TECHNICAL DOCUMENTATION

PRINCIPLES OF PNEUMATICS

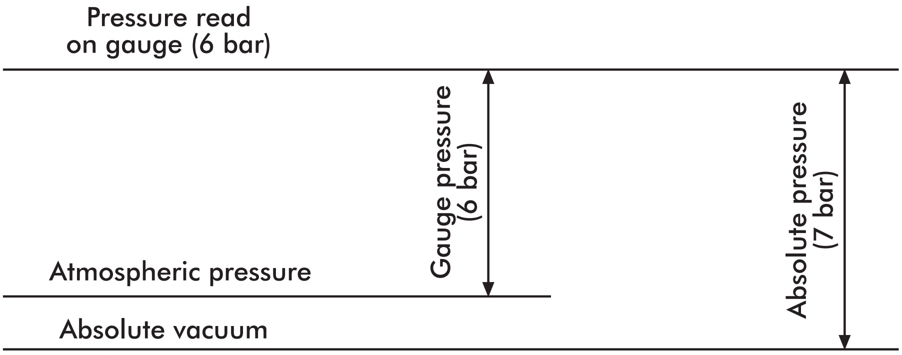
Pressure: The ratio between a force and the surface on which it acts.

$$P = \frac{F\ (N)}{S\ (m^2)} = Pa$$

Atmospheric pressure: Equivalent to the pressure exerted on a surface at sea level at 20°C and with 65% humidity: 10.33 m H_2O; 760 mm Hg; 1.013 x 10^5 Pa.

Absolute pressure: The pressure above the absolute zero value - pressure 0 = absolute vacuum.

Gauge pressure: The pressure referring to ambient atmospheric pressure: it is normally indicated by the pressure gauges used in pneumatic circuits.



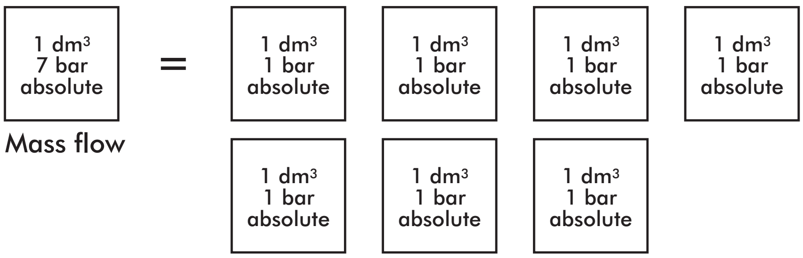
Gauge pressure = (absolute P) - (atmospheric P.)

Upstream pressure: Pressure of the compressed air at the pneumatic component inlet

Downstream pressure: Pressure of the compressed air at the pneumatic component outlet

ΔP pressure drop: Difference between upstream and downstream pressure

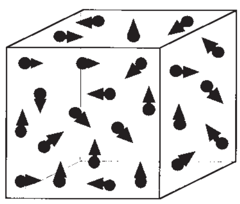
FLOW RATE: The volume of air passing through a given section in a unit of time. In pneumatics, the volume unit of measurement is Nl (Normal litre). In practice it represents the volumetric capacity of the air referring to ambient atmospheric pressure. **E.g.** in a conduit of a given section, there is a mass flow of 1 litre of air (1 dm^3) at 7 bar absolute pressure. This value expressed as volume of air corresponds to 7 litres of air (7 dm^3) at the ambient atmospheric pressure (1 bar).



Volumetric flow rate
(referring to absolute pressure)

- With the same pressure, the flow rate is directly proportional to the port cross section.
- With the same cross section, the pressure is directly proportional to the flow rate.
- Without a ΔP (difference between upstream and downstream pressure), there can be no flow rate.

Pascal's law: A confined fluid transmits externally applied pressure uniformly in all directions.



- Density of air, measured to 20°C to the atmospheric pressure:

$1.275\ \frac{kg}{m^3}$

CALCULATING THE FLOW RATE OF A VALVE USING FLOW COEFFICIENT K_V

Coefficient k_V gives approximate values when used for compressed air.
The flow rate Q_N at a normal volume through a valve is:

Subsonic flow: $P_2 > \frac{P_1}{2}$

$$Q_N = 28{,}6 \cdot k_v \cdot \sqrt{P_2 \cdot \Delta P}\sqrt{\frac{293}{273 + t}}$$

Supersonic flow: $P_2 < \frac{P_1}{2}$

$$Q^*_N = 14{,}3 \cdot k_v \cdot P_1 \cdot \sqrt{\frac{293}{273 + t}}$$

where
Q_N = flow rate at a normal volume [Nl/min]
Q^*_N = critical flow rate at a normal volume [Nl/min]
k_V = hydraulic coefficient in $\frac{l}{min}\left(\frac{kg}{dm^3 \cdot bar}\right)^{1/2}$
P_1 = absolute upstream pressure [bar]
P_2 = absolute downstream pressure [bar]
ΔP = difference in pressure $P_1 - P_2$ [bar]
t = input air temperature [°C]

CALCULATING THE FLOW RATE OF A VALVE USING FLOW COEFFICIENTS C and b

The flow rate Q_N at a normal volume through a valve is:

Subsonic flow: $P_2 > b \cdot P_1$

$$Q_N = C \cdot P_1 \cdot \sqrt{1 - \left(\frac{r - b}{1 - b}\right)^2} \cdot \sqrt{\frac{293}{273 + t}}$$

Supersonic flow: $P_2 < b \cdot P_1$

$$Q^*_N = C \cdot P_1 \cdot \sqrt{\frac{293}{273 + t}}$$

where
Q_N = flow rate at a normal volume [Nl/min]
Q^*_N = critical flow rate at a normal volume [Nl/min]
C = conductance in [Nl/min · bar]
P_1 = absolute upstream pressure [bar]
P_2 = absolute downstream pressure [bar]
r = upstream pressure : downstream pressure ratio P_2 / P_1
b = critical pressure ratio $b = P_2^* / P_1$
t = input air temperature [°C]

CALCULATING THE FLOW RATE OF A VALVE USING FLOW COEFFICIENTS C_V

The flow rate Q_N at a normal volume through a valve is:

Subsonic flow: $P_2 > 0{,}528 \cdot P_1$

$$Q_N = 400 \cdot C_V \cdot \sqrt{P_2 \Delta P} \cdot \sqrt{\frac{273}{273 + t}}$$

Supersonic flow: $P_2 < 0{,}528 \cdot P_1$

$$Q^*_N = 200 \cdot C_V \cdot P_1 \cdot \sqrt{\frac{273}{273 + t}}$$

where
Q_N = flow rate at a normal volume [Nl/min]
Q^*_N = critical flow rate at a normal volume [Nl/min]
C_V = coefficient of flow [*US · GPM / p.s.i.*]
P_1 = absolute upstream pressure [bar]
P_2 = absolute downstream pressure [bar]
t = input air temperature [°C]

CALCULATING THE NOMINAL FLOW RATE

The nominal flow rate Q_{Nm} of a valve, i.e. the flow at normal volume passing through a valve with $P_1 = 6$[bar] ($P_1 = 7$ [bar] absolute) and $\Delta P = 1$ [bar], can be obtained from the previous formula as follows:

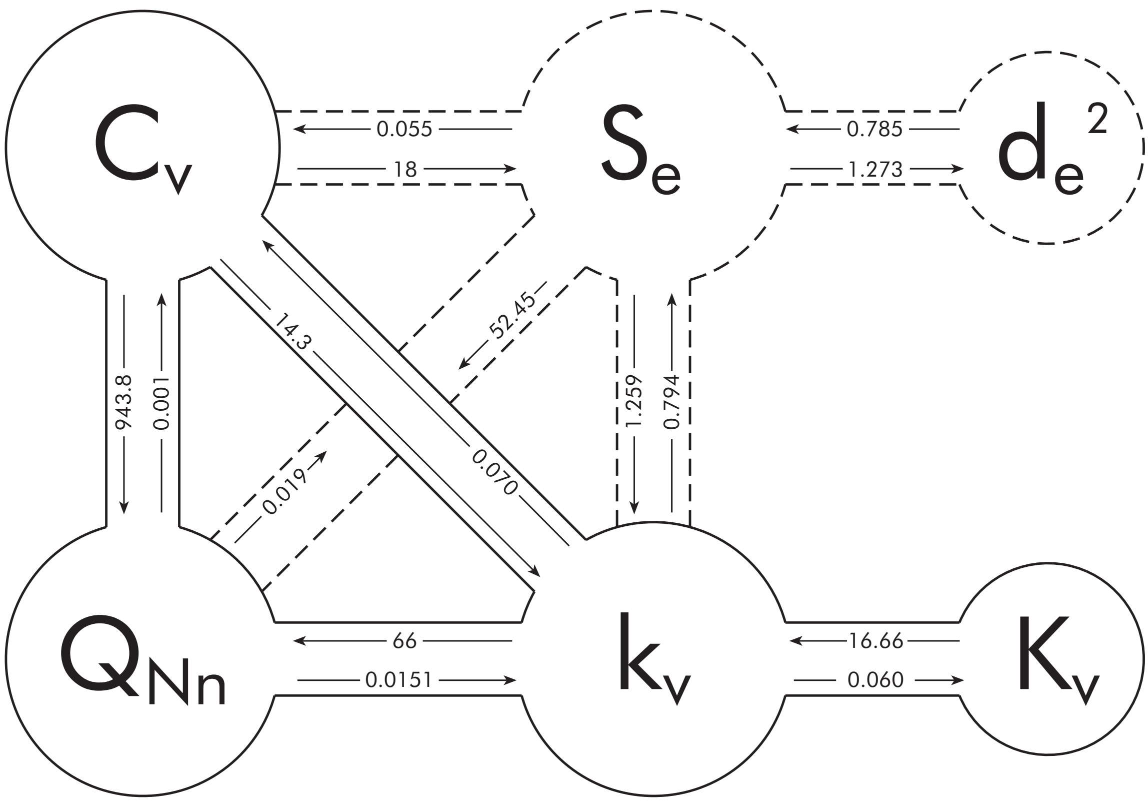
$$Q_{Nn} = 66 \cdot k_v$$

$$Q_{Nn} = 943{,}8 \cdot C_V$$

$$Q_{Nn} = 7 \cdot C \cdot \sqrt{1 - \left(\frac{0{,}857 - b}{1 - b}\right)^2}$$

Equalising the first two formulae gives: $k_V = 14{,}3 \cdot C_V \cdot$

• REACTIONS BETWEEN QNn - C_V - k_v - K_V - S - de^2



Q_{Nn} = flow rate in [Nl/min] with $p_1 = 6$ [bar] (P_1=7 [bar] absolute) and $\Delta P = 1$ [bar]

k_v hydraulic coefficient in $\frac{l}{min}\left(\frac{kg}{dm^3 \cdot bar}\right)^{1/2}$

K_V hydraulic coefficient in $\frac{m^3}{h}\left(\frac{kg}{dm^3 \cdot bar}\right)^{1/2}$

C_V coefficient of flow [*US · GPM / p.s.i.*]

S_e equivalent cross section [mm²]

$d_e^2 = S \cdot \frac{4}{\pi}$ through diameter² in [mm²] obtained from the equivalent cross section

CONVERSION TABLES

TABLE 1 – CONVERSION BETWEEN SYSTEMS OF MEASUREMENT

	Technical system and CGS system	Multiply by →	International system	← Multiply by	British system
Length	m	1	m	0,0254	in (inch)
			m	0,3048	ft (foot)
Time	s	1	s	1	s
Area	m^2	1	m^2	0,000645	in^2
			m^2	0,0929	ft^2
Volume	m^3	1	m^3	$16,39 \cdot 10^{-4}$	in^2
			m^3	0,02832	ft^2
Speed	$m \cdot s^{-1}$	1	$m \cdot s^{-1}$	0,3048	$ft \cdot s^{-1}$
Acceleration	$m \cdot s^{-2}$	1	$m \cdot s^{-2}$	0,3048	$ft \cdot s^{-2}$
Mass	$kg \cdot s^2 \cdot m^{-1}$	9,81	kg	0,4536	lb (pound)
			kg	14,594	slug = lb f $\cdot s^2 \cdot ft^{-1}$
Force	kg o kp	9,81	N	4,4483	lb f (pound)
	kg	0,981	da N = 10 N		
Torque	$kg \cdot m$	9,81	$N \cdot m$	1,356	lb f $\cdot ft$
Density	$kg \cdot s^2 \cdot m^{-1}$	9,81	$kg \cdot m^{-3}$	16,02	$lb \cdot ft^{-3}$
Specific weight	$kg \cdot m^{-1}$	9,81	$N \cdot m^{-3}$	157,16	lb f $\cdot ft^{-3}$
Work, energy	$kg \cdot m$	9,81	J	1,356	lb f $\cdot ft$
			$KWh = 3,6 \cdot 10^6 J$		
Heat	Cal	4186	J	1055,1	BTU
Power	$kg \cdot m \cdot s^{-1}$	9,81	W	1,3558	lb f $\cdot ft \cdot s^{-1}$
	CV	735	W	745,7	HP
Pressure	$kg \cdot m^{-2}$	9,81	Pa	$6,8948 \cdot 10$	p.s.i.=lb f $\cdot in^{-2}$
	$kg \cdot cm^{-2}$	$9,81 \cdot 10$	Pa		
	$kg \cdot cm^{-2}$	0,981	bar = 10^5Pa		
Mass flow	$kg \cdot s \cdot m^{-1}$	9,81	$kg \cdot s^{-1}$	0,4536	$lb \cdot s^{-2}$
Volume flow	$m^3 \cdot s^{-1}$	1	$m^3 \cdot s^{-1}$	0,02832	$ft \cdot s^{-1}$
Dynamic viscosity	Nl/min^{-1}	0,0000167	$Nm^3 \cdot S^{-1}$	0,000472	SCFM
	$kg \cdot s \cdot m^{-2}$	9,81	$Pa \cdot s$	6,896	lb f $\cdot s \cdot in^{-2}$
Kinematic viscosity	Po (poise-system CGS)	0,1	$Pa \cdot s$		
	$m^2 \cdot s^{-2}$	1	$m^2 \cdot s^{-2}$	0,0929	$ft^2 \cdot s^{-1}$
	St (stokes-system CGS)	10^{-4}	$m^2 \cdot s^{-2}$		
	Technical system and CGS system	← Divide by	International system	Divide by →	British system

TABLE 2 – TEMPERATURE CONVERSION

°F = [1,8 · °C] + 32

°C = [°F - 32] · 0,55

°K = °C + 273

°C = degrees Celsius

°K = degrees Kelvin

°F = degrees Fahrenheit

TABLE 3 – MULTIPLES AND SUB-MULTIPLES

Name	Symbol	Value
tera	T	10^{12}
giga	G	10^9
mega	M	10^6
kilo	k	10^3
etto	h	10^2
deca	da	10
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	µ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

TABLE 4 – PRESSURE UNIT CONVERSION FACTORS

To obtain the pressure for the following units, multiply the number given for the source units by the coefficient shown.

Source units	Pa	kPa	MPa	bar	mbar	kp/cm²	cm H_2O	mm H_2O	mm Hg	p.s.i.
Pa	1	10^{-3}	10^{-5}	10^{-5}	10^{-2}	$10,1972 \cdot 10^{-6}$	$10,1972 \cdot 10^{-3}$	$101,972 \cdot 10^{-3}$	$7,50062 \cdot 10^{-3}$	$0,145038 \cdot 10^{-3}$
kPa	10^3	1	10^{-3}	10^{-2}	10	$10,1972 \cdot 10^{-3}$	10,1972	101,972	7,50062	0,145038
MPa	10^6	10^3	1	10	10^4	10,1972	$10,1972 \cdot 10^3$	$101,972 \cdot 10^3$	$7,50062 \cdot 10^3$	$0,145038 \cdot 10^3$
bar	10^5	10^2	10^{-1}	1	10^3	1,01972	$1,01972 \cdot 10^3$	$10,1972 \cdot 10^3$	750,062	14,5038
mbar	100	0,1	10^{-4}	10^{-3}	1	$1,01972 \cdot 10^{-3}$	1,01972	10,1972	0,750062	$14,5038 \cdot 10^{-3}$
kp/cm²	98.066,5	98,0665	$98,0665 \cdot 10^{-3}$	0,989665	980,665	1	1000	10.000	735,559	14,2233
cm H_2O	98,0665	$98,0665 \cdot 10^{-3}$	$98,0665 \cdot 10^{-6}$	$0,98665 \cdot 10^{-3}$	0,98665	10^{-3}	1	10	0,735559	$14,2233 \cdot 10^{-3}$
mm H_2O	9,80665	$9,80665 \cdot 10^{-3}$	$9,80665 \cdot 10^{-6}$	$98,0665 \cdot 10^{-6}$	$98,0665 \cdot 10^{-3}$	10^{-4}	0,1	1	$73,5559 \cdot 10^{-3}$	$14,2233 \cdot 10^{-3}$
mm Hg	133,322	$133,322 \cdot 10^{-3}$	$133,322 \cdot 10^{-3}$	$1,33322 \cdot 10^{-3}$	1,33322	$1,35951 \cdot 10^{-3}$	1,35951	13,5951	1	$19,3368 \cdot 10^{-3}$
p.s.i.	6.894,76	6,89476	$6,89476 \cdot 10^{-3}$	$68,9476 \cdot 10^{-3}$	68,9476	$70,307 \cdot 10^{-3}$	70,307	703,07	51,7149	1

METAL WORK PNEUMATIC

TABLE 5 – AIR CONSTANTS

Entity	Symbol	Value	
Dynamic viscosity		$17,89 \cdot 10^{-6}$	Pa s
Kinematic viscosity	μ	$14,61 \cdot 10^{-6}$	$m^2 s^{-1}$
Density	γ	1,225	kg m^{-3}
Specific heat at constant pressure	ρ	1,004	KJ $kg^{-1} K^{-1}$
Speed of sound	Cp	340,29	m s^{-1}
Gas constant	a	287,1	J $kg^{-1} K^{-1}$
	R		

TABLE 6 – CONTENT OF WATER VAPOUR IN SATURATED COMPRESSED AIR

Grams of water vapour per cubic metre (g / m^3) of air at ambient atmospheric pressure 1.013 bar (0 bar gauge pressure), saturated and compressed at the given pressures and temperatures.

	Pressure - bar												
Temperature °C	0	0,4	0,63	1	1,6	2,5	4	6,3	8	10	12,5	16	20
0	4,82	3,45	2,97	2,42	1,87	1,39	0,97	0,67	0,54	0,44	0,36	0,29	0,23
5	6,88	4,93	4,24	3,46	2,68	1,99	1,39	0,95	0,77	0,63	0,52	0,41	0,33
10	9,41	6,74	5,80	4,73	3,66	2,72	1,90	1,30	1,06	0,87	0,70	0,56	0,45
15	12,7	9,08	7,83	6,39	4,94	3,67	2,56	1,76	1,43	1,17	0,95	0,76	0,61
20	17,4	12,5	10,7	8,75	6,77	5,02	3,51	2,41	1,95	1,60	1,30	1,04	0,84
25	23,6	16,9	14,6	11,9	9,18	6,82	4,77	3,27	2,65	2,17	1,77	1,40	1,14
30	30,5	21,8	18,8	15,3	11,9	8,81	6,16	4,22	3,43	2,81	2,29	1,81	1,47
35	39	27,9	24	19,6	15,2	11,3	7,87	5,40	4,38	3,59	2,92	2,32	1,88
40	49,6	35,5	30,6	24,9	19,3	14,3	10	6,87	5,57	4,55	3,72	2,95	2,39
45	63,5	45,45	39,2	31,9	24,7	18,3	12,8	8,79	7,13	5,84	4,76	3,77	3,06
50	81	58	49,9	40,7	31,5	23,4	16,4	11,2	9,10	7,45	6,07	4,82	3,90

TABLE 7 – VOLUME FLOW UNIT CONVERSION FACTORS

To obtain volume flow for the following units, multiply the number given for the source units by the coefficient shown.

Source units	m^3/s	l/s	cm^3/s	m^3/h	m^3/min	l/h	l/min	ft^3/min (scfm)	gallone/ min UK	gallone/ min USA
m^3/s	1	10^3	10^6	3600	60	$3,6 \cdot 10^3$	$60 \cdot 10^3$	$2,1188 \cdot 10^3$	$13,198 \cdot 10^3$	$15,850 \cdot 10^3$
l/s	10^{-3}	1	10^3	3,6	$60 \cdot 10^{-3}$	$3,6 \cdot 10^3$	60	2,1188	13,198	15,850
cm^3/s	10^{-6}	10^{-3}	1	$3600 \cdot 10^{-6}$	$60 \cdot 10^{-6}$	3,6	$60 \cdot 10^{-3}$	$2,1188 \cdot 10^{-3}$	$13,198 \cdot 10^{-3}$	$15,850 \cdot 10^{-3}$
m^3/h	$0,277778 \cdot 10^{-3}$	0,27778	$0,277778 \cdot 10^3$	1	$16,667 \cdot 10^{-3}$	10^3	16,667	0,58856	3,6661	4,4028
m^3/min	$16,667 \cdot 10^{-3}$	16,667	$16,667 \cdot 10^3$	60	1	$6 \cdot 10^4$	10^3	35,313	219,97	$264,17^{-3}$
l/h	$0,27778 \cdot 10^{-6}$	$0,27778 \cdot 10^{-3}$	0,27778	10^{-3}	$16,667 \cdot 10^{-6}$	1	$16,667 \cdot 10^{-3}$	$0,58856 \cdot 10^{-3}$	$3,6661 \cdot 10^{-3}$	$4,4028 \cdot 10^{-3}$
l/min	$16,667 \cdot 10^{-6}$	$16,667 \cdot 10^{-3}$	$16,667^{-6}$	$60 \cdot 10^{-3}$	10^{-3}	60^{-3}	1	$35,313 \cdot 10^{-3}$	$219,97 \cdot 10^{-3}$	$264,17 \cdot 10^{-3}$
ft^3/min	$0,47195 \cdot 10^{-3}$	0,47195	$0,47195 \cdot 10^3$	1,6990	$28,317 \cdot 10^{-3}$	$1,6990 \cdot 10^3$	28,317	1	6,2288	7,4804
UK gallon/min	$75,768 \cdot 10^{-6}$	$75,768^{-3}$	75,768	0,27276	$4,5461 \cdot 10^{-3}$	272,76	4,5461	0,16054	1	1,2009
US gallon/min	$63,090 \cdot 10^{-6}$	$63,090 \cdot 10^{-3}$	63,090	0,22712	$3,7854 \cdot 10^{-3}$	227,12	3,7854	0,13368	0,83266	1

TABLE 8 - RECOMMENDED FLOW RATE

Maximum recommended flow rate in Nl/min for pneumatic circuit piping. Flow rate values are calculated as follows:
• pipes Ø 2 to Ø 12 with a pressure drop equal to 0.3% of operating pressure per metre of pipe.
• pipes Ø 15 to Ø 40 with a pressure drop equal to 0.15% of the operating pressure per metre of pipe.

Inside diameter in mm - Nominal diameter in gas inches

Pressure bar	Ø 2	Ø 4	1/8″ Ø 6	1/4″ Ø 8	3/8″ Ø 10	Ø 12	1/2″ Ø 15	3/4″ Ø 20	1″ Ø 25	1 1/4″ Ø 32	1 1/2″ Ø 40
2	3,5	19	53	110	190	300	370	750	1350	2500	4300
4	6,2	35	97	200	350	550	700	1400	2400	4500	7800
6	9	50	140	290	500	800	1000	2000	3500	6500	11500
8	11,8	66	185	380	660	1050	1300	2600	4500	8500	15000
10	14,5	82	230	470	820	1300	1600	3250	5700	10500	18500

TABLE 9 - INDICATIVE AIR CONSUMPTION FOR DIFFERENT TYPES OF EQUIPMENT

Type of equipment	Consumption at full load Nl/min.	Type of equipment	Consumption at full load Nl/min.
6 mm Ø drill	300	Bench tamper	350
12 mm Ø drill	500	8 kg tamper	700
20 mm Ø drill	1150	10 mm Ø riveting machine	450
45 mm Ø drill	1650	20 mm Ø riveting machine	1000
M6 screwdriver or bolt screwer	300	4 kg chisel	380
M10 screwdriver or bolt screwer	400	6 kg chisel	500
M16 impulse screwer	1150	Small paint-spray gun	160
M25 impulse screwer	1650	Industrial paint-spray gun	500
1″ Ø wheel grinder	350	1 mm Ø cleaning bellows	65
6″ Ø disk grinder	1500	2 mm Ø cleaning bellows	250
9″ Ø disk grinder	2100	5 mm Ø nozzle sandblasting machine	1600
Polishing machine	1200	8 mm Ø nozzle sandblasting machine	4200
1000 kg hoist	2150	Plaster sprayer	500
Spot welder	300	Heavy-duty concrete vibrator	2500
		35 kg concrete breaker	1650
		18 kg breaker	1850
		30 kg breaker	2850

DEGREE OF PROTECTION

Norma EN 60529 e CEI 529

IP 6 5

DEGREE OF PROTECTION AGAINST THE PENETRATION OF LIQUIDS (second digit)

DEGREE OF PROTECTION AGAINST THE PENETRATION OF FOREIGN BODIES COMING INTO CONTACT WITH LIVE PARTS. (first digit)

1st No.	DESCRIPTION	2nd No.	DESCRIPTION
0	Not protected	0	Not protected
1	Protected against solid bodies greater than ∅ 50 mm	1	Protected against water falling vertically (condensate)
2	Protected against solid bodies greater than ∅ 12 mm	2	Protected against drops of water falling up to 15° off the vertical
3	Protected against solid bodies greater than ∅ 2.5 mm	3	Protected against rain water up to 60° off the vertical
4	Protected against solid bodies greater than ∅ 1 mm	4	Protected against sprays of water from any direction.
5	Protected against dust	5	Protected against jets of water fired from any direction
6	Totally protected against dust	6	Protected against sea waves or the like
		7	Protected against the effects of immersion

CHECK COMPATIBILITY

Pneumatic products include elastomer gaskets that are made of acryl-nitrile butadiene (NBR), polyurethane or fluorocarbon rubber (FKM/FPM).
It is important for them not to come into contact with incompatible substances, which could cause them to swell or crack and subsequently malfunction.

In particular, it is necessary to check compatibility of:
• the oil used in the air compressor
• any oil used in the lubricator
• the oil or cutting fluids used on the machine, which could get into the cylinders and from there the valves.

We have drawn up a compatibility table containing a list of chemicals and elastomers, and also Hostaform®, the technopolymer most commonly used in our products. Please refer to the English webpage
www.metalwork.it/eng/materiali_compatibilità.html or the Italian webpage
www.metalwork.it/ita/materiali_compatibilità.html
The website www.parker.com/o-ring/fcg/fcg.asp of Parker Pradifa, one of our gasket suppliers, contains an interactive table defining incompatibility.

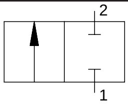
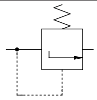
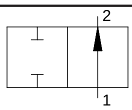
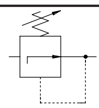
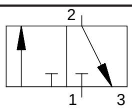
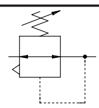
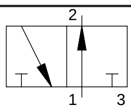
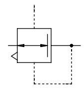
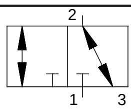
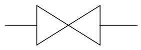
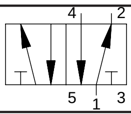
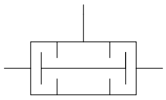
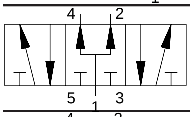
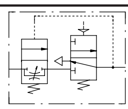
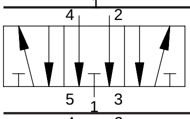
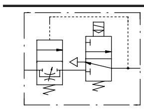
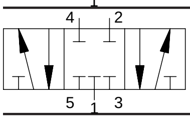
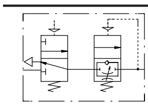
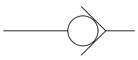
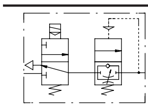
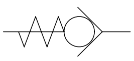
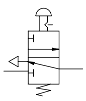
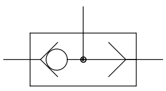
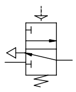
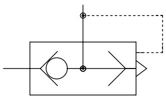
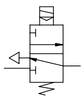
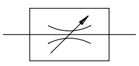
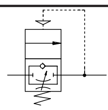
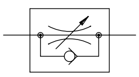
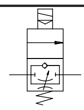
Below are some the oils that are definitely compatible with all the elastomers used with our products:
• UNI and ISO FD 22 lubricants (Energol HPL, Spinesso, Mobil DTE, Tellus Oil).
• low pressure compressor oil: SHELL CORENA OIL D 46
• high pressure compressor oil: SHELL RIMULA X OIL 40.

Please note that some ester-based synthetic oils used in compressors are extremely incompatible with NBR and polyurethane. ROTOROIL 8000 F2 is one of them.

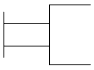
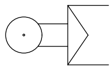
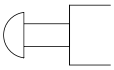
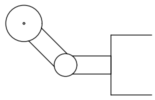
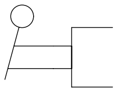
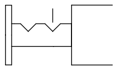
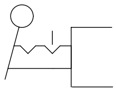
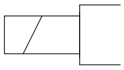
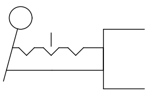
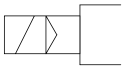
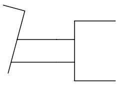
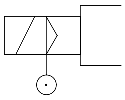
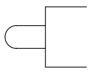
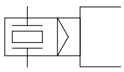
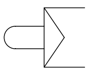
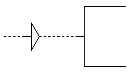
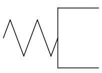
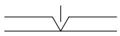
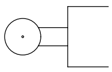
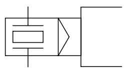
Metal Work can provide you with further information or carry out research and tests if required.

PNEUMATIC SYMBOLS

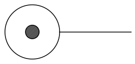
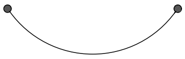
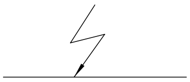
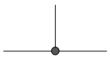
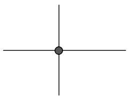
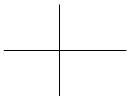
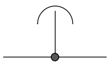
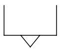
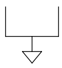
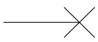
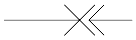
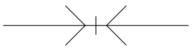
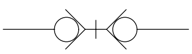
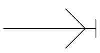
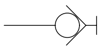
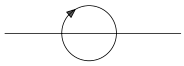
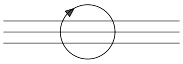
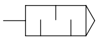
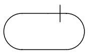
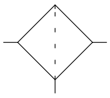
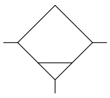
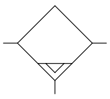
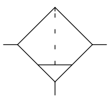
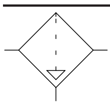
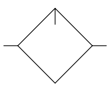
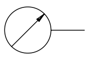
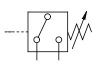
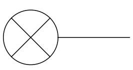
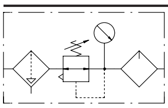
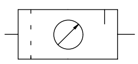
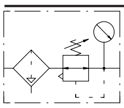
DISTRIBUTION AND REGULATION

	2-way/ 2 positions valve(2/2) normally closed		Sequence valve
	2-way/ 2 positions valve(2/2) normally open		Pressure reducer without blowoff valve
	3-way/ 2 positions valve(3/2) normally closed		Pressure reducer with blowoff relief valve
	3-way/ 2 positions valve(3/2) normally open		Pressure piloted reducer with blowoff relief valve
	3-way/ 2 positions valve(3/2) NC-NO		Shutoff valve
	5-way /2 positions valve(5/2)		Dual pressure valve (AND element)
	5-way/ 3 positions valve(5/3) pressurized centres		Progressive pneumatic starter (APR)
	5-way/ 3 positions valve(5/3) open centres		Progressive solenoid starter (APR)
	5-way /3 positions valve(5/3) closed centres		Progressive pneumatic starter (APR) (SK 100 only)
	Unidirectional valve		Progressive solenoid starter (APR) (SK 100 only)
	Check valve with spring		3-way shutoff valve (V3V) with lockable control
	Circuit selector valve (OR element)		3-way shutoff valve (V3V) with pneumatic control
	Quick-release valve		3-way shutoff valve (V3V) with solenoid control
	Flow regulator with variable choke		2/2 progressive pneumatic valve (VAP) (SK 100 only)
	Unidirectional flow regulator with variable throat		2/2 progressive solenoid valve (VAP) (SK 100 only)

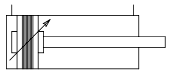
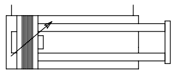
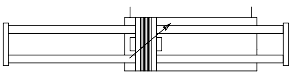
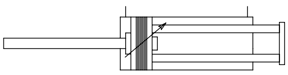
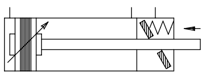
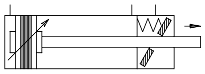
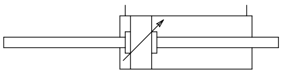
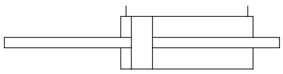
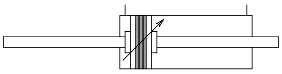
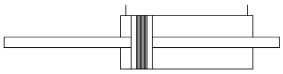
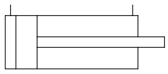
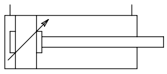
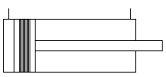
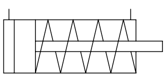
CONTROLS

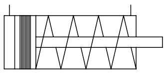
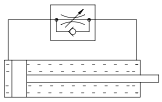
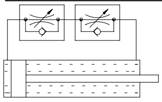
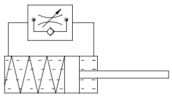
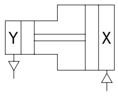
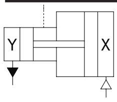
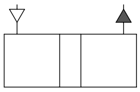
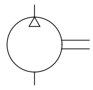
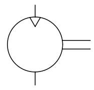
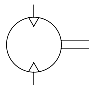
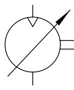
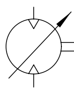
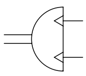
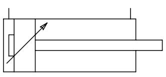
	Manual control		Mechanical control with sensitive roller lever
	Manual pushbutton control		Mechanical control with unidirectional roller lever
	Manual lever control		Mechanical control with drawer
	Manual control with 2-position lever		Electrical control
	Manual control with 3-position lever		Solenoid control
	Manual pedal-operated control		Solenoid, pilot-assisted control
	Mechanical control with ferrule		Piezoelectric control
	Mechanical control with sensitive ferrule		Pneumatic control
	Mechanical control with spring		Mechanical stop
	Mechanical control with roller lever		Release device

TRANSMISSION AND PREPARATION

	Pneumatic pressure source
	Operating line
	Pilot line
	Discharge line
	Flexible line connection
	Electric cable
	Line connection (welding, screwing)
	Line connection (welding, screwing)
	Crossing of unconnected lines
	Discharge point
	Discharge hole without connection
	Discharge hole with connection
	Power pick-up point with closing cap
	Power pick-up point with port
	Quick-fit coupling without unidirectional valve
	Quick-fit coupling with unidirectional valve
	Quick-fit coupling (de-coupling with open terminal section)
	Quick-fit (de-coupling with closed terminal section)
	1-way swivel coupling
	3-way swivel coupling
	Silencer
	Tank
	Filter
	Condensate separator with manual discharge
	Condensate separator with automatic discharge
	Filter with condensate separator with manual discharge
	Filter with condensate separator with automatic discharge
	Lubricator
	Pressure gauge
	Pressure switch
	Optical tester
	FRL+pressure gauge maintenance unit
	FRL+pressure gauge simplified maintenance unit
	FR+pressure gauge maintenance unit

TRANSFORMATION

	DE magnetic cylinder with adjustable bilateral cushioning
	DE magnetic twin-rod cylinder with adjustable bilateral cushioning
	DE magnetic twin-rod cylinder with adjustable bilateral cushioning
	DE magnetic twin-rod cylinder with adjustable bilateral cushioning-single through rod
	DE magnetic cylinder with adjustable bilateral cushioning + DZB mechanical lock
	DE magnetic cylinder with adjustable bilateral cushioning + DZBA mechanical lock
	DE cylinder with adjustable bilateral cushioning, through-rod
	DE through-rod cylinder
	DE magnetic cylinder with adjustable bilateral cushioning, through-rod
	DE magnetic cylinder, through-rod
	DE cylinder
	DE cylinder with cushioning
	DE magnetic cylinder
	SE cylinder

	SE magnetic cylinder
	Hydraulic brake with adjustment in one direction only
	Hydraulic brake with adjustment in both directions
	Cushion
	Pressure multiplier for fluids with identical characteristics
	Pressure multiplier for fluids with different characteristics
	Pneumatic/hydraulic transducer
	Constant volume compressor
	Constant volume pneumatic motor, unidirectional flow
	Constant volume pneumatic motor, bidirectional flow
	Variable volume pneumatic motor, unidirectional flow
	Variable volume pneumatic motor, bi-directional flow
	Rotary pneumatic motor
	Cylinder with adjustable single cushioning