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Analysis of Pneumatic Circuits with FluidSim

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Abstract: *In this paper, we study the pneumatic schemes with FluidSim software from Festo. The pneumatic circuits have the advantage that they do not pollute the air and have a low energy consumption. Therefore, pneumatic installations are used in various technical fields. The pneumatic installations must be adapted according to the purpose for which they are used. At the beginning, the pneumatic installation must be designed and after that, it can be mounted. The project of installations consists in drawing pneumatic schemes. In introduction, we present the role and the main fields in which the pneumatic installations are used. After that, we describe those basic pneumatic devices that constitute the pneumatic schemes. Based on pneumatic devices described, we will make some simple and complex pneumatic circuits.*

Keywords: *FluidSim, pneumatic, scheme, circuit, cylinder*

1. Introduction

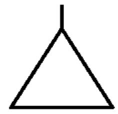
The first inventions described in the field of pneumatics were made by the mathematician Hero (10-75 A.D.) from Alexandria. These inventions in the field of pneumatics are based on the power of wind and steam, [1].
But today all pneumatic devices work based on air pressure is achieved by an air compressor. In order for compressed air to reach from the compressor to the pneumatic devices, it must pass through air line hoses, [2].
In fact, all pneumatic systems generally consist of two parts: operative and control.
The operative part is made of all pneumatic devices. The control part has the role of providing pneumatic control signals to the pneumatic devices, Fig. 1.
Pneumatic installations are used in: education, research, car service, wagon repair workshop, locomotive depot, etc, [3].

Fig. 1. Pneumatic trainer kit type TP 101, [4]

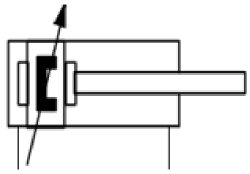
2. Pneumatic devices

In recent years, much has been invested in the development of pneumatic devices, [5].
Thus, the latest generations of devices can operate at a lower In this paper, we present the main features for the following pneumatic devices: air distributor, double acting cylinder, air service unite.

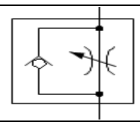
- Compressed air supply

Designation	Range	Value	Unit	Symbol
Operating pressure	0..2	0.6	MPa	
Volume	0.001...1000	0.1	l	
Max flow rate	0...5000	1000	l/min	

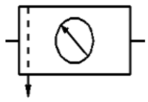
- Double acting cylinder

Designation	Range	Value	Unit	Symbol
Piston diameter	0.001...2	0.02	m	
Piston rod diameter	0...1	0.008	m	
Maximum stroke	0.001...0.2	0.1	m	
Piston position	0..5	0	m	
Mounting angle	0...360	0	deg	

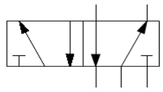
- Throttle check valve

Designation	Range	Value	Unit	Symbol
Standard nominal flow rate	0.1..5000	85	l/min	
Opening level	0...100	100	%	

- Air service unite

Designation	Range	Value	Unit	Symbol
Standard nominal flow rate	0.1..5000	750	l/min	
Nominal pressure	0...2	0.6	MPa	

- Distributor type 5/n way valve

Designation	Range	Value	Unit	Symbol
Standard nominal flow rate	0.1..5000	60	l/min	
Desired position	0...4	2	-	

The advantage of pneumatic installations ist hat the devices can be replaced very easily. For example, double cylinder with cylinder without piston rod. Or types of distribuitors: a 5/n way valve with another a 6/n way directional valve. Change of the devices from the pneumatic installations is made according to the necessities. Usually the pneumatic devices change when: the part fails, there is another type of part, when the pneumatic installation is maintained, etc. Always after mounting the pneumatic device with the air line hoses through which the air passs, check for air leaks, [4].

3. Pneumatic schemes

In order to build a pneumatic installation, a pneumatic circuit must be realised first time. At present, the pneumatic schemes are designed with special software. For the project of pneumatic circuits, we use the FluidSim software. At the beginning, we will represent a simple pneumatic scheme, Fig.2.

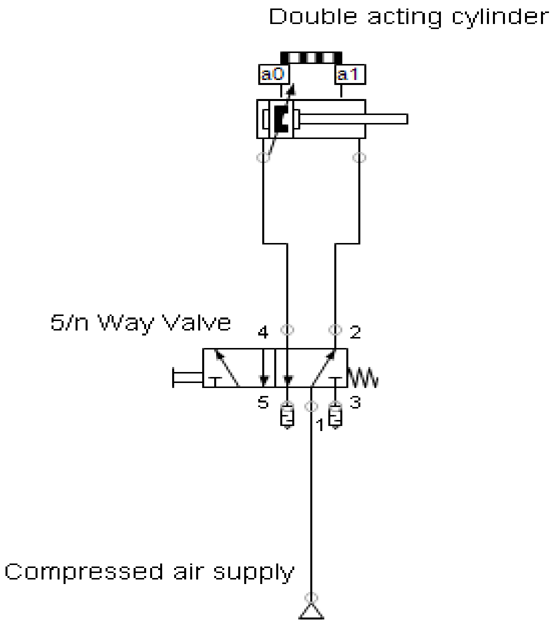


Fig. 2. Pneumatic schemes – Case 1

The first pneumatic circuit is composed of:

- A double acting cylinder.
- A distributor type 5/n way valve.
- A compressor.

For the pneumatic cylinder are three diagrams on the following parameters: position (x), velocity (v) and acceleration (a), Fig. 3.

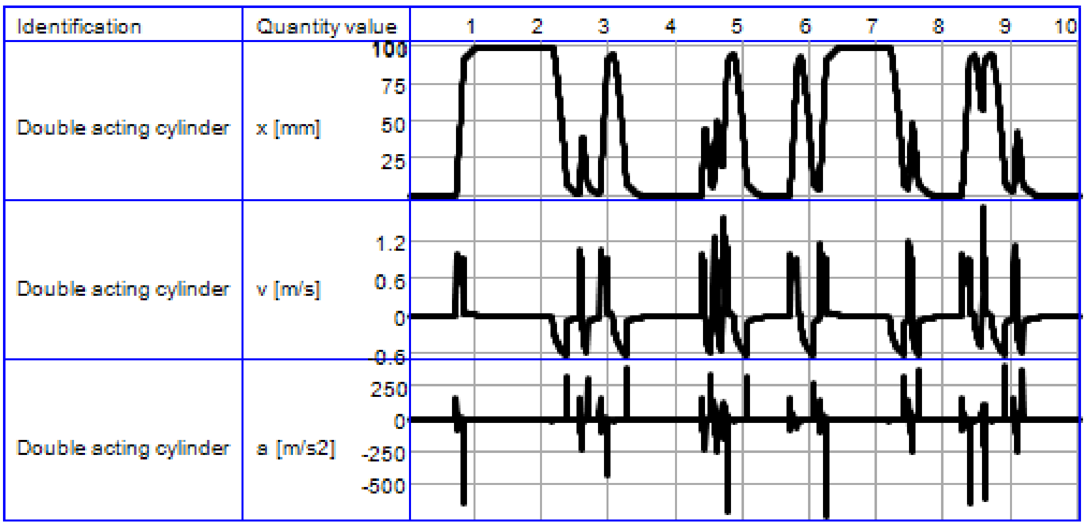


Fig. 3. Double acting cylinder diagrams – Case 1

The compressor supplies air with a maximum pressure of P_{max} = 0.6 MPa.

At the circuit in case 1, we mount a throttle check valve. The throttle check valve is used for controlling the operation speed from pneumatic cylinder, Fig.4.

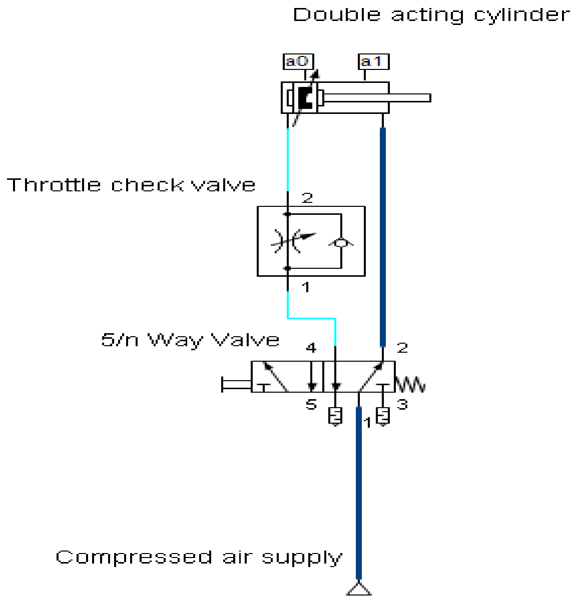


Fig. 4. Pneumatic schemes with throttle check valve – Case 1

Further, to this pneumatic circuit we add an air service unit and air filter, Fig. 5.
Air filter removes impurities present in compressed air before it is delivered to the pneumatic components, [6].

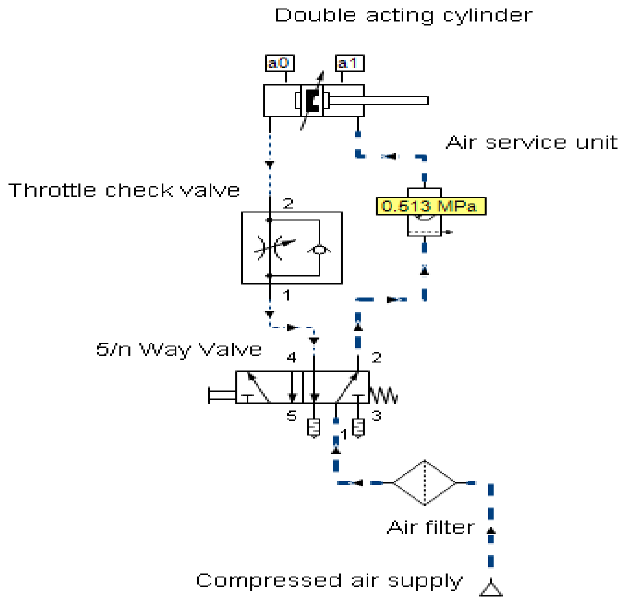


Fig. 5. Pneumatic schemes with air service unit and air filter – Case 1

Ordinarily air service unit is present after a compressor in a pneumatic circuit. The function of this device is to remove humidity, dust particles and moisture from the compressed air, [7].
The piston in the cylinder moves from a0 to a1. The pressure in the air service unit is P= 0.513 MPa, when we recorded the piston movement. When the piston reaches and in a1 then it moves in reverse, meaning from a1 to a0, Fig. 5.
The second pneumatic circuit scheme is made of following devices, Fig. 6:

- two double acting cilynder adjustable (cylinder I and II).
- two pressure gauges.
- Two distributors types 5/n way wave.
- three distribuitors types 3/n way wave
- a compressor.

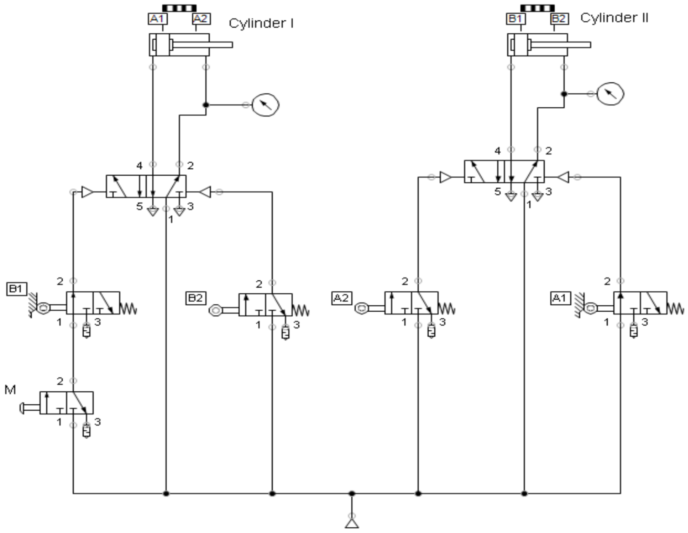


Fig. 6. Pneumatic schemes – Case 2

We perform a simulation of the pneumatic system from case 2. Press the M button to start the pneumatic circuit in case 2. At the beginning, the piston from cylinder I moves between point A1 and point A2. Afterwards, the piston from cylinder II between points B1 and B2. During the movement of the pistons, there are pressure variations in the pneumatic cylinders. In our case, the pressure in cylinder I is P_I = 0.486 MPa and pressure in cylinder II is P_{II} = 0.6 MPa, Fig.7.

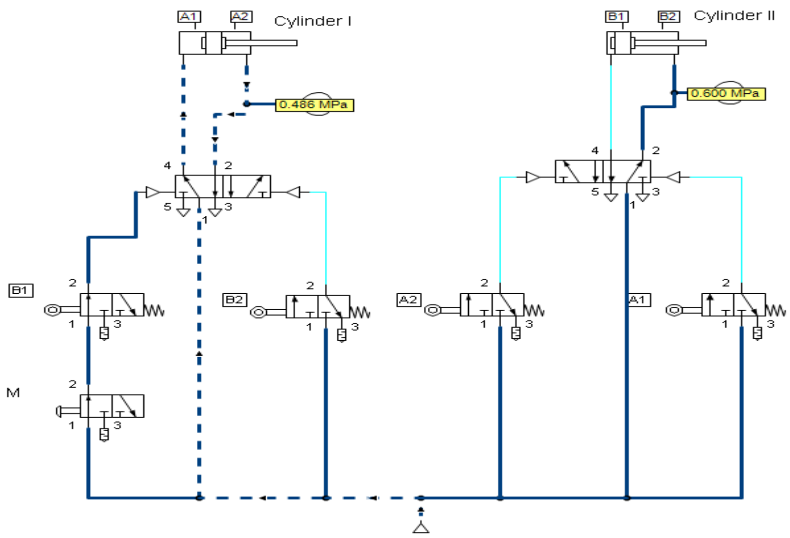


Fig. 7. Pneumatic circuit open – Case 2

After the piston from cylinder II reaches in point B2, then pistons return. First, the piston from cylinder II moves between point B2 and point B2 and then the cylinder I move from points A2 and A1, Fig. 7.

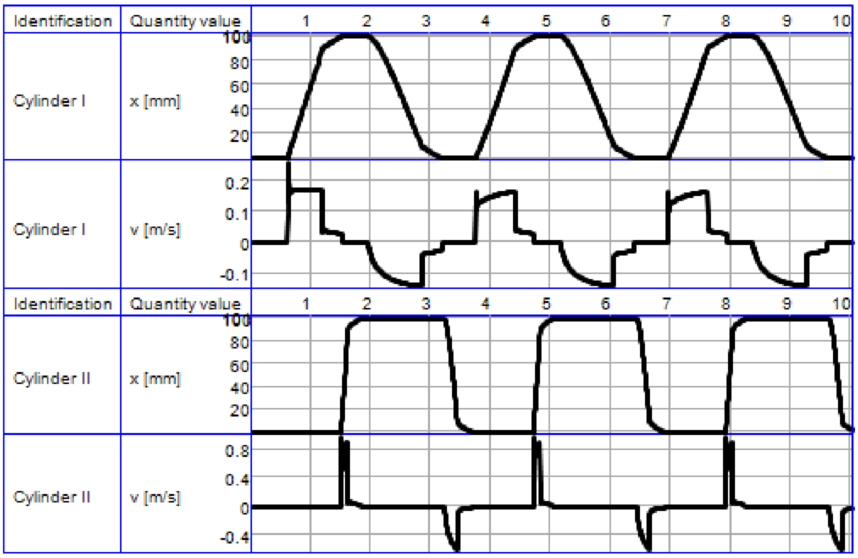


Fig. 8. Pneumatic cylinders diagrams - Case 2

Diagrams are made from both cylinders that have parameters: position(x) and velocity(v), Fig. 8.

4. Conclusions

The project of the pneumatic circuits with the FluidSim software is done in a short time. Pneumatic scheme can be modified depending on the field in which the pnumatic installation is used. After the pneumatic system is designed, a simulation of the circuit can be performed. If in this article, we have simulated pneumatic circuits with one or two cylinders. In the future we cab design pneumatic schemes with three or four pneumatic cylinders. Pneumatic installations can be made quickly and easily if the pneumatic circuits are amde with FluidSim from Festo. Devices that are defective or old, can be replaced with other high performance devices in pneumatic installations bassd on the projected circuits. Based on simple pneumatic circuits, complex pneumatic circuits can be developed. Thus, it is possible to build complex pneumatic installations with an optimal energy consumption

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