical material values (e. g. abrasion and ultimate tensile strength) and accordingly reduces service life. The information summarised under points 1-6 are based on internal and external field research and on the regulations in effect at present. They serve as guidelines for using Masterduct hose types in areas of potential danger but no guarantee is given that they are complete. The catalogue details with respect to the surface resistance are based to some extent on official test results, details supplied by our raw-material suppliers and internal measurements. In cases of doubt, we recommend testing the hoses under operating conditions or similar circumstances before final installation.

# DESCRIPTION OF THE MATERIAL POLYURETHANE (TPU)

## Description of the material polyurethane (TPU)

MASTERDUCT suction and conveying hoses for abrading solids are made of the high-duty material polyurethane. Polyurethane essentially made of the reaction of three components:

- 1.) Polyole (long chain diol)
- 2.) Diisocyanate
- 3.) short chain diol

The kind of raw materials, the reaction conditions and the initial materials are responsible for the product characteristics.

The using Polyole determine the characteristics of thermoplastic polyurethane quite essentially. Either polyester-polyole or polyether-polyole are used for polyoles.

Thermoplastic polyurethane elastomers, also known as TPU, have the quality and properties to meet the most various requirements, such as:

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

## Color

The inherent color lies between yellowish and white opaque and also translucent, whereby the wall thickness is a factor here. Dying is possible.

## Mechanical properties

### Resistance to further tearing

The term resistance to further tearing refers to the resistance of a nicked test sample to further tearing. The test is carried out on corner samples, each with a cut on one side. This means that it is much more difficult to tear MASTERDUCT hoses, even when damaged, than other thermoplastic hoses (e. g. PVC hoses).

### Resistance to abrasion

Abrasion in rubber and elastomers is tested on samples with a particular contact force is brought to bear on a rotating roller covered with a test emery sheet. The entire length of friction amounts to approx. 130 ft. The material consumption due to abrasive wear is measured with due consideration to the thickness of the test sample and the severity of the attack of the test emery sheet. This is indicated as loss of volume in  $\text{mm}^3$ . The standard PUR raw material used by MASTERDUCT has an abrasion of approx.  $30 \text{ mm}^3$ .

Comparative values of raw materials used by MASTERDUCT :

- soft PVC approx.  $150 \text{ mm}^3$
- Santoprene approx.  $225 \text{ mm}^3$
- PUR-EC approx.  $45 \text{ mm}^3$

## 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  $\alpha [ 1/K ]$  as a function of temperature. Shore hardness is also an influencing variable. It is therefore advisable in many applications to take account of the dependence on temperature when selecting the MASTER PUR hoses. These hoses can be used in temperatures up to  $260^\circ\text{F}$  for short periods but a temperature of  $195^\circ\text{F}$  should not be exceeded for longer periods. Soft polyether-based types are flexible in temperatures down to  $-40^\circ\text{F}$ .

# DESCRIPTION OF THE MATERIAL POLYURETHANE (TPU)

## Electrical properties

### Surface resistance

The polyurethane raw material processed by MASTERDUCT has a surface resistance of  $10^{10}$  Ohm and can therefore be used as electrically-insulating protective hoses.

### Discharging electrostatic charge

(See page: TECHNICAL TERMS AND DEFINITIONS)

### Resistance to media

The suitability of a synthetic material for a particular application often depends on its resistance to chemicals. The reaction of thermoplastic polyurethane 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 materials.

Swelling in polyurethane material is often due to the effects of the media. (See also chapter 14.8 Technical Terms and Definitions). For TPU resistance to media see our list of resistance properties in chapter 15. For resistance to microbes: see chapter 14.8.

### Resistance to atmospheric corrosion

The resistance of TPU to ozone and ultraviolet radiation is good. See also chapter 14.8 for explanations. The resistance of TPU to high-energy radiation, such as  $\alpha$ -,  $\beta$ -  $\gamma$ -radiation is superior to that of most other plastics. The resistance of these kinds of radiation depends among other things on the dose and dose rate of the radiation, the form and dimensions of the product, and the climate and atmosphere in the location where used. Certain properties such as e. g. resistance to thermoforming and to chemical attack can be positively influenced by purposeful cross-linking as a result of high-energy irradiation with the aid of cross-linking agents.

### Fire-resisting behaviour

Plastics, like all organic materials, are combustible. The standard TPU we use is also inherently classifiable as such. The fire-resisting behaviour of a material is not a material property however and it is influenced by different criteria. The complexity of the influencing variables makes it impossible to give a comprehensive and generally-applicable description of the fire-resisting behaviour of plastics because the risk of burning depends on, e. g., the thickness of the walling and the form, number and lay-out of the combustible objects and other circumstances of use.

For this reason, the behaviour under fire of plastics should not be described in words or phrases which could be misinterpreted, such as "self-extinguishing" or "non-flammable", but best by code numbers or code letters which refer to a specific method of testing. MASTERDUCT hoses made of special PUR materials are flame retardant as per DIN 4102 B1. (German standard)

# DESCRIPTION OF THE MATERIAL THERMOPLASTIC VULCANISATE (TPV)

The hoses manufactured by Master-flex from the material TPV are produced from a thermoplastic rubber: Thermoplastic rubber belongs to a group of elastomers which combine the performance characteristics of vulcanisable rubbers, such as heat resistance and low compression set, with the easy processibility of thermoplastics in an excellent way

Thermoplastic vulcanisate is a fully vulcanised polyolefin material. Production is carried out in a special dynamic vulcanisation procedure which produces fully cross-linked rubber particles which are distributed in a continuous matrix of thermoplastic material. The average rubber particle size of one micron or less results in extremely favourable physical material properties.

TPV has a resistance to environmental conditions corresponding to the standard EPDM rubber mixtures, whilst the chemical resistance is

comparable to that of chloroprene rubber mixtures.

The performance characteristics of thermoplastic vulcanisates include:

- mechanical properties over a temperature range of -40 °C to +130 °C and up to +150 °C for short periods
- resistance to chemicals in the chloroprene class for aqueous fluids, oils and hydrocarbons
- low compression set and tension set
- excellent hot air ageing behaviour at temperatures of up to +150 °C over periods of up to two weeks and up to +130 °C over longer periods
- excellent dynamic fatigue resistance
- outstanding resistance to ozone and atmospheric corrosion

The standard hoses are manufactured from black raw materials, but can also be coloured in accordance with customer requirements for appropriate delivery quantities.

# TECHNICAL TERMS AND DEFINITIONS

## **Abrasion**

Undesirable alteration of the surface due to the detachment of small particles as a result of mechanical strain. This process in synthetics (and in many other materials) is generally referred to as wear. (See page: DESCRIPTION OF THE MATERIAL POLYURETHANE.)

## **Additives**

All constituents in synthetic mixtures which are not polymers or their primary products or which are only added in relatively low quantities (e. g. conductive soot, flame proofing agents, UV-stabilising agents etc.).

## **Aging**

The entirety of all irreversible chemical and physical processes occurring in a material over the course of time. Usually leads to a deterioration in performance characteristics. Often caused by: heat, light, high-energy radiation, chemicals, weather, oxygen (ozone).

## **Bend radius**

The bend radius is given in inches. All figures refer to the inside of the hose bend at max. operating pressure.

## **Elasticity**

The ability of a material to reverse alterations in shape or volume caused by outside forces or momentum.

## **Elastomers**

Designation for wide-meshed, cross-linked macromolecular materials which can be extended to at least double of their original length under the influence of a slight force at temperatures of room temperature or higher and can resume their original shape quickly and practically completely once the deforming force has been removed.

## **Flame proofing agents**

Are synthetic additives which reduce the flammability of plastics.

## **Flexibility**

Effectual expenditure of energy to attain the minimum bend radius (the greater the expenditure of force, the less the flexibility).

## **Gas permeability**

See permeability.

## **Halogens**

The elements fluorine (F), chlorine (Cl), bromide (Br) und iodine (I) form the group of halogens.

## **Hardness**

The resistance of one body to the penetration of another. In rubber-type material a needle is pressed with a certain spring tension into the sample. The hardness is measured by the depth of penetration (scale range 0 to 100 in Shore).

## **Hydrolysis resistance**

Hydrolysis = irreversible breaking of the polyester chains in polyester polyurethanes. It occurs after a long period in hot water, saturation steam or a tropical climate (moisture combined with heat). The result of hydrolysis is a decrease in mechanical strength properties. Hardly any hydrolytic decomposition is observed in polyester polyurethanes at room temperatures.

## **Lamination**

Application of a surface coating with particular properties onto foil or plates and the application of foil or sheeting onto fabric web.

## **Microbial resistance**

Polyester-based thermoplastic polyurethanes without additional protection against microbes are at risk of decomposition caused by microbial attack. Moisture combined with heat (e. g. in nutritive surroundings such as grass, foliage, agriculture etc.) can accelerate this process. In such surroundings the microorganisms multiply very rapidly. The enzymes they release split ester compounds and destroy the synthetic part. Attack on individual points is evident first, in contrast to hydrolytic decomposition, which occurs over the entire surface. Polyether based polyurethanes are to a large extent resistant to decomposition by microbial attack but their mechanical properties are not as good as those of comparable polyester polyurethanes.

# TECHNICAL TERMS AND DEFINITIONS

## **Permeation**

Passage of a gas through a test sample; this occurs in three stages:

1. Dissolution of the gas in the test body
2. Diffusion of the dissolved gas through the test sample
3. Evaporation of the gas from the test body

The permeation co-efficient is a material constant which indicates the volume of gas which passes through a test sample of known surface and thickness at a given partial pressure difference at a particular time. It depends on temperature.

## **Swelling**

Absorption of liquid or gaseous matter in solids without a chemical reaction occurring between them. The results are an increase in volume and weight accompanied by a corresponding decrease in mechanical values. Once the infiltrated matter has been exhausted and swelling has decreased accordingly, the original properties of the product are almost completely restored. Swelling is therefore a reversible process.

## **Crushing strength**

Resistance of suction and delivery hoses to compression caused by outside loads on top of them.

## **Resistance to further tearing**

The resistance of nicked test sample to further tearing. The test is carried out on a corner sample with a cut in one side.

## **UV radiation**

Synthetics can be chemically broken down by the effects of UV radiation depending on the duration and intensity (ageing). The resistance of polyurethanes to UV radiation is good in general but over the course of time the material turns yellow and the surface becomes slightly brittle. The results includes a slight lowering of the mechanical properties. Stabilisation against ageing can be attained with the aid of UV stabilisers and/or through colour pigmentation.

## **Ozone resistance**

Ozone is the combination of three oxygen atoms into one molecule ( $O_3$ ). It is formed by the action of high-energy ultraviolet radiation on the oxygen in the atmosphere. Due to its composition, ozone is very reactive and reacts easily with organic substances. The resistance of polyurethanes to ozone is good in general.