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Norval Non-Return Valve

Technical Brochure

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Sizing of Norval Non-Return Valves

1.0. Introduction

A non-return valve should be sized so that it is fully open in all normal operating situations. This applies to all types of non-return valve, especially when pulsating flows may cause flutter and disturbance in the system.

The pressure drop across the valve depends on the density and velocity of the flowing media. Because the Norval utilises an elastomeric diaphragm, the maximum velocity in the pipe has to be limited to avoid failure of the diaphragm and the following velocities should not be exceeded:

(A) Liquids – 3.0 m/s continuous velocity
– 3.6 m/s intermittent peak velocity

(B) Gases – 12.0 m/s continuous velocity
– 15.0 m/s intermittent peak velocity

The sizing of Norval non-return valves when used on water are adequately covered in the catalogue under performance characteristics and reproduced here as Chart 1. This chart can be used for Norval non-return valves fitted with EPDM diaphragms.

However, when used with gases or viscous fluids the Norval is slightly more complicated to size and the Norval generalised pressure drop charts for each valve size are to be used, Charts 2 – 8.

Note:

(i) Before sizing the Norval the correct diaphragm must be selected to suit the line media. A guide to the general chemical resistance of the diaphragms is presented in section 9.0.

(ii) Reference must be made to the pressure/temperature rating chart presented in the catalogue, and in Section 2.0 to establish the suitability of the Norval.

1.1. Notes for use with Generalised pressure Loss Charts.

(i) The charts are based on actual tests performed on water and verified on air for some valve sizes.

(ii) The pressure drop characteristic shown is that which would be obtained if the flow rate through the valve were gradually increased from zero. In the horizontal portion the diaphragm is only partially deformed and the valve continues to open as the flow rate increases, giving rise to a constant velocity through the valve aperture and thus a constant pressure drop. At a certain flow rate the valve becomes fully open, and therefore the pressure drop is roughly proportioned to the square of the flow rate as in a normal valve.

(iii) The pressure drops indicated are the maximum values that should be obtained in practice. However depending on the method of operation in a particular installation, considerably lower pressure drops may be experienced. This is due to the fact that once the diaphragm is deformed by an initial high flow rate it has a tendency to retain the same degree of deformation even if the flow rate is subsequently reduced. Thus in an installation where the flow rate is not constant, and provided the valve is not operating entirely in the proportional zone, pressure drops may be lower than indicated by the graphs. This is called valve hysteresis and is fully explained Appendix 1.

(iv) To calculate pressure drops for fluids other than water, the following procedure may be adopted. Whilst this will give pressure drops for most gases and liquids it should not be used for very viscous fluids such as heavy fuel oils.

a) Calculate the velocity, v in m/s of the fluid in pipeline, at the prevailing temperature and pressure.

b) Calculate the valve of $\rho \times v^2$, where ρ is the fluid density in kg/m^3 and v is the velocity in m/s; both measured at the actual temperature and pressure in the pipeline.

c) Read off on the appropriate chart the pressure drop corresponding to this ρv^2 term against the diaphragm suitable for the line media.

1.2. Gas Duty

When sizing for gas duties the flow rate must be at the working conditions, so that the sizing charts can be used. Flow rates can be quoted in Nm^3/s or m^3/s. Nm^3/s, normal cubic metre per second relates to gas flow at 0°C temperature and atmospheric pressure (1.013 bar), and therefore must be corrected for temperature and pressure at the working conditions in the line. Whereas m^3/s, cubic metre per second is the flow rate at the line working conditions and requires no correction.

Example:

Calculate the pressure drop obtained when passing 0.09 Nm^3/s of chlorine gas through a DN100 (4″) Norval with Viton diaphragm, at atmospheric pressure and at 3.45 barg, in both cases at 20°C

(i) At atmospheric Pressure:

Using the Standard Gas Law to convert the flow rate from standard to working conditions

$$\frac{P_1 Q_1}{T_1} = \frac{P_2 Q_2}{T_2}$$

Hence:

$$Q_2 = \frac{Q_1 P_1 T_2}{P_2 T_1}$$

$$Q_2 = \frac{0.09 \times 1.013 \times 288}{1.013 \times 293}$$

$$Q_2 = 0.0885 \text{ m}^3\text{/s @ line conditions}$$

Where: P_1 = Atmospheric absolute pressure (bar)
= 1.013 bar absolute
Q_1 = Flowrate (Nm^3/s)
T_1 = Atmospheric absolute temperature (K)
= 15°C + 273 = 288 K
P2 = Working absolute pressure (bar)
= 1.013 + gauge pressure (bar)
Q_2 = Flow rate @ line conditions (m^3/s)
T_2 = Working absolute temperature (K)
= 20°C + 273 = 293 K

Velocity:

The approach velocity in the pipe is calculated using:

$$v = \frac{Q}{A_P}$$

$$v = \frac{0.0885}{8.213 \times 10^{-3}}$$

$$v = 10.776 \text{ m/s}$$

Where: v = Velocity (m/s)
Q = Flowrate (m^3/s) @ line conditions
A_P = Area of pipe (m^2)

From Table 1 the area of a 4″ pipe is 8.213×10^{-3} m^2

Density:

The density must be the gas density at the line working conditions; hence the density at atmospheric conditions must be converted to the line conditions. As a rule of thumb, as the temperature increases (the gas becomes rarefied), the density falls and as the pressure increases, the density increases.

Hence:

$$\frac{\rho_1 T_1}{P_1} = \frac{\rho_2 T_2}{P_2}$$

$$\therefore \rho_2 = \frac{\rho_1 P_2 T_1}{P_1 T_2}$$

Where ρ = Density kg/m^3

The density for air at 20°C and atmospheric pressure = 1.205 kg/m3.

The specific gravity for chlorine gas = 2.486 (see Table 2).

Therefore the density for chlorine gas at 20°C and atmospheric pressure

= ρ_{air} x $SG_{chlorine}$

= 1.205 x 2.486

= 2.996 kg/m^3

Having now calculated the velocity and density at the line working conditions, the term ρv2 can be calculated to determine the pressure drop.

$$\rho v^2 = 2.996 \times 10.776^2$$

$$= 347.902$$

Referring the Norval generalised pressure loss chart for a DN100 valve fitted with Viton diaphragm:

Pressure drop = 2 kPa.

(ii) At 50 psig pressure:

Flow rate:

$$Q_2 = \frac{Q_1 P_1 T_1}{P_2 T_2}$$

$$Q_2 = \frac{0.09 \times 1.013 \times 288}{4.463 \times 293}$$

$$Q_2 = 0.0201 \text{ m}^3/\text{s @ line conditions}$$

Velocity

$$v = \frac{.0201}{8.213 \text{ x}10^{-3}}$$

$$v = 2.447 \ m/s$$

Density

$$\rho_2 = \frac{\rho_1 P_2 T_1}{P_1 T_2}$$

$$\rho_2 = \frac{2.996 \times 4.463 \times 293}{1.013 \times 288}$$

$$\rho_2 = 13.429 \text{ kg/m}^3$$

$$\rho v^2 = 13.429 \times 2.447^2$$

$$= 80.410$$

Referring the Norval generalised pressure loss chart for a DN100 valve fitted with Viton diaphragm:

Pressure drop = 2 kPa

1.3. Steam Duty

Calculate the pressure drop obtained when passing 410 kg/hr saturated steam 3 BarG through a DN80 (3") Norval with a silicone diaphragm.

Reference steam tables @ 3 bar g steam pressure

Saturation Temperature: 143.63ºC

Specific Volume: $0.462\ m^3/kg$

Density: $2.164\ kg/m^3$

Volumetric flowrate, Q = mass flowrate x specific volume

$$= \frac{410}{3600} \times 0.462$$

$$\therefore Q = 0.0526 m^3/s$$

$$\text{Velocity(ft/s)} = \frac{\text{Flowrate,Q}}{60 \times \text{Pipe area}}$$

From Table 1 the area of a 3″ pipe is $4.769\text{x}10^{-3}\ m^2$

$$\therefore \text{Velocity} = \frac{0.0526}{4.769\text{x}10^{-3}}$$

$$= 11.030\ \text{m/sec}$$

$$\rho v^2 = 2.164 \times 11.030^2$$

$$= 263.274$$

Referring to the generalised pressure loss chart for a DN80 Norval fitted with a silicone diaphragm:

Pressure Drop = 5 kPa

1.4. Viscous Fluids

The pressure drop through the valve aperture can be represented by the equation:

$$\Delta P = \frac{\rho v^2}{2gC_O^2}\left[\left(\frac{A_p}{A_v}\right)^2 - 1\right]$$

where
- p = fluid density
- v = velocity in adjacent pipeline
- A_p = cross sectional area of pipeline
- A_v = cross sectional area of valve aperture
- C_O = a discharge coefficient
- g = gravitational constant

The discharge coefficient C_O is a function of Reynolds number through the valve aperture, but can be taken as a constant, provided the flow through the valve is turbulent.

The degree of deformation of the diaphragm is dependent on the kinetic pressure of the fluid in the pipeline $\frac{\rho v^2}{2g}$, and does not depend on the fluid viscosity. Thus regardless of whether water, gas or viscous oil is flowing through the valve, the value of A_V will be the same if the value of $\frac{\rho v^2}{2g}$ is the same. (Since g is a constant we can omit it and just use the value of ρv^2). It follows, therefore, that to determine pressure drops for other fluids we have only to determine the value of C_O. This can be considered as two constants – one for laminar flow conditions and one for turbulent flow conditions, based on valve Reynolds number. This assumption does not hold for very highly viscous liquids such as cold, heavy fuel oils, but is reasonably accurate for viscosities up to around 500 centistokes.

The value of C_O for the ¾" valve with a Viton diaphragm has been determined to be 0.84 with turbulent flow, and 0.52 with laminar flow. Thus to determine the pressure drop for a medium viscosity oil, first calculate the value of ρv^2 and read off the pressure drop on the generalised pressure loss chart for the size of valve. This pressure drop is then multiplied by $\left(\frac{0.84}{0.52}\right)^2$ to give the actual pressure drop with oil.

Values of C_O for other size valves have not yet been determined but it is expected that the ratio of C_O for turbulent flow to C_O for laminar flow will remain more or less constant. Thus, until further information is available, we can say that the conversion factor from pressure drop in water to viscous liquids is $\left(\frac{0.84}{0.52}\right)^2$, or 2.6 for the same value of ρv^2.

Example:

Determine the pressure drop of Shell Turbo 29 Oil flowing at 1.36 m³/h through a ¾" Norval with a Nitrile diaphragm at 20ºC.

Kinematic viscosity, υ = 134×10^{-6} m²/s

Density ρ = 877 kg/m³

Flowrate = $\frac{1.36}{3600}$

= 377.777×10^{-6} m³/s

Hence

Velocity v = $\frac{377.777 \times 10^{-6}}{288 \times 10^{-6}}$

= 1.312 m/s

To determine if the flow is laminar

Reynolds Number, Re = $\frac{vd}{\upsilon}$

where v = velocity, m/s

d = pipe diameter, m

υ = kinematic viscosity, m²/s

= $\frac{1.312 \times 19.05 \times 10^{-3}}{134 \times 10^{-6}}$

= 186.5

Hence flow through the valve will be laminar at this viscosity

ρv^2 = 877×1.312^2

= 1509.619

Referring to the generalised pressure loss chart for a ¾" Norval fitted with a Nitrile diaphragm.

Pressure drop = 27 kPa

∴ Pressure Drop on oil = 27 x 2.6

= 70.2 kPa.

Table 1. Pipe Areas Based on Schedule 40 Pipe.

Diameter		Area	Diameter		Area
Inch	mm	m²	Inch	mm	m²
½	15	195.075×10^{-6}	2½	65	3.086×10^{-3}
¾	20	345.042×10^{-6}	3	80	4.769×10^{-3}
1	25	557.389×10^{-6}	4	100	8.213×10^{-3}
1¼	32	966.516×10^{-6}	5	125	12.908×10^{-3}
1½	40	1.316×10^{-3}	6	150	18.646×10^{-3}
2	50	2.163×10^{-3}	8	200	32.283×10^{-3}

Table 2. Specific Gravity of Gases Relative to Air.

Gas	Symbol	SG.	Gas	Symbol	SG.
Air	–	1.0000	Hydrogen Sulphide	H_2S	1.1895
Ammonia	NH_3	0.5971	Methane	CH_4	0.5537
Carbon Dioxide	CO_2	1.5300	Methyl Chloride	CH_3Cl	1.7400
Carbon Monoxide	CO	0.9680	Nitrogen	N_2	0.9670
Chlorine	Cl_2	2.4900	Nitrous Oxide	N_20	1.5300
Ethylene	C_2H_4	0.9683	Oxygen	O_2	1.1050
Helium	He	0.1368	Suphur Dioxide	SO_2	2.2640
Hydrogen	H_2	0.0695	Natural Gas	–	0.6000

Chart 1: Pressure Loss for Water - EPDM Diaphragms

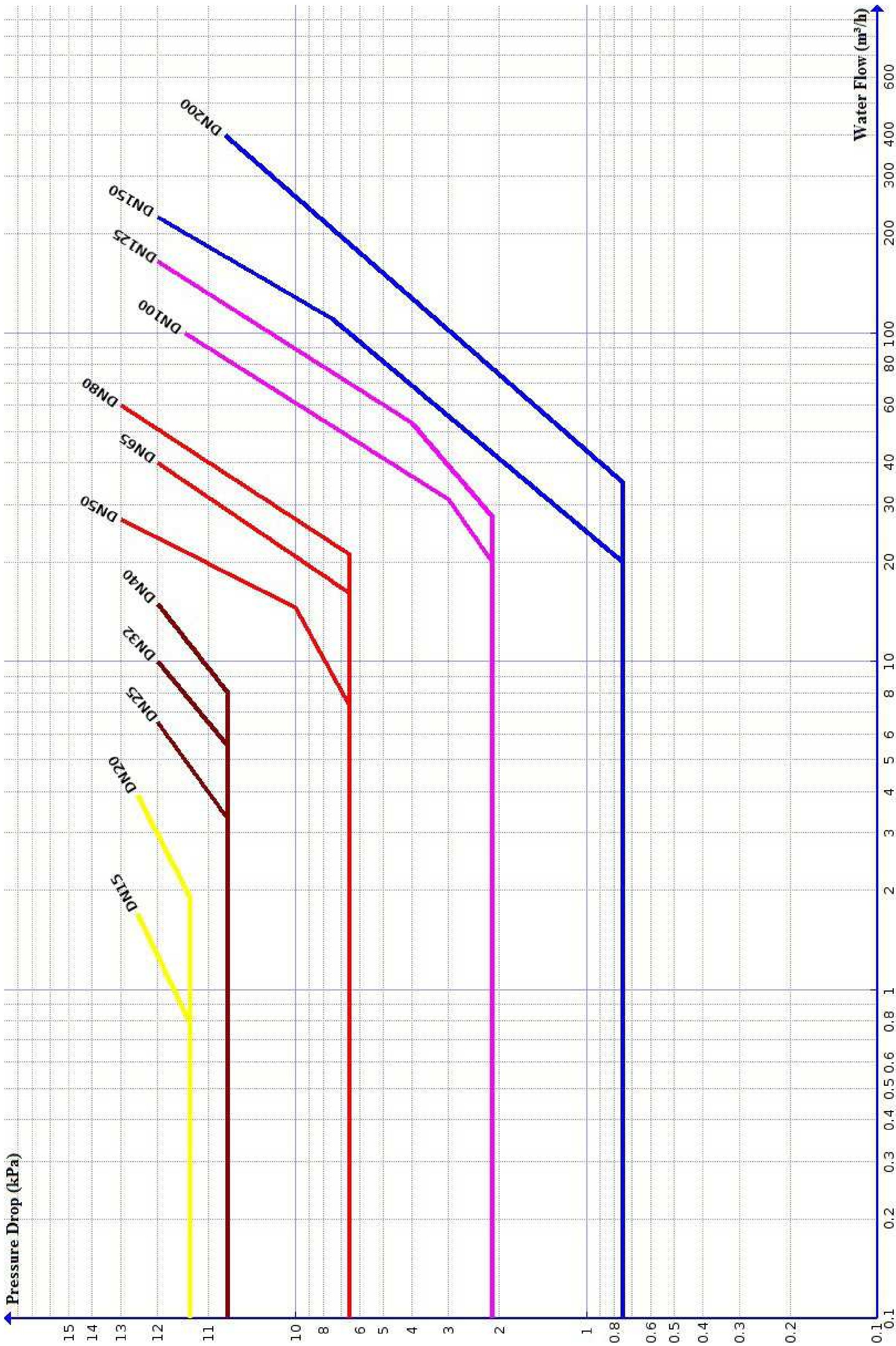


Chart 2: Pressure Loss - Sizes DN15 & DN20

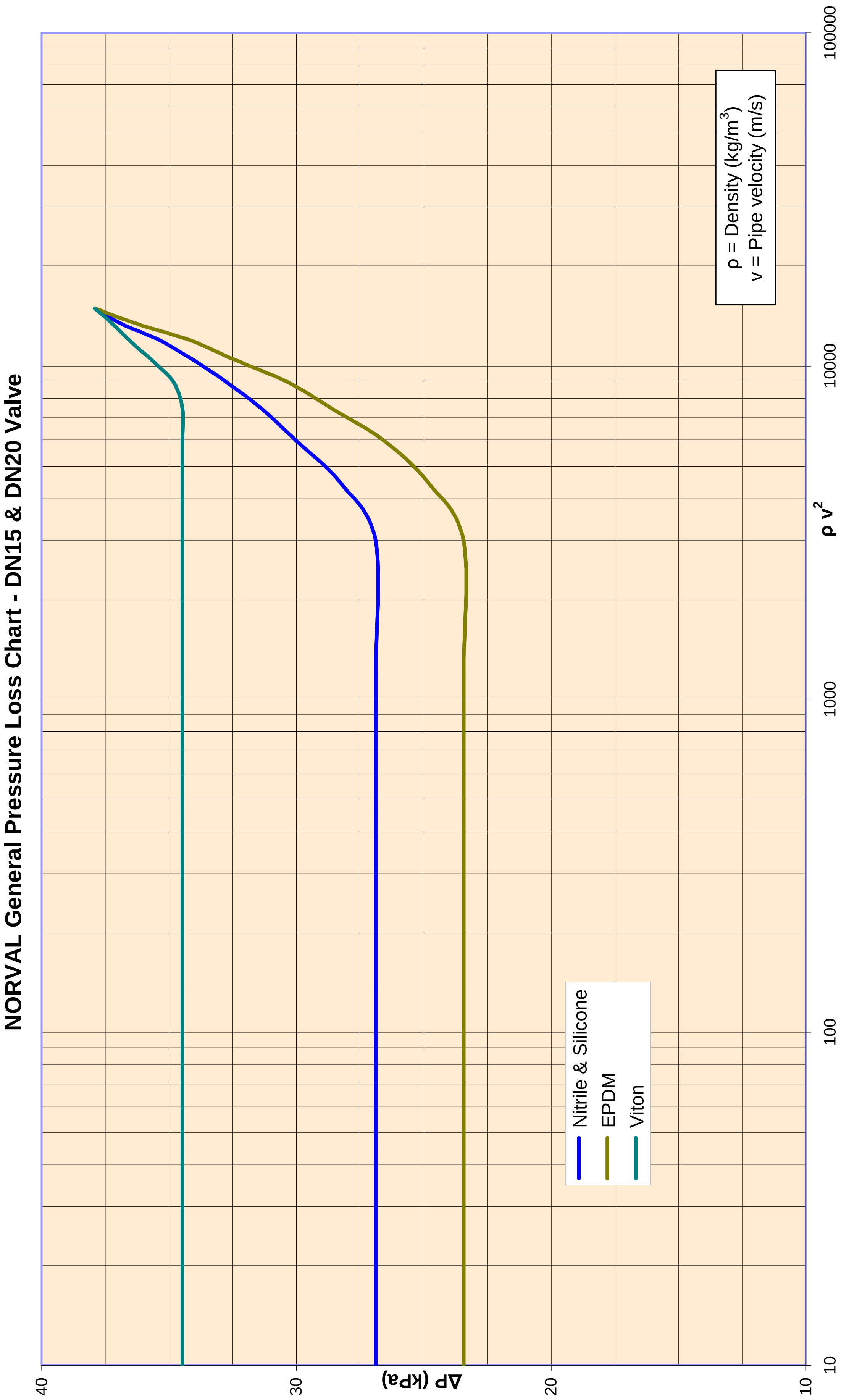


Chart 3: Pressure Loss - Sizes DN25 - DN40

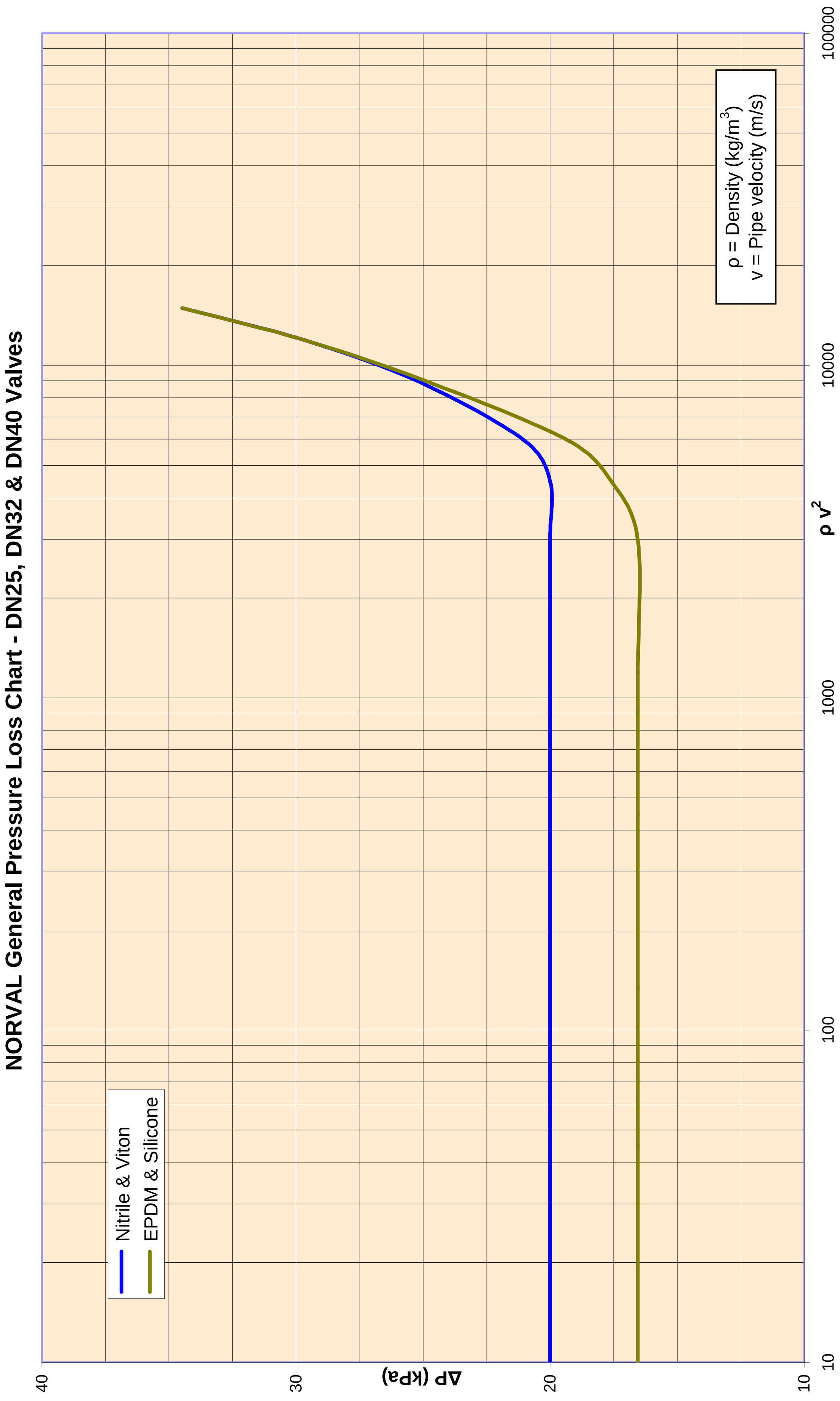


Chart 4: Pressure Loss - Size DN50

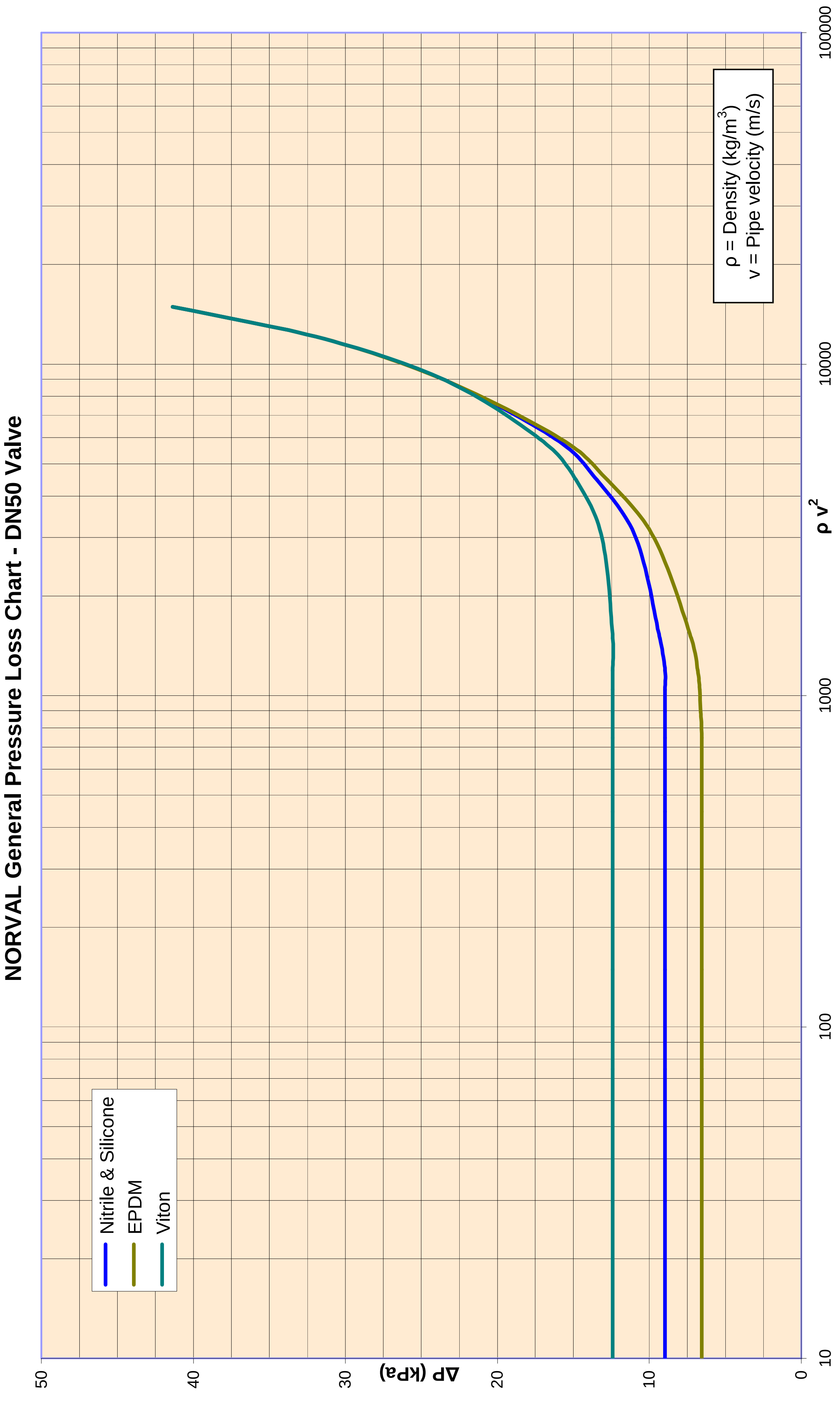


Chart 5: Pressure Loss - Sizes DN65 & DN80

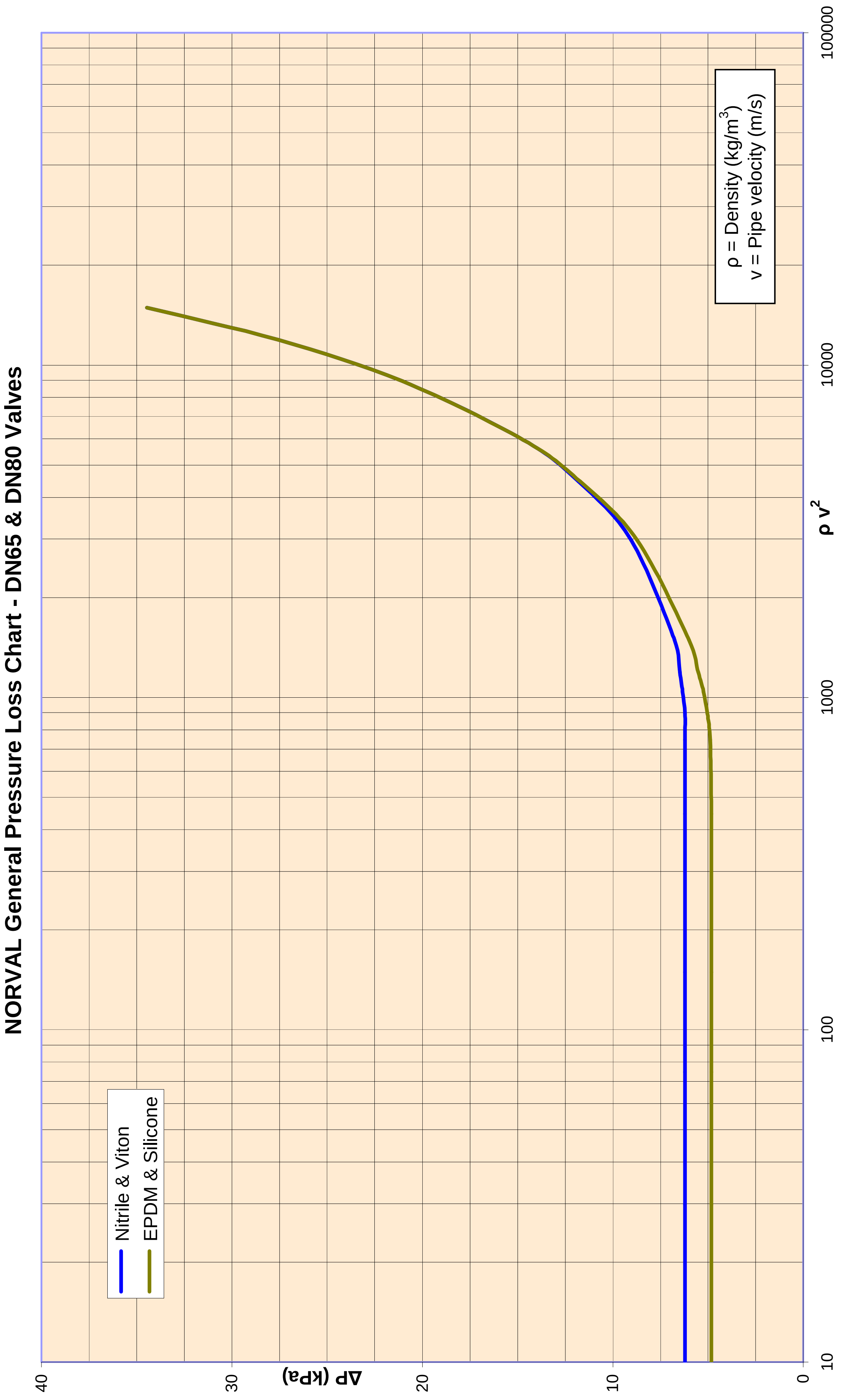


Chart 6: Pressure Loss - Size DN100

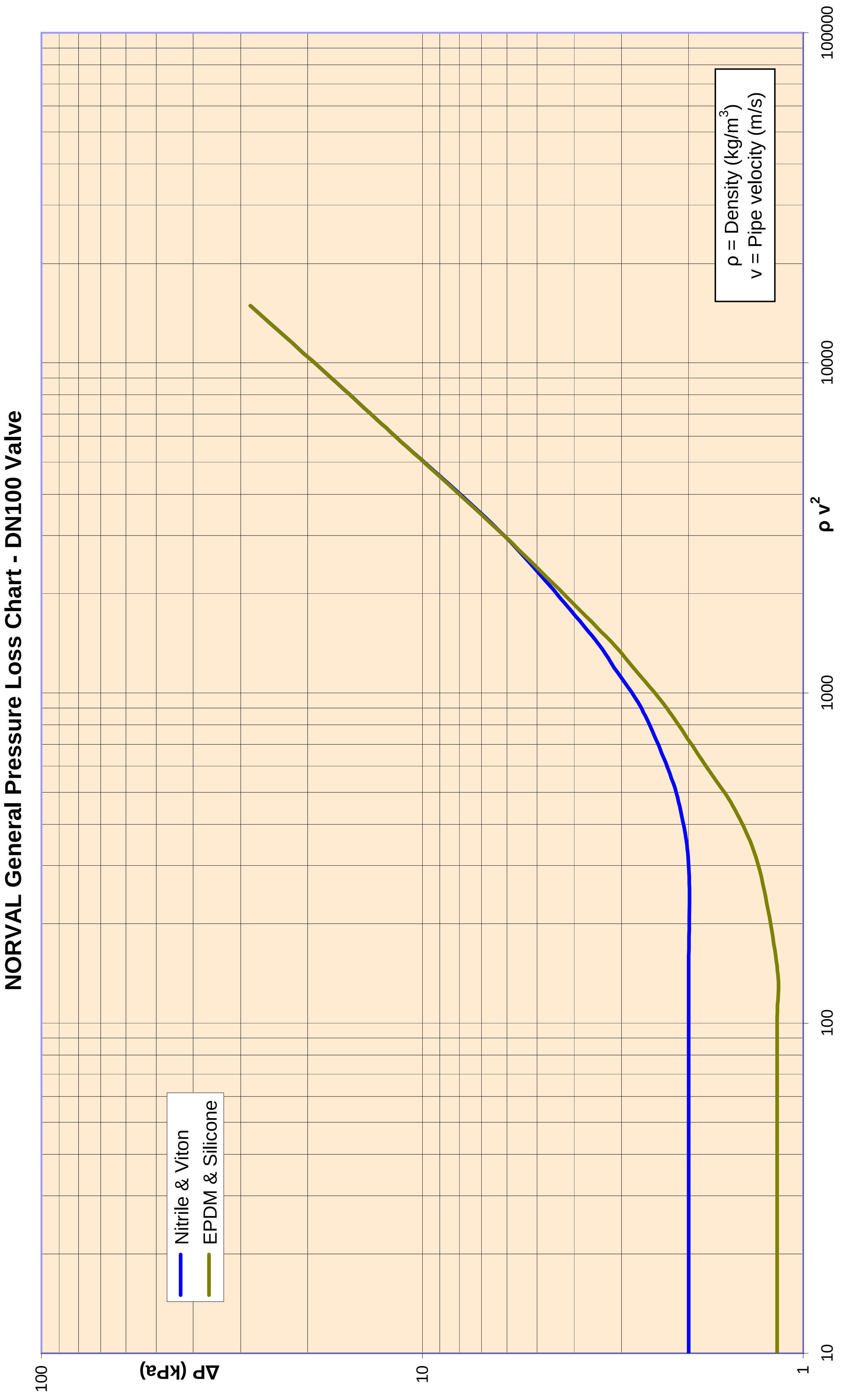


Chart 7: Pressure Loss - Size DN125

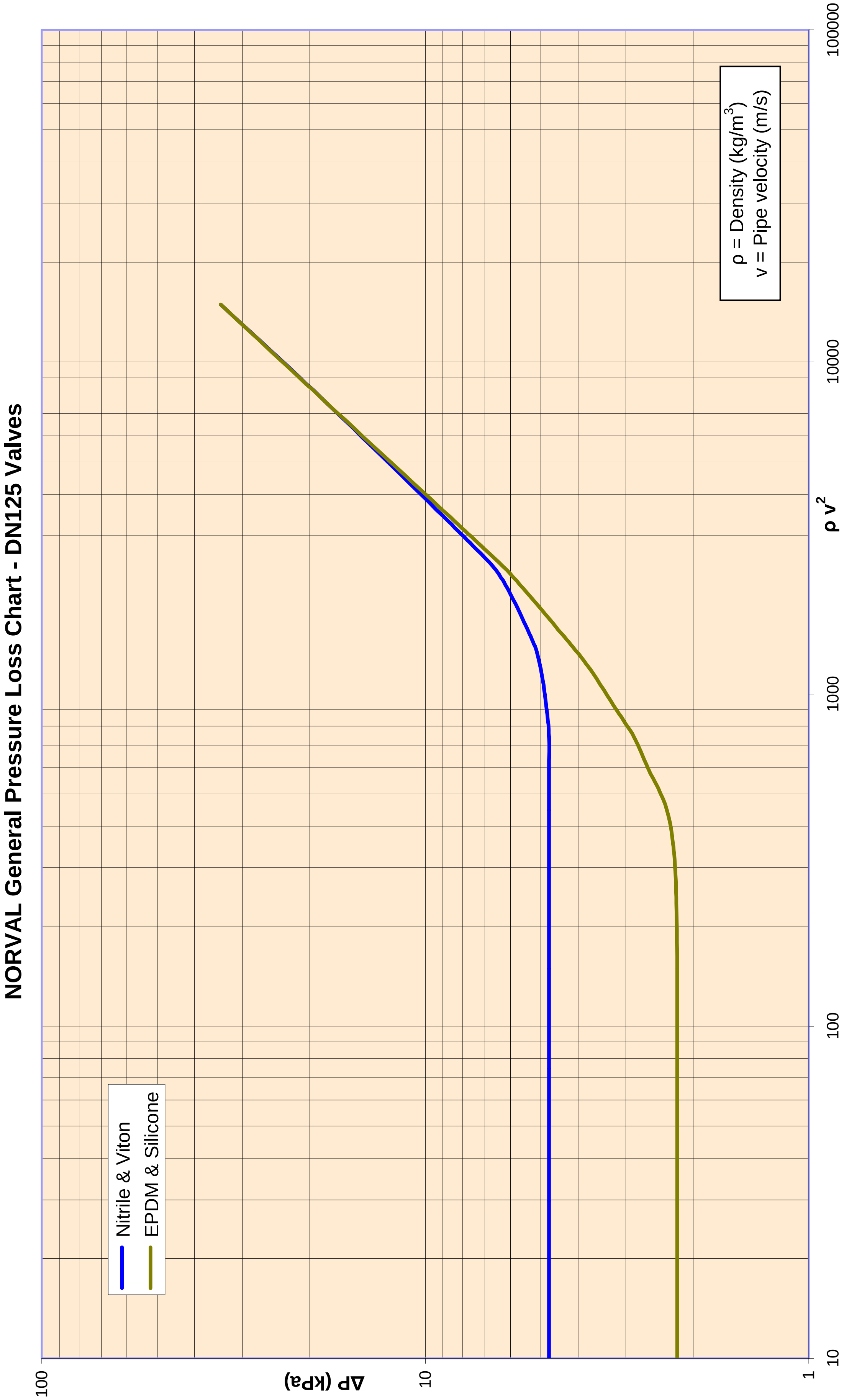
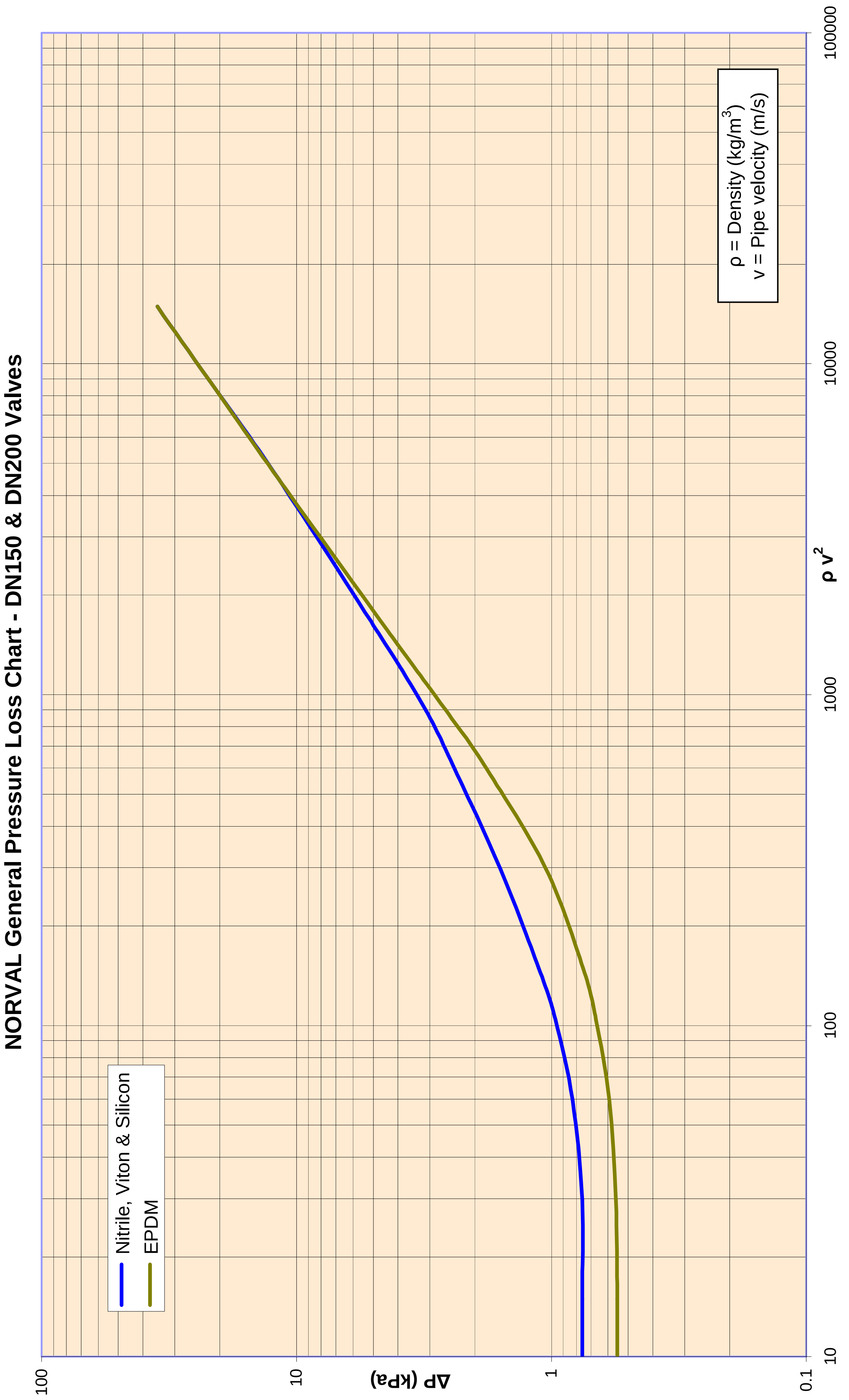


Chart 8: Pressure Loss - Sizes DN150 & DN200



2.0. Pressure/Temperature Chart.

Selection of the correct diaphragm material must take into account the temperature and backpressure in the system. The table below gives the safe working pressures where the backpressure condition exists continuously for long periods.

Table 3. Norval Pressure Temperature Ratings.

Diaphragm Rubber Grade	Temperature °C						
	20	50	70	100	150	200	
Fluorocarbon (3)	16	16	16	16	10	4	Pressure BarG
Silicon (4)	16	14	10	9	8	–	
Nitrile (6)	16	16	14	12	–	–	
EPDM (7)	16	11	8.5	6	3	–	

All Norval valves are rated for 16 BarG at 21ºC (70ºF); variation of pressure with elevated temperature for continuous operation is given in Chart 9.

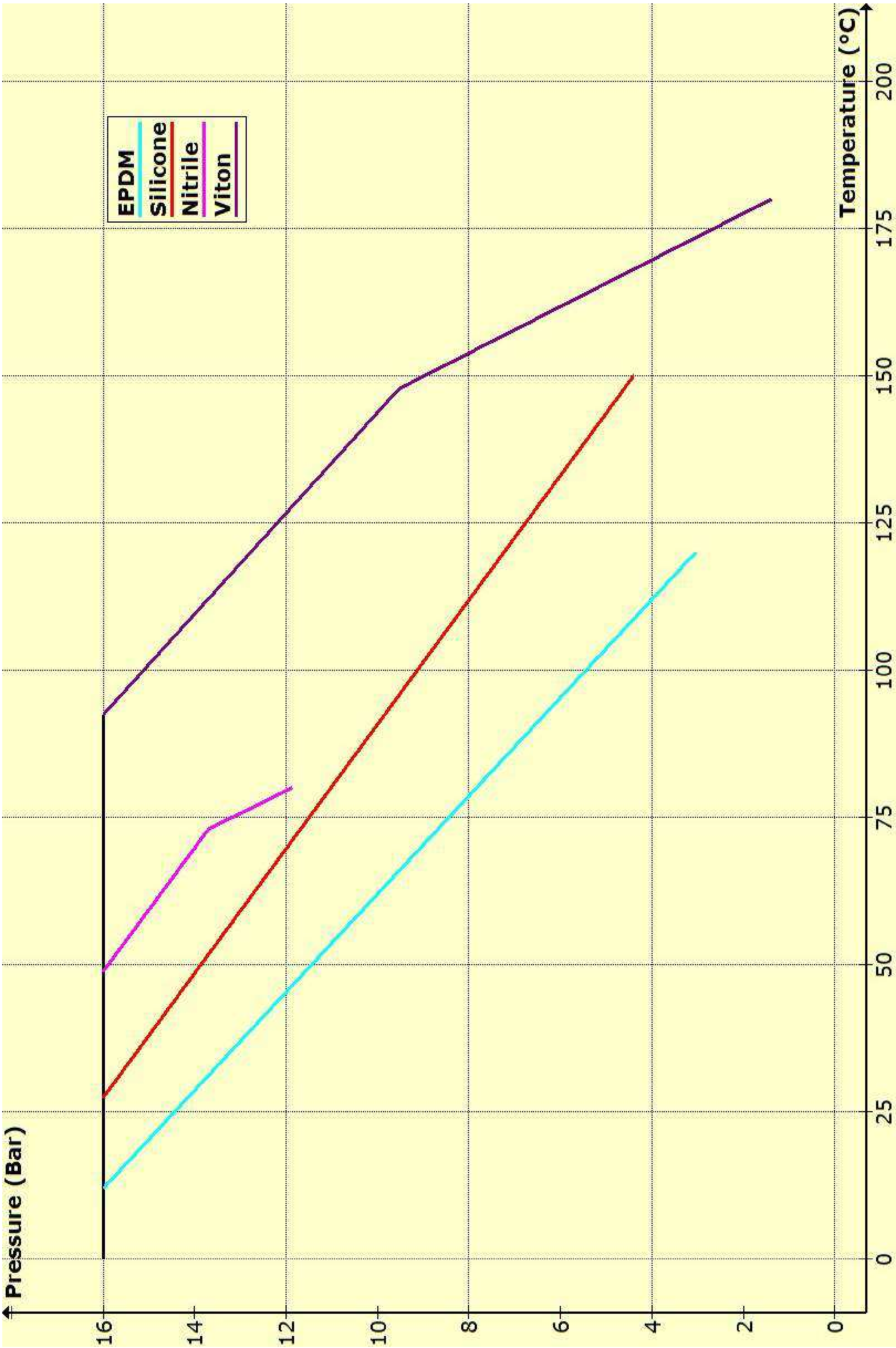
2.1. Temperature Limitations.

For intermittent operation it is permissible to extend the maximum operating temperature in accordance with the following table:

Table 4. Norval Temperature Limitations.

Diaphragm Material	Normal Working Temperature	Maximum Peak Temperature
Fluorocarbon	180°C	200°C
Silicone	150°C	180°C
Nitrile	80°C	100°C
EPDM	120°C	150°C

Chart 9: Pressure/Temperature Ratings



3.0 Limiting Operation Conditions.

Table 5 is a guide to the maximum flowrate for the various size Norvals for water and air duty.

The flowrates are based on the maximum pipe velocities for water and air at entry of 3 m/s and 12 m/s respectively.

Table 5. Maximum Flowrates for Water and Air

Norval Size		Flowrates	
Inch	Metric	Water – l/s	Air – Nm³/h
½	DN15	0.38	4.8
¾	DN20	0.91	11.4
1	DN25	1.50	12.1
1¼	DN32	2.40	32.5
1½	DN40	3.80	48.8
2	DN50	6.00	81.4
2½	DN65	9.80	130.3
3	DN80	13.60	195.4
4	DN100	24.20	342
5	DN125	38.60	521
6	DN150	55.30	765
8	DN200	98.50	1368

Certain pipeline velocities for various fluids have been recommended and these are:

Water and oil	2.75 m/s
Process gas	9-12 m/s
Air	15-23 m/s

It can be seen that the recommended pipeline velocity for air is higher than that recommended for the Norval and that is the reason why in certain cases the Norval is unsuitable.

4.0 Low Temperature Limitations.

Table 6 gives the low temperature limitations of Norval diaphragms. However, it must be borne in mind that the performance of the elastomer at low temperatures will be impaired relative to room or elevated temperatures.

Caution should be exercised in specifying Norval for such duties – especially with potentially hazardous fluids.

Table 6. Low Temperature Limitations

Diaphragm Material	Minimum Operating Temperature
EPDM	-40°C
Nitrile	-10°C
Viton	0°C
Silicone	-50°C

5.0 Norval Diaphragm Storage/Shelf Life.

Diaphragms should be stored away from direct light and protected from extremes of temperature. They should not be allowed to come into contact with ozone, for example from electrical machinery, as this can degrade rubber diaphragms.

To ensure diaphragms are in good condition when installed they should not be stored for longer than the periods shown in Table 7.

Table 7. Diaphragm Shelf Life

Grade	Max. Storage Period at 20°C
Viton (3)	Indefinite (at least 8 years)
Nitrile (6)	15 Years
EPDM (7)	15 Years
Silicone (4)	Indefinite (at least 8 years)

6.0 Limitations on Usage of Synthetic Rubber Diaphragms.

In view of the problems experienced with permanent set and stress relaxation in synthetic rubber diaphragms, please observe the limitations to their use as shown in Table 8, below. The times in days stated in the table are the maximum continuous periods for valves to be in the “open” or “flow” mode.

It is accepted that these limitations are somewhat arbitrary and represent an oversimplification of a very complex phenomenon. One point that should be borne in mind is that, an operating cycle consisting of prolonged periods “open” followed by short periods “closed”, can have a cumulative effect on the set of the diaphragm. For example: the set produced during the first “open” period is not completely reversed at the first closure, and during the second and subsequent “open” periods the initial degree of set will be added, until a point may be reached where the valve fails to close when required. The ideal situation therefore is one in which the “open” and “closed” periods are of similar length.

Table 8. Minimum Frequency of Operation

Temperature °C		
0-50	50-100	Above 100
7 days	3 days	1 day

Note: 1 day = 24 hours.

7.0 Norval Type CD/M - Module Pressure Drop.

To obtain the pressure drop across a CD/M module:

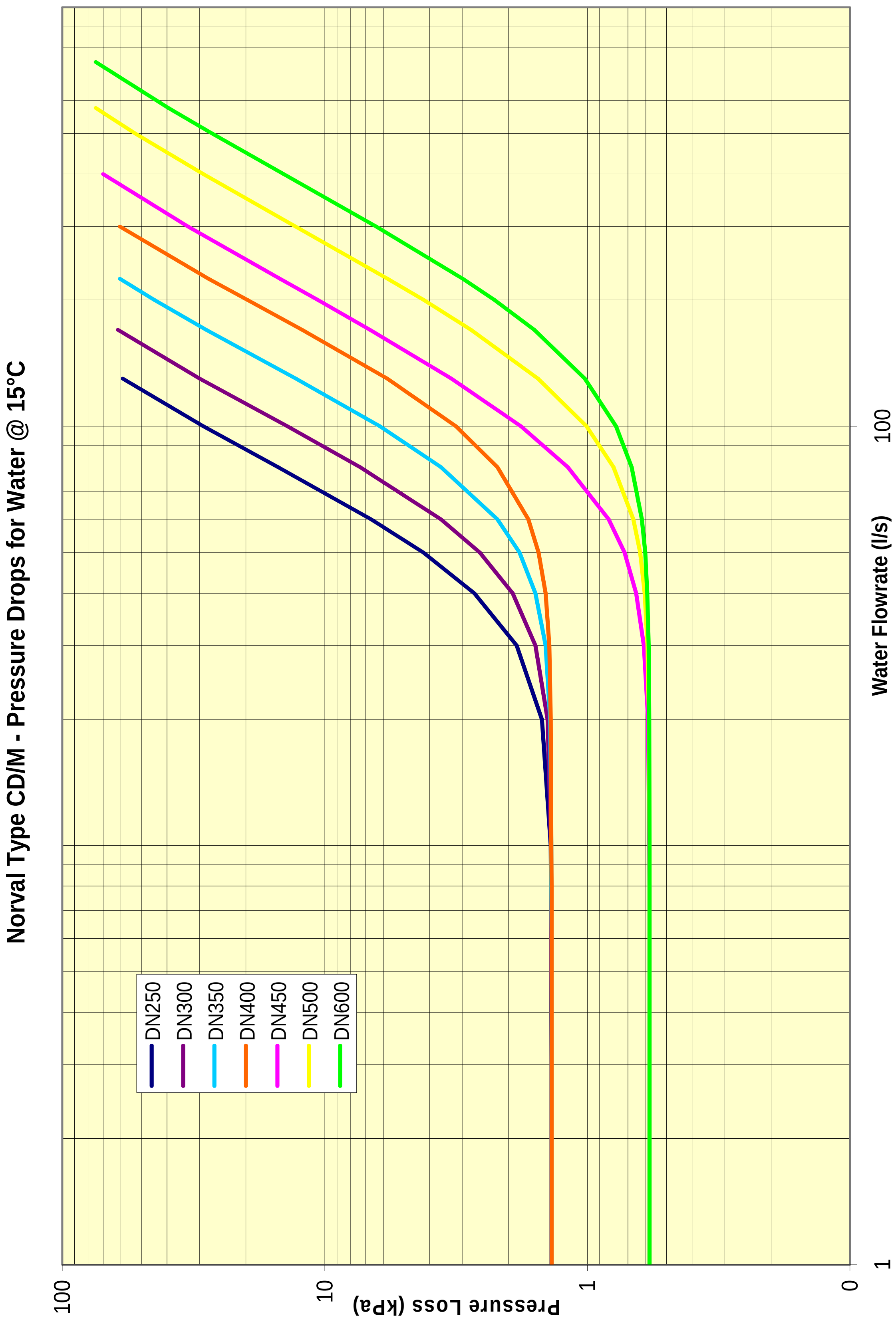
- i) Divide the flowrate by the number of cones in the centre plate. (See Table 9 for cone numbers).
- ii) Look up the pressure drop for DN100 or DN200 Norval (as appropriate) on the pressure loss graph (Chart 6 or Chart 8) for this flowrate.
- iii) Multiply the pressure drop by 1.3 to give the pressure drop for the module.

Table 9. Norval Type CD/M – Number / Size of Cones

Type CD/M Size	Number / Size of Cones
250	7 off / DN100
300	9 off / DN100
350	12 off / DN100
400	16 off / DN100
450	5 off / DN200
500	7 off / DN200
600	9 off / DN200

An inferred pressure drop chart for Norval type CD/M in sizes 250 to 600 with water at 15°C and EPDM diaphragms is shown in below.

Chart 10: Pressure Loss - CD/M Modules



8.0 Cracking Pressure for Norval

The Norval requires a certain pressure, depending on valve size, to initiate opening the valve. This pressure is referred to as the cracking pressure and is defined as the pressure drop to just overcome the natural resistance of the rubber causing sealing. Table 10 is a guide to the cracking pressure for each size of Norval and diaphragm material, tested on air – the pressure to give a steady flow of bubbles.

Table 10. Norval Cracking Pressures

Valve Size		Cracking Pressure kPa	
Inch	Metric	EPDM	Nitrile, Viton & Silicone
½"	DN15	10	14
¾"	DN20	10	14
1"	DN25	10	14
1¼"	DN32	10	14
1½"	DN40	10	14
2"	DN50	6	9
2½"	DN65	3	4
3"	DN80	3	4
4"	DN100	2	2
5"	DN125	4	6
6"	DN150	1	1
8"	DN200	1	1

9.0 The General Chemical Resistance of Various Elastomers

The following pages are offered as General Guide and indication of the suitability of various elastomers in use today for service in these chemicals and fluids.

The ratings are based, for most part on published literature of various polymer suppliers and rubber manufacturers; we cannot guarantee their accuracy nor assume responsibility for their use. Several factors must always be considered in using a rubber part in service.

The most important factors are temperature, pressure, concentration of the liquids and the environment in which elastomers are used. If in doubt, Northvale's Technical Department will be pleased to assist you on receipt of full details of your requirements.

If column is left blank then we have no data or insufficient evidence to make an assessment.

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Acetaldehyde	🔴	🔴	🟢	🟢
Acetamide	🟡	🟢	🟢	🟡
Acetic Acid (30%)	🟡	🟡	🟢	🟢
Acetic Acid (hot, high pressure)	🔴	🔴	🟠	🟠
Acetic Acid Glacial	🔴	🟠	🟡	🟡
Acetic Anhydride	🔴	🔴	🟡	🟠
Acetone	🔴	🔴	🟢	🟡
Acetophenone	🔴	🔴	🟢	🔴
Acetyl Acetone	🔴	🔴	🟢	🔴
Acetyl Chloride	🟢	🔴	🔴	🟠
Acetylene	🟢	🟡	🟢	🟡
Acetylene Tetrabromide	🟢	🔴	🟢	
Adipic Acid		🟢		
Air (below 150°C)	🟢	🟡	🟡	🟢
Air (above 150°C)	🟢	🔴	🔴	🟢
Alkazene	🟡	🔴	🔴	🔴
Alum NH_3CrK (tanning solution)	🔴	🟢	🟢	🟢
Aluminium Acetate	🔴	🟡	🟢	🔴
Aluminium Bromide	🟢	🟢	🟢	🟢
Aluminium Chloride	🟢	🟢	🟢	🟡
Aluminium Fluoride	🟢	🟢	🟢	🟡
Aluminium Nitrate	🟢	🟢	🟢	🟡
Aluminium Phosphate	🟢	🟢	🟢	🟢
Aluminium Sulphate	🟢	🟢	🟢	🟢
Ammonia Anhydrous Liquid	🔴	🟡	🟢	🟠
Ammonia Gas Cold	🔴	🟢	🟢	🟢
Ammonia Gas Hot	🔴	🔴	🟡	🟢
Ammonia & Lithium Metal in Solution	🔴	🟡	🟡	🔴
Ammonium Carbonate		🔴	🟢	
Ammonium Chloride	🟢	🟢	🟢	
Ammonium Hydroxide (concentrated)	🟡	🔴	🟢	🟢
Ammonium Nitrate		🟢	🟢	
Ammonium Nitrite		🟢	🟢	🟡
Ammonium Persulphate Solution		🔴	🟢	
Ammonium Phosphate		🟢	🟢	🟢
Ammonium Phosphate Mono Basic		🟢	🟢	🟢
Ammonium Sulphate	🟢	🟢	🟢	🟢
Ammonium Sulphide	🔴	🟢	🟢	
Amyl Acetate	🔴	🔴	🟢	🔴
Amyl Alcohol	🟡	🟡	🟢	🔴
Amyl Borate	🟢	🟢	🔴	
Amyl Chloride	🟢	🔴	🔴	🔴
Amyl Chloranaphthalene	🟢	🔴	🔴	🔴
Amyl Naphthalene	🟢	🔴	🔴	🔴
Anhydrous Ammonia	🔴	🟡	🟢	🟡
Anhydrous Hydrazine	🔴	🔴	🟡	
Anhydrous Hydrogen Fluoride	🔴	🔴	🟢	
Aniline	🟠	🔴	🟡	
Aniline Dyes	🟡	🔴	🟡	🟠
Aniline Hydrochloride	🟡	🟡	🟡	🔴
Aromatic Fuel (50%)	🟢	🟡	🔴	🔴
Arsenic Acid	🟢	🟢	🟢	🟢
Askarel	🟢	🟡	🔴	🔴

🟢 Recommended. 🟡 Minor/moderate effect 🟠 Moderate/severe effect 🔴 Not recommended.

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Asphalt	🟢	🟡	🔴	🔴
ASTM Oil #1	🟢	🟢	🔴	🟢
Automatic Transmission Fluid	🟢	🟢	🔴	🔴
Automatic Brake Fluid	🔴	🟠	🟢	🟠
Barium Chloride	🟢	🟢	🟢	🟢
Barium Hydroxide	🟢	🟢	🟢	🟢
Barium Sulphate	🟢	🟢	🟢	🟢
Barium Sulphide	🟢	🟢	🟢	🟢
Beer	🟢	🟢	🟢	🟢
Beet Sugar Liquors	🟢	🟢	🟢	🟢
Benzaldehyde	🔴	🔴	🟢	🔴
Benzene	🟢	🔴	🔴	🔴
Benzenesulphonic Acid	🟢	🔴	🔴	🔴
Benzine	🟢	🟢	🔴	🔴
Benzochloride	🟢	🔴	🟢	
Bezoic Acid	🟢	🔴	🔴	🟡
Benzophenone	🟢		🟡	
Benzyl Alcohol	🟢	🔴	🟡	
Benzyl Benzoate	🟢	🔴	🟡	
Benzyl Chloride	🟢	🔴	🔴	🔴
Black Sulphate Liquor	🟢	🟡	🟡	🟡
Blast Furnace Gas	🟢	🔴	🔴	🟢
Bleach Solutions	🟢	🔴	🟢	🟡
Borax	🟢	🟡	🟢	🟡
Boric Acid	🟢	🟢	🟢	🟢
Brake Fluid (non-petroleum)	🔴	🟠	🟢	🟠
Brine		🟢	🟢	
Bromine	🟢	🔴	🔴	🔴

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Bromine Anhydrous	🟢			🟠
Bromine Water	🟢	🔴	🔴	🔴
Biomobenzene	🟢	🔴	🔴	🔴
Bromchloro Trifluoroethane	🟢	🔴	🔴	🔴
Bunker Oil	🟢	🟢	🔴	🟡
Butadiene	🟡	🔴	🟠	🔴
Butane	🟢	🟢	🔴	🔴
Butanol (Butyl Alcohol)	🟢	🟢	🟡	🟡
Butter	🟢	🟢	🟢	🟡
Butyl Acetate	🔴	🔴	🟡	🔴
Butyl Acrylate	🔴	🔴	🔴	🔴
Butyl Amine	🔴	🟠	🔴	🟡
Butyl Benzoate	🟢	🔴	🟢	
Butyl Butyrate	🟢	🔴	🟢	
Butyl Carbitol	🟠	🟡	🟢	🔴
Butyl Oleate	🟢	🔴	🟡	
Butyl Stearate	🟢	🟡	🟡	
Butylene	🟢	🟡	🔴	🔴
Calcium Acetate	🔴	🟡	🟢	🔴
Calcium Bisulphite	🟢	🟢	🔴	🟢
Calcium Carbonate	🟢	🟢	🟢	🟢
Calcium Chloride	🟢	🟢	🟢	🟢
Calcium Cyanide		🟢	🟢	🟢
Calcium Hydroxide	🟢	🟢	🟢	🟢
Calcium Hypochloride	🟢	🔴	🟢	
Calcium Hypochlorite	🟢	🟠	🟢	🟡
Calcium Nitrate	🟢	🟢	🟢	🟢
Calcium Phosphate	🟢	🟢	🟢	🟢

🟢 Recommended. 🟡 Minor/moderate effect 🟠 Moderate/severe effect 🔴 Not recommended.

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Calcium Silicate	● green	● green	● green	
Calcium Sulphide	● green	● yellow	● green	● yellow
Calcium Sulphite	● green	● green	● green	● green
Calcium Thiosulphate	● green	● yellow	● green	● green
Cane Sugar Liquor	● green	● green	● green	● green
Carbolic Acid	● green	● red	● yellow	● red
Carbon Bisulphide	● green	● orange	● red	
Carbon Dioxide (dry)	● yellow	● green	● yellow	● yellow
Carbon Dioxide (wet)	● yellow	● green	● yellow	● yellow
Carbon Disulphide	● green	● red	● red	
Carbon Monoxide	● green	● green	● green	● green
Carbon Tetrachloride	● green	● orange	● red	● red
Carbonic Acid	● green	● yellow	● green	● green
Castor Oil	● green	● green	● yellow	● green
China Wood Oil (Tung Oil)	● green	● green	● red	● red
Chlorinated Salt Brine	● green	● red	● red	● red
Chlorine (dry)	● green	● red	● green	● red
Chlorine (wet)	● green	● red	● orange	
Chlorobenzene	● green	● red	● red	● red
Chlorobromo Methane	● yellow	● red	● yellow	● red
Chloroform	● green	● red	● red	● red
Chrome Plating Solution	● green	● red	● red	● yellow
Chromic Acid	● green	● red	● orange	● orange
Circo Light Process Oil	● green	● green	● red	● red
Citric Acid	● green	● green	● green	● green
Cobalt Chloride	● green	● green	● green	● yellow
Cobalt Chloride, 2N	● green	● green	● green	● green
Coconut Oil		● green	● green	● green

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Cod Liver Oil	● green	● green	● green	● yellow
Coke Oven Gas	● green			● yellow
Copper Acetate		● yellow	● green	
Copper Chloride	● green	● green	● green	● green
Copper Cyanide	● green	● green	● green	● green
Copper Sulphate	● green	● green	● green	● green
Corn Oil	● green	● green	● orange	● green
Cottonseed Oil	● green	● green	● green	● green
Creosote	● green	● yellow	● red	● red
Cresol	● green	● orange	● red	
Cresylic Acid	● green	● orange		
Cumene	● green			
Cyclohexane	● green	● green	● red	● red
Cyclohexanol	● green	● yellow	● red	● red
Cyclohexanone	● red	● red	● yellow	● red
P Cymene	● green			
Denatured Alcohol	● green	● green	● green	● green
Detergent Solutions	● green	● green	● green	● green
Developing Fluids	● green	● green	● yellow	● green
Diacetone	● red	● red	● green	
Diacetone Alcohol		● red	● green	● green
Dibenzyl Ether		● red	● yellow	
Dibutyl Ether	● orange	● orange	● orange	● red
Dibutyl Phthalate	● yellow	● red	● green	● yellow
Dibutyl Sebecate	● yellow	● red	● yellow	● yellow
O Dichlorobenzene	● green	● red	● red	● red
Dichloro-isopropyl Ether	● orange	● red	● orange	● red
Dicyclohexamine		● orange		

● green Recommended. ● yellow Minor/moderate effect ● orange Moderate/severe effect ● red Not recommended.

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Diesel Oil	🟢	🟢	🔴	🔴
Diethlamine	🔴	🟠	🟡	🟡
Diethyl Benzene	🟢	🔴	🔴	🔴
Diethyl Ether	🔴	🔴	🔴	🔴
Diethylene Glycol	🟢	🟢	🟢	🟡
Diethyl Sebecate	🟡	🔴	🟡	🟡
Diisobutylene	🟢	🟡		🔴
Diisopropyl Benzene	🟢	🔴	🔴	
Diisopropyl Ketone	🔴	🔴	🟢	
Dimethyl Aniline	🔴		🟡	
Dimethyl Formamide	🔴	🟡		🟡
Dimethyl Phthalate	🟡	🔴	🟡	
Dinitrotoluene	🟠	🔴	🔴	
Dicotyl Phthalate	🟡		🟡	🟠
Diocyl Sebecate	🟡	🔴	🟡	🟠
Dioxane			🟡	
Dioxolune		🔴	🟡	
Dipentene	🟢	🟡		
Diphenyl	🟢			
Diphenyl Oxides	🟢		🟢	🟠
Dowtherm Oil	🟢		🔴	🟡
Dry cleaning fluids	🟢	🟠	🔴	
Epichlorochydrin	🔴		🟡	
Ethane	🟢	🟢	🔴	🔴
Ethanolamine	🔴	🟡	🟡	🟡
Ethyl Acetate	🔴	🔴	🟡	🟡
Ethyl Acetotate	🔴	🔴	🟡	🟡
Ethyl Acrylate	🔴		🟡	🟡

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Ethyl Alcohol	🟢	🟢	🟢	🟢
Ethyl Benzene	🟢	🔴	🔴	
Ethyl Benzoate	🟢		🟡	
Ethyl Cellosolve	🔴		🟡	
Ethyl Cellulose	🔴	🔴	🟡	🟠
Ethyl Chloride	🟢	🟢	🟢	🔴
Ethyl Chlorocarbonate	🟢			
Ethyl Chloroformate	🟢			
Ethyl Ether	🔴	🟠	🟠	
Ethyl Formate	🟢	🔴	🟡	
Ethyl Mercaptan	🟢	🔴	🔴	
Ethyl Oxalate	🟢	🔴	🟢	
Ethyl Pentochlorobenzene	🟢	🟠	🔴	
Ethyl Silicate	🟢	🟢	🟢	
Ethylene	🟢	🟢		
Ethylene Chloride	🟢		🟠	
Ethylene Chlorohydrin	🟢	🔴		🟠
Ethylene Diamine	🔴	🟢	🟢	🟢
Ethylene Dichloride	🟢	🔴	🟠	🟠
Ethylene Glycol	🟢	🟢	🟢	🟢
Ethylene Oxide	🔴	🔴	🟠	🟠
Ethylene Trichloride	🔴	🔴	🟠	🟠
Fatty Acids	🟢	🟡	🔴	🟠
Ferric Chloride	🟢	🟢	🟢	🟢
Ferric Nitrate	🟢	🟢	🟢	🟠
Ferric Sulphate	🟢	🟢	🟢	🟡
Fish Oil	🟢	🟢		🟢
Fluoroboric Acid		🟢	🟢	

🟢 Recommended. 🟡 Minor/moderate effect 🟠 Moderate/severe effect 🔴 Not recommended.

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Fluorine (liquid)	🟡		🟠	🔴
Fluorobenzene	🟢	🔴	🔴	🔴
Flurocarbon Oil			🟢	
Fluorlube	🟡	🟢	🟢	
Fluorinated Cycline Ester			🟢	
Fluosilicic Acid		🟢		
Formaldehyde	🟢	🟡	🟢	
Formic Acid	🟠	🟡	🟢	🟡
Freon 11	🟢	🟢	🔴	🔴
Freon 12	🟡	🟢	🟡	🔴
Freon 21	🔴	🔴	🔴	🔴
Freon 32	🟠	🟢	🟢	
Fuel Oil	🟢	🔴	🔴	🔴
Fumaric Acid	🟢	🟢		🟡
Futon, Furfuran		🔴	🟠	
Fufural	🔴	🔴	🟡	
Gallic Acid	🟢	🟡	🟡	
Gasoline	🟢	🟢	🔴	🔴
Gelatin	🟢	🟢	🟢	🟢
Glauber’s Salt	🟢		🟡	
Glucose	🟢	🟢	🟢	🟢
Glue	🟢	🟢	🟢	🟢
Glycorin	🟢	🟢	🟢	🟢
Glycois	🟢	🟢	🟢	🟢
Green Sulphate Liquor	🟢	🟡	🟢	🟢
N Hexaldehyde		🔴	🟢	🟡
Hexane	🟢	🟢	🔴	🔴
N Hexene 1	🟢	🟡	🔴	🔴

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Hexyl Alcohol	🟢	🟢	🟠	🟡
Hydrazine		🟡	🟢	🟠
Hydraulic Oil (Petroleum)	🟢	🔴	🔴	🟠
Hydrobromic Acid	🟢	🔴	🟢	🔴
Hydrochloric Acid (hot - 37%)	🟢	🔴	🟠	🔴
Hydrochloric Acid (cold - 37%)	🟢	🟡	🟢	🟡
Hydrocyanic Acid	🟢	🟡	🟢	
Hydrofloric Acid (concentrated hot)	🟡	🔴	🔴	🔴
Hydrofloric Acid (concentrated cold)	🟢	🔴	🟡	🔴
Hydrofloric Acid Anydrous			🟡	🔴
Hydrofluosilicic Acid	🟢	🟡	🟢	🔴
Hydrogen Gas	🟢	🟢	🟢	🟠
Hydrogen Peroxide (90%)	🟡	🔴	🟠	🟢
Hydrogen Sulfide (wet - cold)	🔴	🔴	🟢	🟠
Hydrogen Sulfide (wet - hot)	🔴	🔴	🟢	🟠
Hydroquinone	🔴	🟠		
Hydrochlorous Acid	🟢	🔴	🟡	
Iodine Pentafluoride	🔴	🔴	🔴	🔴
Iodoform			🟢	
Isobutyl Alcohol	🟢	🟡	🟢	🟢
Isooctane	🟢	🟢	🔴	🔴
Isophorone	🔴	🔴	🟢	
Isopropyl Acetate	🔴	🔴	🟢	
Isopropyl Alcohol	🟢	🟡	🟢	🟢
Isopropyl Chloride	🟢	🔴	🔴	
Isopropyl Ether	🔴	🟡	🔴	
Kerosene	🟢	🟢	🔴	🔴

🟢 Recommended. 🟡 Minor/moderate effect 🟠 Moderate/severe effect 🔴 Not recommended.

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Lacquers	🔴	🔴	🔴	🔴
Lacquer Solvents	🔴	🔴	🔴	🔴
Lactic Acid	🟢	🟢	🟢	🟢
Lard	🟢	🟢	🔴	🟡
Lavender Oil	🟢	🟡	🔴	
Lead Acetate		🟡	🟢	🔴
Lead Nitrate		🟢	🟢	🟡
Lead Sulfamate	🟢	🟡	🟢	🟡
Lime Bleach	🟢	🟢	🟢	🟡
Lime Sulphur	🟢	🔴	🟢	🟢
Lindol	🟡		🟢	🟠
Linoleic Acid	🟡	🟡	🔴	🟡
Linseed Oil	🟢	🟢	🟡	
Liquefied Petroleum Gas	🟢	🟢	🔴	🟠
Lubricating Oils (Petroleum)	🟢	🟢	🔴	🔴
Lye	🟡	🟡	🟢	🟡
Magnesium Chloride	🟢	🟢	🟢	🟢
Magnesium Hydroxide	🟢	🟡	🟢	
Magnesium Sulfate	🟢	🟢	🟢	🟢
Maleic Acid	🟢		🟠	
Malic Acid	🟢	🟢	🔴	🟡
Mercury Chloride	🟢	🟢	🟢	
Mercury	🟢	🟢	🟢	
Methane	🟢	🟢	🔴	🔴
Methyl Acetate	🔴	🔴	🟡	
Methyl Acrylic	🔴	🔴	🟡	
Methylacrylic Acid	🟡		🟡	
Methyl Alcohol	🟠	🟢	🟢	🟢

Methyl Bromide	🟢	🟡		
Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Methyl Butyl Ketone	🔴	🔴	🟢	🟡
Methyl Cellosolve	🔴		🟡	
Methyl Chloride	🟢	🔴	🟠	🔴
Methyl Cyclopentane	🟢		🔴	
Methylene Chloride	🟡	🔴	🔴	
Methyl Ethyl Ketone	🔴	🔴	🟢	
Methyl Formate		🔴	🟡	🟡
Methyl Isobutyl Ketone	🔴	🔴	🟠	🟠
Methyl Methacrylate	🔴	🔴	🔴	🟠
Methyl Oleate	🟢	🔴	🟡	
Methyle Salicylate			🟡	
Milic	🟢	🟢	🟢	🟢
Mineral Oil	🟢	🟢	🔴	🟡
Monochlorobenzene	🟢	🔴	🔴	🔴
Monomethyl Aniline	🟡	🔴		
Monoethanolamine	🔴	🔴	🟡	🟡
Monomethyl Ether		🟢	🟢	
Monovinyl Acetylene	🟢	🟢	🟢	🟡
Mustard Gas			🟢	🟢
Naptha	🟢	🟠	🔴	🔴
Napthalene	🟢	🔴	🔴	🔴
Napthenic Acid	🟢	🟡	🔴	
Natural Gas	🟢	🟢	🔴	🟢
Neatsfoot Oil	🟢	🟢	🟡	🟡
Nickel Acetate	🔴	🟡	🟢	
Nickel Chloride	🟢	🟢	🟢	🟢
Nickel Sulfate	🟢	🟢	🟢	🟢

🟢 Recommended. 🟡 Minor/moderate effect 🟠 Moderate/severe effect 🔴 Not recommended.

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Nitric Acid (concentrated)	Green	Red	Orange	Red
Nitric Acid (dilute)	Green	Red	Yellow	Yellow
Nitric Acid Red Fuming	Orange	Red	Red	Red
Nitrobenzene	Yellow	Red	Red	Red
Nitrobenzine	Green		Orange	
Nitroethane	Red	Red	Yellow	Red
Nitromethane	Red	Red	Yellow	Red
Nitrogen	Green	Green	Green	Green
Nitrogen Tetroxide	Red	Red	Orange	Orange
Octadecane	Green	Green	Red	Red
N-Octane	Green		Red	Red
Octachlorctoluene	Green	Red	Red	Red
Octyl Alcohol	Green	Yellow	Green	Yellow
Oleic Acid	Yellow	Orange	Yellow	
Oleum Spirits	Green	Yellow		
Olive Oil	Green	Green	Yellow	Red
O Dichlorobenzene	Green	Red		
Oxalic Acid	Green	Yellow	Green	Yellow
Oxygen (cold)	Green	Yellow	Green	Green
Oxygen (95°C – 180°C)	Yellow	Red	Red	Yellow
Ozone	Green	Red	Green	Green
Paint Thinners, Duco	Yellow		Red	
Palmatic Acid	Green	Green	Yellow	
Peanut Oil	Green	Green	Orange	Green
Perchloric Acid	Green		Yellow	Red
Perchloroethylene	Green	Orange	Red	Yellow
Petroleum (below 120°C)	Green	Red	Red	Yellow
Petroleum (above 120°C)	Yellow	Red	Red	Red

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Phenol	Green		Yellow	Orange
Phenyl Benzene	Green	Red	Red	
Phenyl Ethyl Ether		Red	Red	
Phenyl Hydrazine	Green	Red	Orange	
Phosphoric Acid (20%)	Green	Yellow	Green	
Phosphoric Acid (45%)	Green	Red	Yellow	Red
Phosphorous Trichloride	Green	Red	Green	
Pickling Solution	Yellow		Orange	
Pine Oil	Green	Yellow	Red	
Plating Solution Chrome	Green		Green	Red
Polyvinyl Acetate Emulsion			Green	
Potassium Acetate	Red	Yellow	Green	
Potassium Chloride	Green	Green	Green	Green
Potassium Cupro Cyanide	Green	Green	Green	Green
Potassium Cyanide	Green	Green	Green	Green
Potassium Dichromate	Green	Green	Green	Green
Potassium Hydroxide	Yellow	Yellow	Green	Orange
Potassium Nitrate	Green	Green	Green	Green
Potassium Sulphate	Green	Green	Green	Green
Producer Gas	Green	Green	Red	Yellow
Propane	Green	Green	Red	Red
Propyl Acetate	Red	Red	Yellow	
N-Propyl Acetate	Red	Red	Green	
Propyl Alcohol	Green	Green	Green	Green
Propyl Nitrate	Red		Yellow	Orange
Propylene	Green	Red	Red	
Propylene Oxide			Yellow	Red
Pyranol	Green	Green	Red	Yellow

Green: Recommended. Yellow: Minor/moderate effect. Orange: Moderate/severe effect. Red: Not recommended.

Pyridine	🔴	🔴	🟡	
Fluid	**Diaphragm Material**			
	Viton	**Nitrile**	**EPDM**	**Silicone**
Rape Seed Oil	🟢	🟡	🟢	🔴
Red Oil	🟢	🟢	🔴	🔴
Salicylic Acid	🟢	🟢	🟢	
Salt Water	🟢	🟢	🟢	
Sewage	🟢	🟢	🟡	🟡
Silicate Esters	🟢	🟡	🔴	🔴
Silicone Greases	🟢	🟢	🟢	🟠
Silicone Oils	🟢	🟢	🟢	🟠
Silver Nitrate	🟢	🟡	🟢	🟢
Soap Solutions	🟢	🟢	🟢	🟢
Soda Ash	🟢	🟢	🟢	🟢
Sodium Acetate	🔴	🟡	🟢	
Sodium Bicarbonate	🟢	🟢	🟢	🟢
Sodium Bisulphite	🟢	🟢	🟢	🟢
Sodium Borate	🟢	🟢	🟢	🟢
Sodium Chloride	🟢	🟢	🟢	🟢
Sodium Cyanide	🟢	🟢	🟢	🟢
Sodium Hydroxide	🟡	🟡	🟢	🟡
Sodium Hypochlorite	🟢	🟡	🟡	🟡
Sodium Metaphosphate	🟢	🟢	🟢	
Sodium Nitrate		🟡	🟢	🔴
Sodium Perborate	🟢	🟡	🟢	🟡
Sodium Peroxide	🟢	🟡	🟢	🔴
Sodium Phosphate	🟢	🟢	🟢	🔴
Sodium Silicate	🟢	🟢	🟢	
Sodium Sulphate	🟢	🟢	🟢	🟢
Sodium Thiosulfate	🟢	🟡	🟢	🟢

Soybean Oil	🟢	🟢	🟠	🟢
Fluid	**Diaphragm Material**			
	Viton	**Nitrile**	**EPDM**	**Silicone**
Stannic (ous) Chloride	🟢	🟢	🟡	🟡
Steam (below 150°C)	🔴	🔴	🟢	🔴
Steam (above 150°C)	🔴	🔴	🟡	🔴
Stearic Acid		🟡	🟡	🟢
Styrene	🟡	🔴	🔴	🔴
Sucrose Solution		🟢	🟢	
Sulphite Liquors	🟢	🟡	🟡	🔴
Sulphur	🟢	🔴	🟢	🟢
Sulphur Chloride	🟢	🟠	🔴	
Sulphur Dioxide	🟢	🔴	🟢	🟢
Sulphur Hexafluoride	🟢	🟢	🟢	🟢
Sulphur Trioxide	🟢	🔴	🟡	🟡
Sulphuric Acid (dilute)	🟢	🔴	🟡	🔴
Sulphuric Acid (concentrated)	🟢	🔴	🟡	🔴
Sulphuric Acid (20% Oleum)	🟢	🔴	🔴	🔴
Sulphurous Acid	🟢	🟡	🟡	🔴
Tannic Acid	🟢	🟢	🟢	🟡
Tar, Bituminous	🟢	🟡	🔴	🟡
Tartaric Acid	🟢	🟢	🟡	🟢
Terpineol	🟢	🟡	🟠	
Tertiary Butyl Alcohol	🟢	🟡	🟡	🟡
Tetrabromomethane	🟢	🔴	🔴	
Tetrabutyl Titanate	🟢	🟡	🟢	
Tetrachloroethylene	🟢	🔴	🔴	
Tetraethyl Lead	🟢	🟡	🔴	
Tetrahydrofuran	🔴		🟡	
Tetralin	🟢	🔴	🔴	

🟢 Recommended. 🟡 Minor/moderate effect 🟠 Moderate/severe effect 🔴 Not recommended.

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Thionyl Chloride	● (green)		● (red)	
Titanium Tetrachloride	● (green)	● (orange)	● (red)	
Toluene	● (green)	● (red)	● (red)	● (red)
Toluene Diisocyanate			● (green)	
Transformer Oil	● (green)	● (green)	● (red)	● (yellow)
Transmission Fluid Type A	● (green)	● (green)	● (red)	● (yellow)
Triacetin	● (red)	● (yellow)	● (green)	
Tributoxy Ethyl Phosphate	● (green)	● (red)	● (green)	
Tributyl Phosphate	● (red)	● (red)	● (green)	
Tributyl Mercapton	● (green)	● (red)	● (red)	
Trichloroethane	● (green)	● (red)	● (red)	● (red)
Trichloroacetic Acid	● (orange)	● (yellow)	● (yellow)	
Trichloroethylene	● (green)	● (orange)	● (red)	● (yellow)
Tricreoyl Phosphate	● (yellow)	● (red)	● (green)	● (orange)
Triethanol Amine	● (red)	● (orange)	● (yellow)	
Triethyl Aluminium	● (yellow)			
Triethyl Borane	● (green)			

Fluid	Diaphragm Material			
	Viton	Nitrile	EPDM	Silicone
Trinitrotoluene	● (yellow)	● (red)	● (red)	
Trioctyl Phosphate	● (yellow)	● (red)	● (green)	● (orange)
Tung Oil	● (green)	● (green)	● (red)	
Turbine Oil	● (green)	● (yellow)	● (red)	
Turpentine	● (green)	● (green)	● (red)	● (red)
Varnish	● (green)	● (green)	● (red)	
Vegetable Oil	● (green)	● (green)	● (green)	● (green)
Vinegar	● (green)	● (yellow)	● (green)	● (green)
Vinyl Chloride	● (green)	● (yellow)		
Water	● (green)	● (green)	● (green)	● (green)
Whiskey, Wines	● (green)	● (green)	● (green)	● (green)
White Pine Oil	● (green)	● (yellow)	● (red)	
Wood Oil	● (green)	● (green)	● (red)	● (red)
Xylene	● (green)	● (red)	● (red)	● (red)
Zinc Acetate	● (red)	● (red)	● (green)	● (red)
Zinc Chloride	● (green)	● (green)	● (green)	
Zinc Sulphate	● (green)	● (green)	● (green)	● (green)

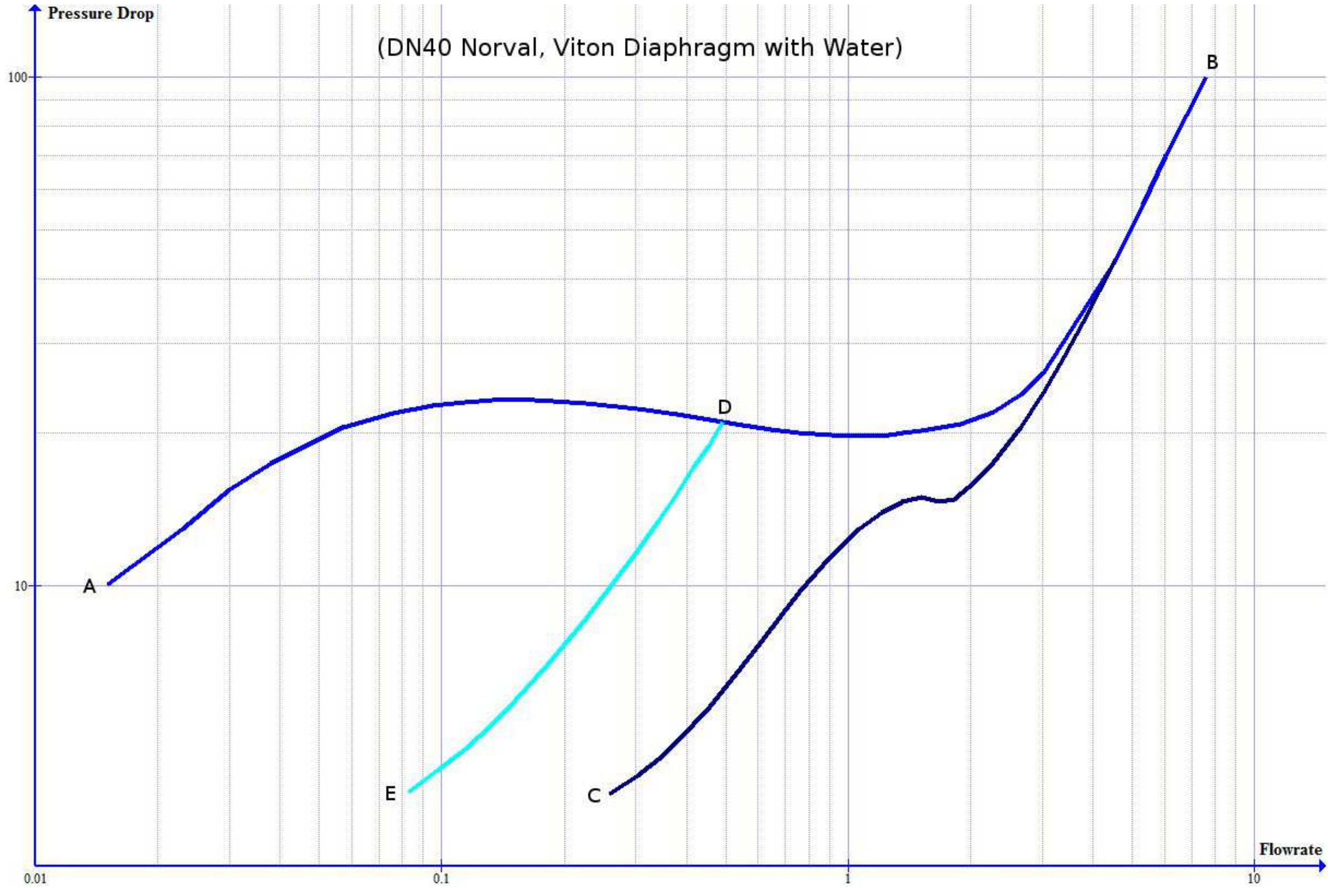
● (green) Recommended. ● (yellow) Minor/moderate effect ● (orange) Moderate/severe effect ● (red) Not recommended.

APPENDIX 1

Valve Hysteresis

The Norval non-return valve fitted with Viton diaphragm exhibits hysteresis as shown below.

Chart 11: Pressure Drop Graph Showing Hysteresis.



Referring to the chart which is derived from tests carried out on a DN40 Norval, the explanation of the various curves is as follows.

Curve ADB

This represents the pressure drops that would be obtained if the flow rate through the valve were increased directly from zero to any set value. The section of the graph where the pressure drop remains constant despite increases in flow rate, corresponds to the increasing deformation of the diaphragm with increasing flow.

The pressure drop through the valve aperture can be represented by the equation:

$$\Delta P = \frac{\rho v^2}{2gC_o^2}\left[\left(\frac{A_p}{A_v}\right)^2 - 1\right]$$

Where ρ = fluid density

v = velocity in adjacent pipeline

A_p = cross sectional area of pipeline

A_v = cross sectional area of valve aperture

C_o = a discharge coefficient

g = gravitational constant

The discharge coefficient C_o is a function of Reynolds number through the valve aperture, but can be taken as a constant, provided the flow through the valve is turbulent.

The value of C_o has been determined for the case of the DN20 valve with a Viton diaphragm, to be 0.84 in turbulent flow and 0.52 in laminar flow. For other sizes this value has yet to be determined.

Since C_o and A_p can be taken as constant for any particular installation the pressure drop depends on v and A_v. It can be seen that any increase in v tends to be compensated by an equal increase in A_v; resulting in the observed valve characteristic.

When the valve is open to its full extent the aperture remains constant despite increasing flow rate, and the curve rises to point B following a more typical characteristic.

Curve BC

This represents the pressure drops obtained when the flow rate is reduced from point B. The pressure drops fall significantly below curve ADB due to the hysteresis in the diaphragm. The diaphragm apparently remains fully deformed, and the valve characteristic is similar to that of an orifice of constant area, (apart from a small horizontal portion). Subsequent variations in flow rate, both upwards and downwards, will follow the same curve, but if the flow rate is reduced to zero and subsequently increased, they return to curve ADB.

Curve DE

If the flow rate is increased from point A to point D and subsequently reduced the characteristic would follow curve DE due to the hysteresis in the diaphragm in its partially deformed state. Curve DE is merely a typical example, and an infinite number of parallel curves are possible. Again, on reducing the flow rate to zero and then increasing it, this would revert to curve ADB.

Practical Significance of Norval Hysteresis

If a valve is selected from the Generalised Pressure Loss Charts the pressure drop actually obtained could, in fact, be significantly lower than indicated by these charts, depending on the method of operation of the installation. For instance, if a flow rate of 0.4 l/s is specified through a DN40 Norval, the pressure drop would be quoted as 0.22 bar. However, by first increasing the flow rate to 0.8 l/s then reducing to 0.4 l/s, a pressure drop of only 0.15 bar could be obtained; or by first increasing to 5 l/s then reducing to 0.4 l/s, a pressure drop of 0.05 bar could be obtained.

Unless the exact conditions of operation are known before specifying the valve, it is virtually impossible to predict precisely what the pressure drop will be, so it is considered prudent to quote the highest value – i.e. that obtained from curve ADB.

APPENDIX 2

Food Quality Norval Diaphragm Rubbers

According to our diaphragm supplier, the definition of the phrase 'food quality' is rather nebulous. There appears to be no hard or fast rules governing what is a food quality rubber but only three types of rubber are generally used within the food industry, following these guide lines:-

For Fatty Foods

Silicone or Nitrile rubber.

For Non-Fatty Foods

Silicone, EPDM or Nitrile rubber.

At present it is Northvale's policy to offer EPDM, because it has WRAS approval, for potable water applications (also extensively used in the brewing industry) and Silicone for food industry applications.

There should be no problem if the best diaphragm material for the application is offered.

Diaphragm Preparation:

It is important, however, that any diaphragm rubber supplied as food quality should be washed thoroughly in distilled water to remove the 'almond' smell of the released agent and packed in a sealed plastic bag.

Up-to-date approval letters from our rubber supplier for EPDM and Silicone are available on request.