Index chapter 0

TECHNICAL INFORMATION

Polígono Industrial O Rebullón s/n. 36416 - Mos - España - rodavigo@rodavigo.com

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FLUID

Most of WAIRCOM M.B.S. products must be fed with lubricated or unlubricated compressed filtered air.

FLUID COMPATIBILITY
Before realising the plant it's a good rule to check the chemical compatibility of used oils in the air compressor, oils used in the lubricator, if present, and oils or cutting fluids used on the machines downstream of the plant that may enter in the cylinders and go back to the valves. If these oils that come in contact with the fluid are not compatible with elastomer seals present in our products, they can reinflate or crack them causing malfunctions. For more information about the compatibility between the different materials see table on page 0.6

FILTERS
It's important that input fluid to a pneumatic plant is always filtered to remove solid impurities, condensation or any traces of substances which are not compatible with elastomers coming from devices placed upstream of the plant.
Waircom always suggest to filter incoming air with filters with a void fraction of at least 40 um. The condensate drainage system accumulated in the filter bowl can be manual, semi-automatic or automatic and it is set up of a cock situated on the bottom of the bowl.

LUBRICATORS
A correct lubrication keeps the performance of the components in the course of time. The absence of lubrication leaves space to the only initial lubrication that each component receives during the assembly. Lubrication, when applied, must be maintained, in its absence the seals of the components may go bad jeopardizing the operation. Waircom, for proper lubrication of the components, advises to use 1 drop of "WAIRSOL" grease class ISO22 every 300/500 Nl, a lubricant especially studied for pneumatic plants compatible with all materials used in both our components and the equipment usually used in pneumatic

AIR PURITY CLASS
ISO8573-1 standard summarizes what is described above by defining the degree of purity of the air in terms of solid particles, moisture, and oil concentration.

FLUID CHARACTERISTICS
Fluid temperature: from -10 to + 60 ° depending on the component
Environment temperature: from -20 to + 80 ° depending on the component
Air filtering according to ISO 8573-1: not superior to 5/5/4 (see table)
Lubrication: not necessary, in case to use WAIRSOL grease ISO 22 and don't stop it
Oil quantity: a drop every 300 ÷ 500 liters of air.

AIR PURITY CLASSES			
Class	**Solid bodies** max. dimensions of the particles	**Water content** dew point	**Oil quantity** max. concentration
1	0,1 µ	-70 °C	0,01 mg/m³
2	1 µ	-40 °C	0,1 mg/m³
3	5 µ	-20 °C	1 mg/m³
4	15 µ	+3 °C	5 mg/m³
5	40 µ	+7 °C	25 mg/m³

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PRESSURE

DEFINITION OF PRESSURE
It is the ratio between a force and the surface on which it acts; it is dimensionally expressed in force units per surface units.
$P^{(Pa)} = F^{(N)} / S^{(m^2)}$

ATMOSPHERIC PRESSURE
It is the pressure exerted on a surface of 1 cm2 at sea level, at a temperature of 20 °C and with a relative humidity of 65%; it is equivalent to a column of water of 10,33 m or to 760 mmHg.

GAUGE PRESSURE
It is the differential pressure of a fluid above and below the atmospheric pressure normally read on the pressure gauges.

ABSOLUTE PRESSURE
It is the pressure of a fluid respect to the absolute vacuum and it is obtainable adding the atmospheric pressure to the gauge one.

UPSTREAM PRESSURE
Pressure of the compressed air at the inlet of the pneumatic component.

DOWNSTREAM PRESSURE
Pressure of the compressed air at the outlet of the pneumatic component.

DIFFERENTIAL PRESSURE (P)
It is the difference between upstream and downstream pressure.

BOYLE-MARIOTTE'S LAW
The volume of a closed quantity of gas with constant temperature is inversely proportional to the absolute pressure, thus means that for a given quantity of gas the product between the absolute pressure and the volume is a constant value:
$P_1 \cdot V_1 = P_2 \cdot V_2 = \text{costante}$

GAY - LUSSAC'S LAW
The volume of a quantity of gas with constant pressure is proportional to its temperature:
$V_1 / V_2 = T_1 / T_2$
or even, with constant volume, the pressure of a quantity of gas is proportional to its temperature.
$P_1 / P_2 = T_1 / T_2$
Then we obtain the General Equation of Gases:
$P \cdot V = n \cdot R \cdot T$
where:
P = pressure (atm)
V = volume (Nl)
n = gram molecules of gas contained in the volume (mol)
R = perfect gas constant (0,0821 Nl · atm · K-1 · mol-1)
T = absolute temperature in Kelvin (273 K = 0 °C)

NORMAL CONDITIONS OF AIR
In the design of industrial pneumatic circuits are employed measures that refer to the "Normal conditions of air".
As "normal cubic meter of air" (1Nm3) we refer to 1 m3 of air at a temperature of 273 K (0 °C) and at a pressure of 1,0013 bar (pressure of the normal air at the sea level): 1 Nm3 = 1000 Nl.

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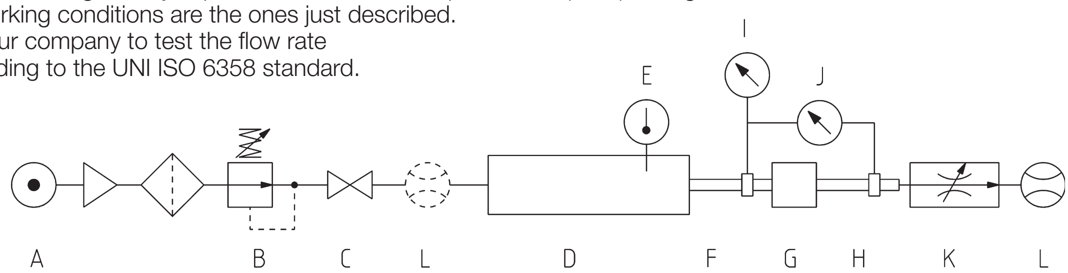
RATED FLOW RATE

It is the volume of fluid passing through a given section of measurement in a unit of time with an upstream gauge pressure P1=6 bar (7 absolute bar) and with a pressure drop P=1 bar (thus means a downstream gauge pressure P2=5 bar, 6 absolute bar) with a fluid temperature of +20 °C. The rated flow rate, generally expressed in normal liters per minute (Nl/m), can give some indications on the performances of the valves if the working conditions are the ones just described.
Herebelow are the circuits used in our company to test the flow rate measurements of products in according to the UNI ISO 6358 standard.



Testing circuit for components with input/output connection.

A – Filter and supply unit
B – Adjustable pressure regulator
C – Shut-off valve
D – Tube for temperature measurement
E – Device for the measure of temperature
F – Tube for upstream pressure measurement
G – Component on trial
H – Tube for downstream pressure measurement
I – Device for the measure of upstream pressure
J – Device for the measure of differential pressure
K – Flow regulator valve
L – Device for the measure of flow rate

FLOW CALCULATION

To determine the flow of the liquids that pass through the solenoid valves of "W" Series, we use the formula shown below, in which the hydraulic coefficient Kv, the fluid density and differential pressure are used. The hydraulic coefficient is determined in an experimental way as indicated by VDE 2174 standards and it represents the flow of water in m3/h which runs through the solenoid valve with a differential pressure of 1 bar and a temperature between 5 ° C and 40 ° C.

Liquids

$$Q = Kv \sqrt{\frac{\Delta p}{\rho}}$$

This calculation method provides approximate data in case of compressed air, however, the transfer from the hydraulic case to the air one can be done considering the density variation and with the hypothesis that the passage of air will produce the same effects of water, with same losses and contractions flow.

In subsonic regime $P_2 > \frac{P_1}{2}$ or $\Delta p = \Delta p < \frac{P_1}{2}$

Air

$$Q_N = 28{,}6 \cdot K_V \cdot \sqrt{P_2 \Delta P} \cdot \sqrt{\frac{T_N}{T_1}}$$

Gas

$$Q_N = 514 \cdot K_V \sqrt{\frac{\Delta p \times P_2}{\rho_n \times (273 + T_1)}}$$

Vapors

$$G = 31{,}6 \cdot K_V \sqrt{\frac{\Delta p}{V_2}}$$

In sonic regime $P_2 > \frac{P_1}{2}$ or $\Delta p = \Delta p > \frac{P_1}{2}$

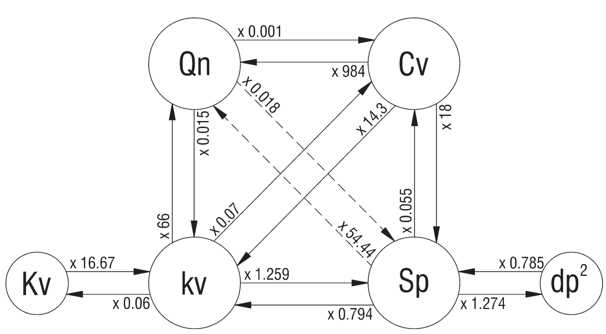
$$Q_N = 14{,}3 \cdot K_V \cdot P_1 \cdot \sqrt{\frac{T_N}{T_1}}$$

$$Q_N = 257 \cdot K_V \frac{P_1}{\sqrt{\rho_n \times (273 + T_1)}}$$

$$G = 31{,}6 \cdot K_V \sqrt{\frac{P_1}{V_1}}$$

$Kv = m^3/h \left(\frac{kg}{dm^3 . bar}\right)^{1/2}$	Hydraulic coefficient
$Q = m^3/h$	Flow
$Q_n = m^3n/h$	Normal flow (20 °C 760 mm Hg)
$P_1 = bar$	Absolute inlet pressure (gauge pressure +1)
$P_2 = bar$	Absolute outlet pressure (gauge pressure +1)
$\Delta p = bar$	Pressure drop (presure differential between the inlet pressure and the outlet pressure)
$\rho = Kg/dm^3$	Relative gravity than water (water at 4 °C = 1)
$\rho_n = Kg/dm^3$	Normal relative density than air
$G = Kg/h$	Mass
$T_1 = K$	Absolute input temperature (for converting °C in K = > 273+°C)
$T_N = 293 K$	Absolute temperature reference
$V_1 = m^3/Kg$	Specific input volume
$V_2 = m^3/Kg$	Volume specifico in uscita alla pressione P_2 and the temperature t

RELATIONS BETWEEN Kv, kv, Cv, Sp, dp^2



Qn	Nominal flow	Nl/min
kv	Hydraulic coefficient	l/min
Kv		m³/h
Cv		Usa Gallons/min
Sp	Nominal passing section	mm²
dp²	Nominal passing diameter*	mm²

* to derive the diameter dp (mm) perform the square root of dp

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SPECIFIC WEIGHT

Liquid	Temp. (°C)	Specific weight (Kg/dm³)	Gases and vapors	Specific weight	
				Relative density to air	(Kg/dm³)
Acetone	25	0,787	Acetylene (ethyme)	0,90	1,085
Acetylene liquid	70 °F	0,38	Air*	1	1,205
Alcohol, ethyl (ethanol)	25	0,787	Alcohol vapor	1,6	1,929
Alcohol, methyl (methanol)	25	0,791	Ammonia	0,59	0,711
Alcohol, propyl	25	0,802	Argon	1,38	1,663
Ammonia (aqua)	25	0,826	Benzene	2,70	3,249
Aniline	25	1,022	Butane	2,01	2,417
Benzene	25	0,876	Isobutene	1,94	2,338
Benzil	25	1,084	Carbon dioxide	1,52	1,830
Bromine	25	3,12	Carbon monoxide	0,97	1,165
Butane, liquid	25	0,601	Chlorine	2,49	2,996
Caustic soda 9% - NaOH	15	1,1	Cyclobutane	1,94	2,335
Caustic soda 18% - NaOH	15	1,2	Cyclopentane	2,42	2,919
Caustic soda 27% - NaOH	15	1,3	Cyclopropane	1,45	1,748
Caustic soda 47% - NaOH	15	1,5	Deuterium	0,07	0,084
Chloroform	25	1,469	Ethane	1,04	1,251
Ethane	- 89	0,572	Ether vapor	2,59	3,116
Ether	25	0,716	Ethel Chloride	2,23	2,687
Ethylene glycol	25	1,1	Ethylene (Ethene)	0,97	1,167
Formaldehyde	45	0,815	Flourine	1,31	1,579
Freon R-11	25	1,48	Helium	0,14	0,166
Freon R-12	25	1,315	Heptanes	3,46	4,168
Freon R-22	25	1,197	Hexane	2,97	3,582
Fuel oil	60° F	0,893	Hydrogen	0,07	0,084
Gasoline, Vehicle	60 °F	0,739	Hydrogen chloride	1,27	1,528
Hydrocloric acid 10%	15	1,05	Hydrogen sulfide	1,18	1,417
Hydrocloric acid 20%	15	1,1	Hydrofluoric acid	2,37	2,856
Hydrocloric acid 30%	15	1,15	Hydrochloric acid	1,26	1,520
Hydrocloric acid 40%	15	1,2	Iluminanting gas	0,4	0,482
Kerosene	60 °F	0,82	Isobutane	2,01	2,442
Mercury	25	13,633	Isopentane	2,48	2,988
Milk	15	1,035	Mercury vapor	6,94	8,363
Naphta	15	0,667	Methane	0,55	0,667
Nitric acid 17%	15	1,1	Natural gas (typical)	0,7 - 0,5	0,844 - 0,723
Nitric acid 25%	15	1,15	Neon	0,70	0,840
Nitric acid 47%	15	1,3	Nitrogen	0,97	1,165
Nitric acid 94%	15	1,5	Nitrous oxide	1,53	1,844
Octane	25	0,701	Octane	3,94	4,753
Olive oil	15	0,703	Oxygen	1,1	1,331
Oxygen	-183	1,14	Ozone	1,66	2,000
Potassium Hydroxide 21%	15	1,2	Pentane	2,49	2,997
Potassium Hydroxide 49%	15	1,5	Propane	1,52	1,834
Propane	25	0,495	Propene (Propylene)	1,45	1,834
Sulphuric acid 27%	15	1,2	R-12	4,17	5,030
Sulphuric acid 50%	15	1,4	R-134a	3,52	4,244
Sulphuric acid 87%	15	1,8	Sulfur Dioxide	2,26	2,728
Sulphuric acid, pure	15	1,89	Water vapor	0,62	0,749
Turpentine	25	0,871	Xenon	4,53	5,459
Water, pure	4	1			
Water, sea	77° F	1,025			

*NTP - Normal Temperature and Pressure - is defind as air at 20° C and 1 atm. Specific gravity is the ratio between the density (mass per unit volume) of the actual gas and the density of air, specific gravity has no dimension. The density of air at NTP is 1.205 Kg/dm³.

STEAM

Relative pressure (bar)	Absolute pressure (bar)	Temperature (°C)	Steam specific volume (m³/kg)
-	0,050	32,88	28,192
-	0,500	81,33	3,240
0,00	1,013	10,00	1,673
0,10	1,113	102,66	1,533
0,20	1,213	105,10	1,414
0,35	1,363	108,50	1,268
0,50	1,513	111,61	1,149
0,70	1,713	115,40	1,024
1,00	2,013	120,42	0,881
1,50	2,513	127,62	0,714
2,00	3,013	133,69	0,603
2,50	3,513	139,02	0,522
3,00	4,013	143,75	0,461
3,50	4,513	148,02	0,413
4,00	5,013	151,96	0,374
4,50	5,513	155,55	0,342
5,00	6,013	158,92	0,315
6,00	7,013	165,04	0,272
7,00	8,013	170,50	0,240
8,00	9,013	175,43	0,215
9,00	10,013	179,97	0,194
10,00	11,013	184,13	0,177

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SEAL MATERIALS

DESIGNATION	TYPICAL APPLICATION
NBR (Acrylic-nitrile-butadylene)	Water with a max temperature 70 °C, air with a max temperature 90 °C. Mineral oils and their derivatives, hydrocarbons, methane, ethane, propane, butane, kerosene oil, fuel oil.
EPDM* (Ethylene-propylene-dylene)	Hot water and steam. Detergents. Potassium and sodic solutions. Hydraulic fluids. Polarised solvents. Skydrol 500 e 700. Up to 140 °C
FPM (Fluorocarbon)	For general use up to 130 °C.
PTFE (Polytetrafluorethylene)	For general use up to 160 °C.

*Warning: not to be used with mineral oils and grease

CHEMICAL COMPATIBILITY TABLE

MEDIA	Brass	Stainless Steel	NBR	EPDM	FPM	PTFE
Acetone	●	●	-	●	-	●
Acetylene	●	●	-	●	●	●
Argon hold	●	●	-	●	●	●
Benzol	●	●	-	-	-	●
Butane	●	●	-	-	●	●
Calcium monoxide	●	●	●	●	●	●
Carbon dioxide (liquid)	-	●	-	-	-	●
Carbon disulphide	●	●	-	-	-	●
Chloroform	●	●	-	-	-	●
De-ionised water	-	●	●	●	●	●
De-meniralised water	-	●	●	●	●	●
Dry carbon dioxide (gas)	●	●	●	●	●	●
Ethane	●	●	●	-	●	●
Ethanol	●	●	-	-	-	●
Ethyl acetate	●	●	-	-	-	●
Ethyl cloride	●	●	●	●	●	●
Ethylene glycol	●	●	●	●	●	●
Formaldehyde	●	●	●	●	●	●
Freon	●	●	-	-	-	●
Fuel oil	●	●	●	-	●	●
Glycerine	●	●	●	-	●	●
Hard water	●	●	●	●	●	●
Helium	●	●	●	-	●	●
Heptane	●	●	●	-	●	●
Hexane	●	●	●	-	●	●
Hot water <75 °C	●	●	●	●	●	●
Hot water and steam < 140 °C	●	●	-	●	-	●
Hydrogen	●	●	-	-	●	●
Hydrogen dioxide	-	●	-	-	●	●
Isobutane	●	●	●	-	●	●
Isopentane	●	●	●	-	●	●
Methane	●	●	●	-	●	●
Methanol	●	●	-	●	-	●
Methyl cloride	●	●	-	-	-	●
Mineral oil	●	●	●	-	●	●
Natural gas	●	●	●	-	●	●
Neon	●	●	●	-	●	●
Nitrobenzene	●	●	-	-	-	●
Nitrogen	●	●	●	●	●	●
Oxygen	●	●	●	-	●	●
Pentane	●	●	●	●	●	●
Petrol	●	●	-	-	●	●
Propane-n	●	●	●	-	●	●
Soapy water	●	●	●	-	●	●
Toluene	●	●	-	-	●	●
Trichlorethylene dry	●	●	-	-	●	●
Vinegar	●	●	-	●	-	●
Water with glycol	●	●	-	-	●	●
Xilol	-	●	-	-	●	●

● Compatible
- Not compatible

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PROTECTION CLASS FOR COILS WITH CONNECTOR

For protection class, we mean the intrinsic ability of live electrical equipment to protect and to protect itself against casual contatcts and penetration of solid particles and water. It is defined with the abbreviation “I.P.” followed by 2 figures: the first, 0 to 6, defines the protection against casual contacts and penetration of foreign particles; the second, 0 to 8, the protection against water.
The tables shown below describe the various degrees.

Protection class against casual contacts and penetration of foreign particles

First figure	Denomination	Explanation
0	No protection.	No special protection for people against casual contacts with live parts or moving parts. No protection of the equipment against the penetration of foreign solid particles.
1	Protection against the penetration of large-sized solid particles.	Protection against casual contacts of large surfaces with live parts or moving parts inside the equipment, for example contacts with hands, but no protection against the voluntary access to these parts. Protection of the equipment against the penetration of solid particles with a diameter larger than 50 mm.
2	Protection against the penetration of fluid-sized solid particles.	Protection against contacts of fingers with live parts or moving parts inside the equipment. Protection against the penetration of solid particles with a diameter larger than 12 mm, such as fingers.
3	Protection against the penetration of small-sized solid particles.	Protection against contacts of tools, wires or the like, thicker than 2.5 mm with live parts of moving parts inside the equipment. Protection against the penetration of solid particles with a diameter larger than 2.5 mm, such as tools, wires, and so on.
4	Protection against the penetration of very small-sized solid particles.	Protection against contacts of tools, wires or the like, thicker than 1 mm with live parts or moving parts inside the equipment. Protection against the penetration of solid particles with a diameter larger than1 mm, such as thin tools and wires and so on.
5	Protection against dust deposits.	Full protection against contacts with means of any kind with live parts or moving parts inside the equipment. Protection against dust deposits. The penetration of dust is not fully eliminated, but it is reduced to such an extent as to assure the good operation of the equipment.
6	Protection against dust penetration.	Full protection against contacts with means of any kind with live parts or moving parts inside the equipment. Protection against dust deposits. Full protection against the penetration of dust.

Protection class against penetration of water

Second figure	Denomination	Explanation
0	No protection.	No special protection.
1	Protection against water drops falling perpendicularly.	Water drops that fall perpendicularly must not cause harmful effect.
2	Protection against water drops falling slantwise.	Water drops that fall at a slanted angle of up to 15° to the perpendicular direction must not cause harmful effect.
3	Protection against water dripping.	Water that falls at a slanted angle of up to 60° to the perpendicular direction must not cause harmful effect.
4	Protection against water sprays.	Water sprayed against the equipment from any direction must not cause harmful effect.
5	Protection against water jets.	Water jets fired against the equipment from any direction must not cause harmful effect.
6	Protection against inondation.	The water penetrating into the equipment due to a temporary flood, for example during rough sea conditions, must not cause harmful effect.
7	Protection against immersion.	Water must not penetrate in such a quantity as to damage the equipment, should the equipment itself be immersed for pre-established times and at pre-defined pressure.
8	Protection against submersion.	Water must not penetrate in such a quantity as to damage the equipment, should the equipment itself be submerged at pre-defined pressure and for an undetermined period of time.

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Pipes and connections		
Designation	**Explanation**	**Symbol**
Pressure line	Line for the energy transfer	
Control line	Line for the transfer of the control energy (including regulation)	
Exhaust or leakage line		
Line connection	Fixed connection, e.g. welded,saldered, screwed (including fittings)	
Crossover	Crossing of unconnected lines	
Flexible line	Connectors of mobile parts	
Electric line	Line for transmitting electrical energy	
Pneumatic pressure source		
Discharge point or vent		
Air exhaust	With not threaded connection	
	With threaded connection	
Compressed air pick-up point	With plug	
	With connecting line	
Quick-acting couplings	Connected, without check valve	
	Connected, with check valve	
	Uncoupled with open end	
	Uncoupled, end blocked by check valve	
Rotating joint (device that allows a rotating movement)	1-way	
	3-way	
Silencer		
Pneumatic accumulator (capacity)		

Air treatment equipment		
Designation	**Explanation**	**Symbol**
Air filter	Device for removing impurity	
Condensate separator	With manual draining	
	With automatic draining	
Filter with condensate separator	With manual draining	
	With automatic draining	
Air drier	Device in which the air is dried	
Lubricator	Device in which small quantities of oil are added to the air flowing through it	
Sequence valve	Valve which, by opening the outlet against the spring force, makes connection with further units	
Pressure reducer (valve which to a large extent holds the outlet pressure at a constant level, even with altered inlet pressure)	Without exhaust valve	
	With exhaust valve (Relieving)	
	Piloted pressure reducer with exhaust valve (Relieving)	
Pneumoelectric transducer	Device converting an input pneumatic signal into an output electrical signal	
Pressure switch	Device switching at an adjustable fixed pressure	
Filter - pressure reducer lubricator group (Detailed symbol)		
Filter - pressure reducer lubricator group (Simplified symbol)		
Filter - pressure reducer group		
Soft - start valve	Pneumatic actuated	
	Solenoid actuated	
Pressure gauge		
Thermometer		
Flowmeter		
Totalizator flowmeter		
Optical tester	Device indicating the presence of pressure by means of an optical reflector	

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Distribution		
Designation	**Explanation**	**Symbol**
2/2 port valve	Two positions at rest, normally closed (N.C.)	
	Two positions at rest, normally open (N.O.)	
3/2 port valve	Two positions at rest, normally closed (N.C.)	
	Two positions at rest, normally open (N.O.)	
4/2 port valve	With two positions and one exhaust	
3/3 port valve	With three positions and closed the neutral one	
5/2 port valve	With two positions and two exhausts	
5/3 port valve	Open centre	
	Pressure centre	
	Closed centre	
Check valve	Unloaded (without spring)	
	Spring-loaded	
Controlled check valve	Pilot operated to close check valve	
	Pilot operated to open check valve	
Shuttle valve (OR type)	The inner port with the higher pressure is automatically connected to the outlet port, while the other inlet port is closed	
Quick-exhaust valve	When the inlet port is not supplied with air, the outlet port is exhausted directly into the atmosphere	
Flow regulator	Bidirectional	
	Unidirectional fixed	
	Unidirectional adjustable	
Flow divider	The flow is divided in two quite similar parts that are indipendent from the variations of pressure	
Shut-off valve	Two port	
	Three port	
Two pressure valve (AND type)	The outlet port is pressurized only when pressure is supplied to both of the inlet ports	

Controls		
Designation	**Explanation**	**Symbol**
Manual actuation	General (without specifying the type of control)	
	By push-button	
	By lever	
	By pedal	
	By pedal with safety device	
Mechanical actuation	By stem or key	
	By spring	
	By roller lever	
	By unidirectional roller lever	
Pneumatic actuation	Direct action by application of pressure	
	Direct action by pressure relief	
	Differential (i.e. pressure dominant pilot)	
	Indirect actuation by application of pressure to the pilot valve	
	Indirect actuation by relieving of pressure on the pilot valve	
Electrical actuation	By solenoid with one winding	
	By solenoid with two in-phase windings	
	By solenoid with two opposing windings	
Combined actuation	By solenoid with one pilot valve	
	By solenoid pilot assisted	
Detent	Device for maintaining a given position	
Release unit	Device for preventing the equipment from blocking at a dead spot	

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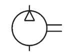
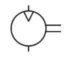
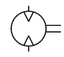
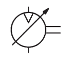
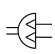
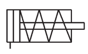
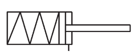
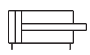
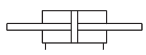
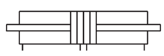
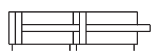
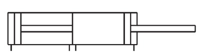
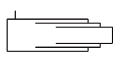
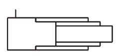
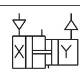
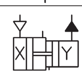
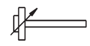
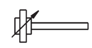
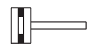
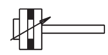
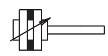
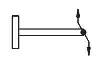
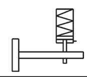
GRAPHIC SYMBOLS

Energy conversion (actuators)		
Designation	**Explanation**	**Symbol**
Compressor	With constant displacement volume (only one direction of rotation)	
Pneumatic motor with constant displacement volume	With one direction of rotation	
	With two directions of rotation	
Pneumatic motor with variable displacement volume	With one direction of rotation	
	With two directions of rotation	
Pneumatic rotary cylinder	With rotary drive limited range of oscillation	
Single acting cylinder	Front spring	
	Rear spring	
Double acting cylinder		
Double acting cylinder through rod		
Tandem cylinder	Opposed	
	Double push	
	Double stroke	
Telescopic cylinder	Single acting	
	Double acting	
Pressure multiplier	For fluids with the same characteristics	
	For fluids with different characteristics	

Rod and piston unit options		
Designation	**Explanation**	**Symbol**
Rod and piston unit	Standard	
	With adjustable cushioning at one end	
	With adjustable cushioning at both ends	
	With magnetic piston	
	With magnetic piston and adjustable cushioning at one end	
	With magnetic piston and adjustable cushioning at both ends	
	With non-rotating piston rod device	
	With piston rod locking unit	

Technical information

COMPARISON AND DESINATION OF CONNECTIONS

Port	ISO 5599	Letter designations
Supply/inlet port	1	P
Working or outlet line	2	B
Exhaust line	3	S
Working or outlet line	4	A
Exhaust line	5	R
Pilot line that reset the output signal	10	Z
Pilot line	12	Y
Pilot line	14	Z
Pre-pilot exhaust line	82	—
Pre-pilot exhaust line	84	—

MULTIPLES AND SUB-MULTIPLES

Prefix	Symbol	Factor
yotta	Y	10^{24}
zetta	Z	10^{21}
exa	E	10^{18}
peta	P	10^{15}
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}
femto	f	10^{-15}
atto	a	10^{-18}
zepto	z	10^{-21}
yocto	y	10^{-24}

*In the U.S.A. this prefix is commonly defined “deka”

CONSUPTION OF AIR TABLE

Cylinder bore D (mm)	Piston rod diameter d (mm)	Motion	Useful area cm²	Consumption of air in thrust and in traction expressed in Nl per cm of stroke as a function of the operating pressure P expressed in bar, at 20°C									
				1 bar	2 bar	3 bar	4 bar	5 bar	6 bar	7 bar	8 bar	9 bar	10 bar
12	4	Thrust	1,13	0,0023	0,0034	0,0045	0,0057	0,0068	0,0079	0,009	0,0102	0,0113	0,0124
		Traction	1	0,002	0,003	0,004	0,005	0,006	0,007	0,008	0,009	0,01	0,011
16	6	Thrust	2,01	0,004	0,006	0,008	0,01	0,0121	0,0141	0,0161	0,0181	0,0202	0,0221
		Traction	1,73	0,0035	0,0052	0,0069	0,0086	0,0104	0,0121	0,0138	0,0156	0,0173	0,019
20	8	Thrust	3,14	0,0063	0,0094	0,0126	0,0157	0,0188	0,022	0,0251	0,0283	0,0314	0,0346
		Traction	2,64	0,0053	0,0079	0,0106	0,0132	0,0158	0,0185	0,0211	0,0238	0,0264	0,029
25	12	Thrust	4,91	0,0098	0,0147	0,0196	0,0245	0,0295	0,0344	0,0393	0,0442	0,0491	0,054
		Traction	3,78	0,0076	0,0113	0,0151	0,0189	0,0227	0,0264	0,0302	0,034	0,0378	0,0415
32	12	Thrust	8,04	0,016	0,024	0,032	0,04	0,048	0,056	0,064	0,072	0,08	0,088
		Traction	6,91	0,014	0,021	0,028	0,035	0,042	0,049	0,058	0,063	0,07	0,076
40	16	Thrust	12,56	0,025	0,038	0,05	0,063	0,076	0,088	0,1	0,113	0,126	0,138
		Traction	10,55	0,021	0,032	0,042	0,053	0,063	0,074	0,088	0,095	0,106	0,116
50	20	Thrust	19,63	0,039	0,059	0,079	0,098	0,118	0,137	0,157	0,177	0,196	0,216
		Traction	16,49	0,033	0,05	0,066	0,082	0,099	0,115	0,132	0,149	0,165	0,181
63	20	Thrust	31,16	0,062	0,093	0,125	0,156	0,187	0,218	0,249	0,28	0,312	0,343
		Traction	28,02	0,056	0,084	0,112	0,14	0,168	0,196	0,224	0,252	0,28	0,308
80	25	Thrust	50,24	0,1	0,15	0,2	0,25	0,301	0,351	0,402	0,452	0,502	0,552
		Traction	45,36	0,091	0,138	0,181	0,227	0,272	0,318	0,363	0,408	0,454	0,5
100	32	Thrust	78,54	0,157	0,238	0,314	0,382	0,471	0,549	0,628	0,706	0,785	0,862
		Traction	70,5	0,141	0,211	0,282	0,352	0,423	0,493	0,564	0,635	0,705	0,775
125	32	Thrust	122,66	0,245	0,368	0,49	0,613	0,736	0,859	0,981	1,104	1,226	1,349
		Traction	114,67	0,229	0,344	0,459	0,573	0,688	0,803	0,917	1,032	1,147	1,262
160	40	Thrust	201,06	0,402	0,603	0,804	1,005	1,206	1,407	1,608	1,809	2,01	2,211
		Traction	188,49	0,377	0,565	0,754	0,942	1,13	1,319	1,508	1,696	1,884	2,673
200	40	Thrust	314,15	0,628	0,942	1,257	1,571	1,885	2,199	2,513	2,827	3,145	3,456
		Traction	301,59	0,603	0,905	1,206	1,508	1,81	2,111	2,413	2,714	3,016	3,318
250	50	Thrust	490,87	0,982	1,473	1,963	2,454	2,945	3,436	3,927	4,418	4,909	5,400
		Traction	471,24	0,943	1,414	1,885	2,356	2,827	2,299	3,770	4,241	4,712	5,184
320	63	Thrust	804,25	1,608	2,413	3,217	4,021	4,825	5,630	6,434	7,238	8,042	8,847
		Traction	773,08	1,546	2,319	3,092	3,865	4,638	5,411	6,185	6,958	7,731	8,504

The following formula is used to determinate the consumption of air:

Q = H x (S+T) x N   where:

Q = consumption of air (Nl/min)

H = cylinder stroke (cm)

S = consumption of air per 1 cm of stroke in thrust

T = consumption of air per 1 cm of stroke in traction

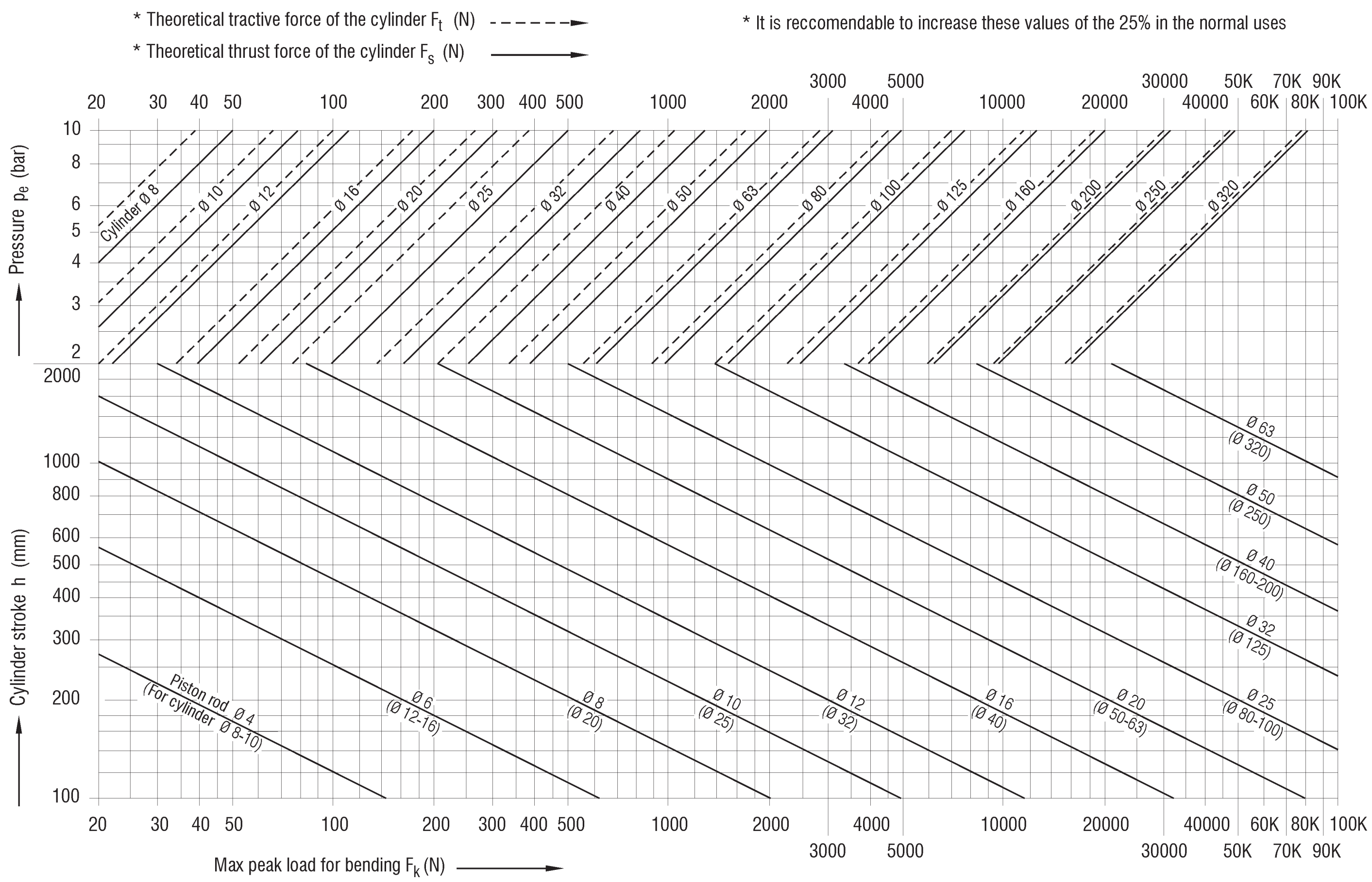
N = number of cycles per minute

Polígono Industrial O Rebullón s/n. 36416 - Mos - España - rodavigo@rodavigo.com

Technical information

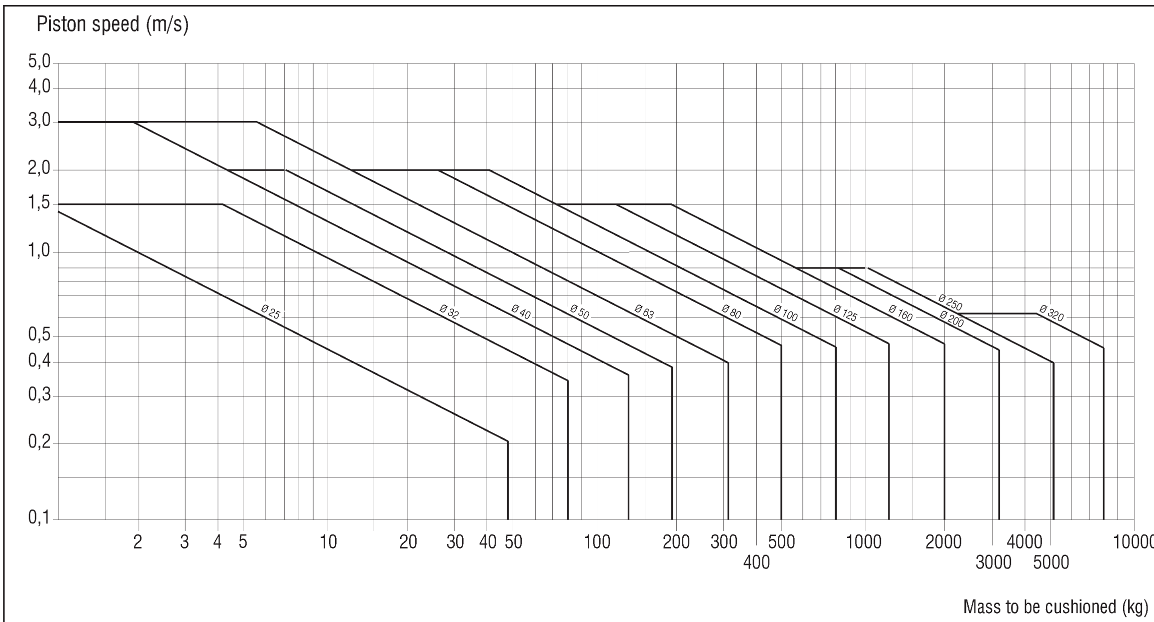
0

PEAK LOAD AND THEORETICAL FORCES



In particular applications the piston rod of the cylinder may be subjected to the peak load; it is then important to control the piston rod diameter in relation to the stroke that should be made, the force developed by the cylinder, the working pressure and the fixings.
The diagram shown has been realized considering the worst condition, consisting in a rear hinge fixing on the cylinder body (in vertical position with the load charging the rod end) and fork on the piston rod.
Given the stroke, the relevant horizontal line is followed until the relevant line to the piston rod diameter (cylinder bore) is crossed; from that point, drawing the vertical line till reaching the x-axis, is obtainable the maximum acceptable peak load.

CUSHIONING DIAGRAM



In order not to compromise the correct fuctioning of the cylinders with harmful impacts, it is necessary to cushion the moving mass to gradually reduce its kinetic energy.
The maximum absorbable mass depends on the speed of traslation and on the absorption capacity of the pneumatic damper.
This diagram gives the speed and the maximum absorbable mass at a pressure of 6 bar for various bores.

Technical information

SPRING THEORETICAL TRACTIVE FORCE FOR SINGLE ACTING CYLINDERS

SERIES X-XT

Stroke (mm)	5		10		15		20		25		30	
Bore (mm)	F.min (N)	F.max (N)	F.min (N)	F.max (N)	F.min (N)	F.max (N)	F.min (N)	F.max (N)	F.min (N)	F.max (N)	F.min (N)	F.max (N)
32	6,2	7,9	-	-	4,6	9,5	-	-	3,8	10,8	-	-
40	-	-	6,9	9,3	7,1	10,3	-	-	6,5	11,1	-	-
50	-	-	12	24,7	-	-	11,1	28,3	-	-	10,9	30,1
63	-	-	13	19,5	-	-	12,4	22,7	-	-	-	-
80-100	18,5	20	-	-	17,5	21,9	-	-	-	-	15,8	23,5

Stroke (mm)	35		40		45		50		100	
Bore (mm)	F.min (N)	F.max (N)	F.min (N)	F.max (N)	F.min (N)	F.max (N)	F.min (N)	F.max (N)	F.min (N)	F.max (N
32	3,9	12,2	4,3	13	4,8	13,5	6,5	14,4	-	-
40	5,8	11,7	-	-	-	-	5,6	12,2	-	-
50	-	-	10,5	31,2	12,5	31,9	13,9	32,4	-	-
63	9,7	24,8	11,5	26,3	-	-	11,3	27,5	-	-
80-100	-	-	15,2	24,8	-	-	14,9	26	10,3	30,9

SERIES C

Bore (mm)	Stroke (mm)					
	5		10		15	
	F.min (N)	F.max (N)	F.min (N)	F.max (N)	F.min (N)	F.max (N)
6	1,6	3,7	1,6	3,9	1,6	3,9
10	7,4	11,5	6	12,5	6,8	12,8
16	8,4	9,5	8,4	10,7	7,4	10,7

SERIES U

Bore (mm)	Stroke max (mm)	F.min (mm)	F.max (mm)
8 - 10	20	1,5	2
12 - 16	50	2	4
20	50	2,9	5,8
25	50	7,3	11,1

SERIES P

Bore (mm)	Stroke max (mm)	F.min (mm)	F.max (mm)
32	50	11,5	60,9
40	50	46,4	84,5
50	50	72	124,3
63	50	66,3	142

SERIES BX

Bore (mm)	Stroke max (mm)	F.min (mm)	F.max (mm)
20	25	4	9
25	25	7	22
32	25	11	27
40	25	19	36
50	25	32	54
63	25	41	76
80	25	58	96
100	25	55	95

SERIES BU

Bore (mm)	Stroke max (mm)	F.min (mm)	F.max (mm)
20	25	6	17
25	25	10	37
32	25	20	51
40	25	24	52
50	25	39	69
63	25	54	92
80	25	76	125
100	25	111	179

SERIES B

Bore (mm)	Stroke max (mm)	F.min (mm)	F.max (mm)
12-16	25	6	13
20	25	8	23
25	25	11	28
32	30	14	37
40	30	25	73
50	30	40	100
63	30	45	111
80	30	70	166
100	30	90	198

SERIES HB

Bore (mm)	Stroke max (mm)	F.min (mm)	F.max (mm)
20	20	12	33
27	25	40	85
35	35	30	67
40	60	39	84
50-70	70	48	120
58	60	54	139
85	90	75	225
100	100	81	259

Technical information

0 CONVERSION TABLES

Torque

	inchounce (ozf·in)	inchpound (lbf·in)	footpound (lbf·ft)	kilogrammetro (kgf·m)	Newtonmetro (N·m)
1 inchounce =		0,0625	0,0052	7,2·10^{-4}	7,06·10^{-3}
1 inchpound =	16		0,0833	1,152·10^{-2}	0,113
1 footpound =	192	12		0,1383	1,356
1 kilogrammetro =	1388,7	86,796	7,233		9,80665
1 Newtonmetro =	141,6	8,85	0,7375	0,102	

Length

	Inch (in)	foot (ft)	yard (yd)	millimeter (mm)	meter (m)
1 inch =		0,0833	0,0278	25,4	0,0254
1 foot =	12		0,333	304,8	0,304
1 yard =	36	3		914,4	0,9144
1 millimeter =	0,03937	0,0033	0,00109		0,001
1 meter =	39,37	3,2808	1,0936	1000	

Area

	$inch^2$ (in^2)	$foot^2$ (ft^2)	$yard^2$ (yd^2)	square millimeter (mm^2)	square meter (m^2)
1 $inch^2$ =		0,0069	0,00077	645,16	6,45·10^{-4}
1 $foot^2$ =	144		0,111	92903	0,0929
1 $yard^2$ =	1296	9		836100	0,8361
1 $millimetro^2$ =	0,0016	1,0764·10^{-5}	1,196·10^{-6}		10^{-6}
1 $meter^2$ =	1550	10,764	1,196	10^6	

Force

	Newton (N)	kilopound (kp)	poundforce (lbf)
1 Newton =		0,10197	0,22481
1 kilopound =	9,80665		2,20463
1 poundforce =	4,4482	0,45359	

Density

	ounce / $inch^3$ (ozf / in^3)	pound / $foot^3$ (lbf / ft^3)	grams / $centimeter^3$ (g/cm^3)
1 ounce / $inch^3$ =		108	1,73
1 pound / $foot^3$ =	0,0092		0,016
1 gram / $centimeter^3$ =	0,578	62,43	

Mass

	ounce (oz)	pound (lb)	Kilogram (kg)
1 ounce =		0,0625	0,0283
1 pound =	16		0,4536
1 Kilogram =	35,274	2,2046	

Speed

	foot/second (ft/s)	foot/minute (ft/min)	mile/hour (mi/h)	meter/second (m/s)	Kilometers/hour (km/h)
1 foot/second =		60	0,6818	0,3048	1,097
1 foot/minute =	0,017		0,0114	0,00508	0,01829
1 mile/hour =	1,4667	88		0,447	1,609
1 meter/second =	3,28	196,848	2,237		3,6
1 Kilometer/hour =	0,9113	54,68	0,6214	0,278	

Temperature

	Kelvin (K)	Celsius degree (°C)	Fahrenheit degree (°F)
1 K =		K - 273,15	K · 9/5 - 459,67
1 °C =	°C + 273,15		°C · 9/5 + 32
1 °F =	5/9 · (°F - 32) + 273,15	(°F - 32) · 5/9	

Volume

	$inch^3$ (in^3)	US quart (liq qt)	Imperial gallon (UK) (Imp gall)	$foot^3$ (cu ft)	US gallon (gal)	liter (l)
1 $inch^3$ =		0,0173	0,0036	0,00058	0,0043	0,0164
1 US quart =	57,75		0,2082	0,0334	0,25	0,9464
1Imperial gallon =	277	4,8		0,1604	1,2	4,546
1 $foot^3$ =	1728	29922	6,23		7,48	28,317
1 US gallon =	231	4	0,8327	0,1337		3,785
1 liter =	61,024	1,0567	0,22	0,0353	0,264	

Pressione

	inch Hg	psi	atmosphere	torr	mm Hg	bar	Mpa	kg/cm^2
1 inch Hg =		0,491	0,0334	25,4	25,4	0,0339	0,00339	0,0345
1 psi =	2,036		0,068	51,715	51,715	0,0689	0,00689	0,0703
1 atmosphere =	29,921	14,696		760	760	1,0133	0,10133	1,0332
1 torr =	0,0394	0,0193	0,0013		1	0,0013	0,00013	0,00136
1 mm Hg =	0,0394	0,0193	0,0013	1		0,0013	0,00013	0,00136
1bar =	29,53	14,504	0,987	749,87	749,87		0,1	1,02
1 Mpa =	295,3	145,04	9,869	7498,7	7498,7	10		10,2
1 kg/cm^2 =	28,95	14,22	0,968	735,35	735,35	0,98	0,098	

Flow rate

	m^3/s	l/s	cm^3/s	m^3/h	m^3/min	l/h	l/min	ft^3/min (scfm)	UK Gallon/min	US Gallon/min
1 m^3/s =		10^3	10^6	3600	60	3.6·10^3	60·103	2.1188·10^3	13.198·10^3	15.850·10^3
1 l/s =	10^{-3}		10^3	3,6	60·10^{-3}	3.6·10^3	60	2,1188	13,198	15,85
1 cm^3/s =	10^{-6}	10^{-3}		3600·10^{-6}	60·10^{-6}	3,6	60·10^{-3}	2.1188·10^{-3}	13.198·10^{-3}	15.850·10^{-3}
1 m^3/h =	0.277778·10^{-3}	0,27778	0.277778·10^3		16.667·10^{-3}	10^3	16,667	0,58856	3,6661	4,4028
1 m^3/min =	16.667·10^{-3}	16,667	16.667·10^3	60		6·104	10^3	35,313	219,97	264.17^{-3}
1 l/h =	0.27778·10^{-6}	0.27778·10^{-3}	0,27778	10^{-3}	16.667·10^{-6}		16.667·10^{-3}	0.58856·10^{-3}	3.6661·10^{-3}	4.4028·10^{-3}
1 l/min =	16.667·10^{-6}	16.667·10^{-3}	16.667^{-6}	60·10^{-3}	10–3	60^{-3}		35.313·10^{-3}	219.97·10^{-3}	264.17·10^{-3}
1 ft^3/min =	0.47195·10^{-3}	0,47195	0.47195·10^3	1,699	28.317·10^{-6}	1.6990·10^3	28,317		6,2288	7,4804
1 gallon m. UK =	75.768·10^{-6}	75.768^{-3}	75,768	0,27276	4.5461·10^{-3}	272,76	4,5461	0,16054		1,2009
1 gallon m. USA =	63.090·10^{-6}	63.090·10^{-3}	63,09	0,22712	3.7854·10^{-3}	227,12	3,7854	0,13368	0,83266	

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THREADS COMPARISON TABLE

Ø external (mm)	Ø core (mm)	lead* - turns/inch	metric coarse pitch	metric fine pitch	BSP, G	NPT	UNF
3,8 ÷ 3,9	3,2 ÷ 3,4	0,7	M 4				
4 ÷ 4,2	3,4 ÷ 3,6	36					No. 8-36
4,6 ÷ 4,8	4,0 ÷ 4,2	32					No.10-32
4,8 ÷ 4,9	4,1 ÷ 4,3	0,8	M 5				
5,7 ÷ 5,9	4,9 ÷5,2	1	M 6				
7,7 ÷ 7,9	6,9 ÷ 7,2	1		M 8 x 1			
7,7 ÷ 7,9	6,6 ÷ 6,9	1,25	M 8				
7,7 ÷ 7,9	6,8 ÷ 7,1	24					5/16 x 24
maximum 7,9	minimum 6	27				1/16	
9,5 ÷ 9,7	8,5 ÷ 8,8	28			1/8		
9,7 ÷ 9,9	8,9 ÷ 9,2	1		M 10 x 1			
9,7 ÷ 9,9	8,6 ÷ 8,9	1,25		M 10 x 1,25			
9,7 ÷ 9,9	8,4 ÷ 8,7	1,5	M 10				
maximum10,3	minimum 8,3	27				1/8	
10,9 ÷ 11,1	9,7 ÷ 10	20					7/16 x 20
11,7 ÷ 11,9	10,6 ÷ 10,9	1,25		M 12 x 1,25			
11,7 ÷ 11,9	10,4 ÷ 10,7	1,5		M 12 x 1,5			
11,6 ÷ 11,9	10,1 ÷ 10,4	1,75	M 12				
12,5 ÷ 12,7	11,3 ÷ 11,7	20					½ x 20
12,9 ÷ 13,2	11,4 ÷ 11,9	19			¼		
13,6 ÷ 13,9	11,8 ÷ 12,2	2	M 14				
maximum 13,7	minimum 10,7	18				¼	
15,7 ÷ 15,9	14,4 ÷ 14,7	1,5		M 16 x 1,5			
15,6 ÷ 15,9	13,8 ÷ 14,2	2	M 16				
15,7 ÷ 15,9	14,4 ÷ 14,7	16					5/8 x 16
16,4 ÷ 16,7	14,9 ÷ 15,4	19			3/8		
maximum 17,1	minimum 14,2	18				3/8	
17,6 ÷ 17,9	15,3 ÷ 15,7	2,5	M 18				
18,8 ÷ 19,1	17,3 ÷ 17,8	16					¾ x 16
19,7 ÷ 19,9	18,9 ÷ 19,2	1		M 20 x 1			
19,7 ÷ 19,9	18,4 ÷ 18,7	1,5		M 20 x 1,5			
19,6 ÷ 19,9	17,3 ÷ 17,7	2,5	M 20				
20,7 ÷ 20,9	18,6 ÷ 19,2	14			½		
maximum21,3	minimum 17,4	14				½	
21,7 ÷ 21,9	20,4 ÷ 20,7	1,5		M 22 x 1,5			
21,9 ÷ 22,6	20,3 ÷ 20,8	14					7/8 x 14
23,7 ÷ 23,9	22,4 ÷ 22,7	1,5		M 24 x 1,5			
23,6 ÷ 23,9	20,8 ÷ 21,3	3	M 24				
25,1 ÷ 25,4	23,1 ÷ 23,6	12					1 x 12
26,2 ÷ 26,4	24,1 ÷ 24,7	14			¾		
26,6 ÷ 26,9	24,8 ÷ 25,2	2		M 27 x 2			
maximum 26,7	minimum 22,5	14				¾	
28,3 ÷ 28,6	26,3 ÷ 26,8	12					1 1/8 x 12
29,7 ÷ 29,9	28,4 ÷ 28,7	1,5		M 30 x 1,5			
31,5 ÷ 31,7	29,5 ÷ 30	12					1 ¼ x 12
32,9 ÷ 33,2	30,3 ÷ 30,9	11			1		
maximum 33,4	minimum 28,5	11 ½				1	
35,7 ÷ 35,9	34,4 ÷ 34,7	1,5		M 36 x 1,5			
35,6 ÷ 35,9	33,8 ÷ 34,2	2		M 36 x 2			
37,7 ÷ 37,9	36,4 ÷ 36,7	1,5		M 38 x 1,5			
37,8 ÷ 38,1	35,8 ÷ 36,4	12					1 ½ x 12
41,6 ÷ 41,9	38,9 ÷ 39,6	11			1 ¼		
41,7 ÷ 41,9	40,4 ÷ 40,7	1,5		M 42 x 1,5			
41,6 ÷ 41,9	39,8 ÷ 40,2	2		M 42 x 2			
maximum 42,2	minimum 37	11 ½				1 ¼	
44,7 ÷ 44,9	43,4 ÷ 43,7	1,5		M 45 x 1,5			
47,9 ÷ 47,8	44,8 ÷ 45,5	11			1 ½		
47,6 ÷ 47,9	45,8 ÷ 46,2	2		M 48 x 2			
maximum 48,3	minimum 43,5	11 ½				1 ½	
59,3 ÷ 59,6	56,7 ÷ 57,3	11			2		
59,7 ÷ 59,9	58,4 ÷ 58,7	1,5		M 60 x 1,5			
maximum 60,3	minimum 55	11 ½				2	
79,7 ÷ 79,9	78,4 ÷ 78,7	1,5		M 80 x 1,5			

* for metric screw thread

metric = metric screw thread (coarse pitch = MA; fine pitch = MB)
G = Gas thread ("BSP" according to ISO standard)
NPT = tapered gas thread (used in the U.S.A.)
UNF = fine pitch thread (used in the Anglo-Saxon countries)

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Technical information

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GENERAL TECHNICAL DATA FOR CYLINDERS

OPERATING LIFE

The life cycle of cylinders is affected by manifold factors including: loads (axial and radial), speeds and frequencies of use, average working temperatures, shocks, tolerances of the acceptable pneumatic leakage. Due to the variability of all the factors above mentioned it's not possible to give indications on the life of cylinders that would not be purely theoretical data. The intent of these indications is only to supply a reference value that could help the end user to planning properly during the implementation phase of any installation, and not binding or guaranteed towards the customer. In consideration of all the above, we can give the following values (without radial loads):

- 15,000 km for cylinders with polyurethane seals;
- 8,000 km for cylinders with NBR seals;
- 5,000 km for rodless cylinders.

STROKE TOLERANCES

The actual stroke of the cylinders has a tolerance with respect to the nominal stroke but always in compliance with the applicable standards, if any, or anyway within the following tolerances:

- -0/+1.5 mm for cylinders to ISO 6432 Ø 8 ÷ 25;
- -0.5/+1.5 mm for round cylinders Ø 32 ÷ 63;
- -0/+2 mm for cylinders to ISO 15552 Ø 32 ÷ 50;
- -0/+2.5 mm for cylinders to ISO 15552 Ø 63 ÷ 320;
- -0/+2.5 mm for compact cylinders to AFNOR Ø 20 ÷ 100;
- -0/+1 mm for compact cylinders Ø 12 ÷ 100;
- -0/+2.5 mm for rodless cylinders Ø 18 ÷ 63.

STROKES EXCEEDING THE MAXIMUM VALUE INDICATED IN THE CATALOGUE

Customer can address our commercial office even the "Demand for Feasibility" of cylinders having strokes exceeding the maximum value indicated in the catalogue. By and large Waircom will always be able to supply these cylinders, obviously with the physical limitations of the production technologies, but it will be care and responsibility of only the end user to realize proper solutions (e.g. guiding the piston rod, avoiding peaks loads, etc.) so that these cylinders with non-standard strokes could work properly and securely.

MAGNETIC SENSORS

The intensity and the shape of the magnetic fields generated by permanents magnets housed in the piston assembly depend on the presence of magnetic metal masses in the vicinity of the cylinders that could create mutual magnetic inductance. Therefore these masses may prevent the sensors from switching correctly, in which case non-magnetic materials should be used as, for instance, convenient stainless steel.

INSULATION CLASS - COILS

INSULATION CLASS	TEMPERATURE °C
Y	90
A	105
E	120
B	130
F	155
H	180
200	200
220	220
250	250

The indicated temperature is the effective temperature of the insulation and not the over temperature.

CONTINUOUS SERVICE "ED" - COILS

The coils are normally expected to be used in continuous service (ED 100%). Defination of "Continuous service": when the electrical connection time exceed the thermal constant of the coil by approx. 1/4. As a general rule, the continuous service correspond to an electrical connection time that is equal or higher than 15 minutes. It's possible, for non-continuous service (e.g.ED50%), either to have coils at powers that are higher than the standard ones, or to use the coils with an ambient temperature higher than the ones indicated.

$$ED = \frac{\text{connection time}}{\text{(connection time + disconnection time)}} \times 100$$

EXAMPLE:
$$\frac{5' \text{ (connection time)}}{5' \text{ (connection time)} + 5' \text{ (disconnection time)}} \times 100 = ED\ 50\%$$

Technical information

ATEX DIRECTIVE

Since 1st July 2003, all products marketed in the European Union and intended for use in potentially explosive atmospheres must be approved in compliance with European Directive 2014/34/EU, also know as ATEX.
ATEX word comes from French “Atmospherès Explosibles”, ie explosive atmosphere.
Explosive atmosphere means a mixture with air, under atmospheric conditions of flammable substances in the form of gases, vapours, mists (or dusts) in wich, after ignition has occurred, combustion spreads to the entire unburned mixture (1999/92/CE directive, EN 13237)

A source ignition can be:
a) of electrical origin (electric arcs, induced currents, heat generated by the Joule effect);
b) of mechanical origin (hot surface generated by friction, sparks generated by impact between metal bodies, electrostatic discharge, adiabatic compression);
c) of chemical origin (exothermic reaction between materials);
d) naked flames.

An explosive atmosphere that, if explodes, causes damage is called dangerous (EN 1127-1).

The main points introduced by the directive are:
a) non-electrical equipment and devices, such as pneumatic cylinders, pneumatic valves and air tratment groups are inserted in the directive;
b) each device is assigned a category associated tocertain potentially explosive atmospheres;
c) all products must bear the CE marking;
d) each devices sold for use in potentially explosive areas must be provided with instructions for use and declaration of conformity;
e) the devices are intended for use in potentially explosive atmosphere for the presence of dust fall in the directive similar to products intended for areas with the presence of dust fall in the directive similar to products intended for areas with the presence of dangerous gases with the exception of:

- **a)** medical devices
- **b)** equipment intended for use in places of production or storage of explosives
- **c)** equipment on board ships, or offshore
- **d)** transportation (excluding those for use in explosive atmosphere)
- **e)** equipment for household use
- **f)** biogas plants

Products subjects to approval are all those which, during normal use or due to a malfunction, present one or more sources of ignition for potentially explosive atmospheres.

Responsability lies both with the manufacturer of the device and whoever installs it in equipment that is to operate in a hazardous atmpsphere. This requires co-operation between the parties to ensure correspondence between the category of device and the hazardous area in which it is to operate.

The manufacturer of the device must comply with the specifications and classify the product according to directive 2014/34/EU.
The manufacturer of the equipment, who knows the area in which the device will be operating, must select a suitable device according to the category, pursuant to directive 99/92/EC.

MIXED EQUIPMENT (ELECTRICAL AND MECHANICAL)

According to the Directive 2014/34/EU, both electrical and mechanical devices are subject to the approval of compliance.
The classification of a product composed by multiple devices makes reference to the lowest class of the same devices that compose it.
For example, the product “solenoid valve”, composed by the electrical device“coil” marked 3GD and mechanical device “valve” marked 2GD, it will be put intooperation only in areas of category 3GD

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Technical information

0 ZONES CLASSIFICATION

Devices for use in potentially explosive areas are divided into the following GROUPS:
- GROUP I: devices used in mines
- GROUP II: devices used in surface installations

ZONES CLASSIFICATION ACCORDING TO THE 2014/34/EU DIRECTIVE:

FEATURES OF THE ENVIRONMENT				FEATURES OF THE EQUIPMENT			
Application environment	Flammable material	Potentially Explosive Atmospheres	Classification of potentially explosive atmospheres: ZONE	According to ATEX 94/9/CE		According to IEC 60079-0 EPL	Required level of protection
				Marking required by the equipment: CATEGORY	Marking required by the equipment: GROUP		
Mine				M1	I	Ma	Very high
				M2		Mb	High
Surface	Gas	It's present continuously, for long periods or frequently	0	1G	II	Ga	Very high
		It's likely present	1	2G		Gb	High
		It's unlikely present and if it's present, it is infrequently and for short periods	2	3G		Gc	Normal
	Dust	It's present continuously, for long periods or frequently	20	1D		Da	Very high
		It's likely present	21	2D		Db	High
		It's unlikely present and if it's present, it is infrequently and for short periods	22	3D		Dc	Normal

CORRESPONDENCES BETWEEN ZONES AND CATEGORIES ACCORDING TO 2014/34/EU DIRECTIVE

ZONE 0 / ZONE 20 => CATEGORY 1: equipment of this category guarantees the required level of safety even under rarely occurring equipment fault conditions. This equipment is used where an explosive atmosphere consisting of a mixture of air and gases, vapours or mist or of a dust/air mixture is present continuously or for long periods.

ZONE 1 / ZONE 21 => CATEGORY 2: equipment of this category guarantees the required level of safety even under frequently occurring equipment fault conditions. This equipment is used where an explosive atmosphere consisting of a mixture of air and gases, vapours or mist or of a dust/air mixture is present occasionally.

ZONE 2 / ZONE 22 => CATEGORY 3: equipment of this category provides the required level of safety under normal operating conditions. This equipment is used in areas where in all probability an explosive atmosphere consisting of a mixture of air and gases, vapours or mist or of a dust/air mixture will occur either not at all or only for a short time.

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EXAMPLE OF MARKING FOR MECHANICAL DEVICES (WITHOUT ELECTRICAL COMPONENTS)

Ɛx	II	2	GD	c	T4	T120 °C	20 °C<Ta<60 °C
1	2	3	4	5	6	7	8

1 - ATEX symbol, indicates that the device can be used in Atex zone
2 - Belonging group: mines or other
3 - Belonging category: indicates the use in the different areas
4 - Type of atmosphere (G=gas D=dust)
5 - Method of protection from sources of ignition
6 - Class indicating maximum surface temperature reachable by the device. Indication for Gas
7 - Maximum surface temperature, written in full, reachable from the device. Indication for Dust
8 - Environment temperature for use of the device

EXAPLE OF MARKING FOR MECHANICAL AND ELECTRICAL DEVICES

Ɛx	II	3	G	Ex	nA c	IIC	T4	Gc	/	20 °C<Ta<60 °C
	II	3	D	Ex	Tc	IIIC	T120 °C	Dc	IP65	20 °C<Ta<60 °C
1	2	3	4	5	6	7	8	9	10	11

1 - ATEX symbol, indicates that the device can be used in Atex zone
2 - Belonging group: mines or other
3 - Belonging category: indicates the use in the different areas
4 - Type of atmosphere (G=gas D=dust)
5 - It indicates that the device can be used in ATEX zone
6 - Method of protection from sources of ignition
7 - Subdivision of explosion group
IIC: explosion subgroup that includes all types of gas
IIIC: subgroup subgroup that includes fuels particles, conductive powder and not
8 - Maximum temperature of the device:
Class indicating maximum surface temperature reachable by the device. Indication for Gas
Maximum surface temperature, written in full, reachable from the device. Indication for Dust
9 - Equipment Protection Level
10 - Degree of protection IP (for dust only)
11 - Environment temperature for use of the device

Technical information

0 PROTECTION METHODS AND REFERENCE STANDARDS

Protection symbol		**Zone**						**Description**	**Reference regulation (IEC Ex) (European EN)**
		1		2		3			
		G	D	G	D	G	D		
		0	20	1	21	2	22		
Basic requirements		X	X	X	X	X	X	General requirements	IEC 60079-0 EN 60079-0
c				X	X	X	X	Protection by constructional safety	EN 13463-5
d				X		X		Flameproof enclosure. Type of protection in which the parts which can ignite an explosive atmosphere are placed in an enclosure which can withstand the pressure developed during an internal explosion of an explosive mixture and which prevents the transmission of the explosion to the explosive atmospheres surrounding the enclosure.	IEC 60079-1 EN 60079-1
e				X		X		Increased Safety Electrical apparatus with a high safety coefficient	IEC 60079-7 EN 60079-7
i	ia	X						Intrinsic Safety Type of protection when no spark or any thermal effect in the circuit, produced in the test conditions prescribed in the standard (which include normal operation and specific fault conditions), is capable of causing ignition.	IEC 60079-11 EN 60079-11
	ib			X					
	ic					X			
	iD		X		X		X		IEC 61241-11 EN 61241-11
m	ma	X						Encapsulation Type of protection in which the parts which can ignite an explosive atmosphere are enclosed in a resin sufficiently resistant to the environmental influences in such a way that this explosive atmosphere cannot be ignited by either sparking or heating which may occur within the encapsulation.	IEC 60079-11 EN 60079-11
	mb			X					
	mc					X			
	mD		X		X		X		EN 61241-18 IEC 61241-18
n						X		Method of protection for electrical equipment designed so that it will not ignite the surrounding explosive atmosphere in normal operation and under certain fault conditions specified in the standard. There are 4 categories of equipment: nA (non-sparking), nC (enclosed break), nR (restricted breathing), nL (limited energy).	IEC 60079-15 EN 60079-15
o				X		X		Oil immersion. Type of protection in which the electrical apparatus is immersed in oil.	IEC 60079-6 EN 60079-6
p	px			X				Pressurized enclosure Type of protection in which the protective inert gas inside the enclosure is maintained at a higher pressure than that of the surrounding atmosphere.	IEC 60079-6 EN 60079-6
	py			X					
	pz					X			
	pD				X				EN 61241-4 IEC 61241-4
q				X		X		Type of protection in which the enclosure is filled with a material in a finely granulated state.	IEC 60079-5 EN 60079-5