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Efficiency analysis of the single-acting pneumatic cylinder

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Abstract
This paper work presents aspects related with the use of single acting cylinder. Besides of it, the single acting cylinder is a pneumatic actuator. In the manuscript there are presented two pneumatic circuits with single acting cylinder. The first pneumatic circuit contains of the following devices: compressed air supply, 3/2 way solenoid with spring and a single acting cylinder (Cl 1-1). Forward, the second pneumatic circuit contains of the following devices: compressed air supply, throttled valves, 3/2 way solenoid valve and single acting cylinders (Cl 2-1 and Cl 2-2). Besides it also contains: compressed air supply, air service unit, throttle check valve, 3/2 way solenoid valve solenoid, single-acting cylinder (Cl 3-1), relays, lamps and valves solenoid. The design and simulation of the both pneumatic circuits from this manuscript is done by FluidSim software from Festo.

Keywords: Efficiency, Cylinder, Pneumatic, Spring

1. Introduction

A single-acting pneumatic cylinder has only one port, this allows the compressed air to enter the actuator chamber. Folowing this case the piston rod it can move in one direction only, as shown in Fig 1 below.

Fig 1: Single-acting pneumatic cylinder

Adjustable parameters of single acting cylinder are shown in Table 1 below.

Table 1: Adjustable parameters and symbol

Designation	Value	Unit
Bore	$20 \cdot 10^{-3}$	m
Stroke	$25 \cdot 10^{-3}$	m
Length	$49.5 \cdot 10^{-3}$	m
Width	$32 \cdot 10^{-3}$	m
Height	$34 \cdot 10^{-3}$	m
Minimum operating temperature	274.15	K
Maximum operating temperature	353.15	K

The single-acting pneumatic cylinder has a specific symbol that is used in the specialized literature, as shown in Fig 2 below.

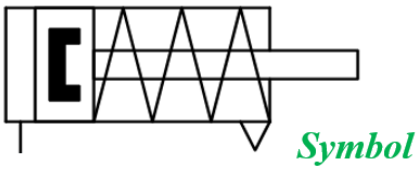

Fig 2: Symbol of single-acting cylinder

2. Study of single-acting cylinders

The pneumatic installations uses compressed gas or air under pressure to produce mechanical movement for tools and devices [1].

In fact, the first pneumatic circuit is made for a simple installation.

The first pneumatic circuit studied by authors has one single-acting cylinder, as in Fig 3.

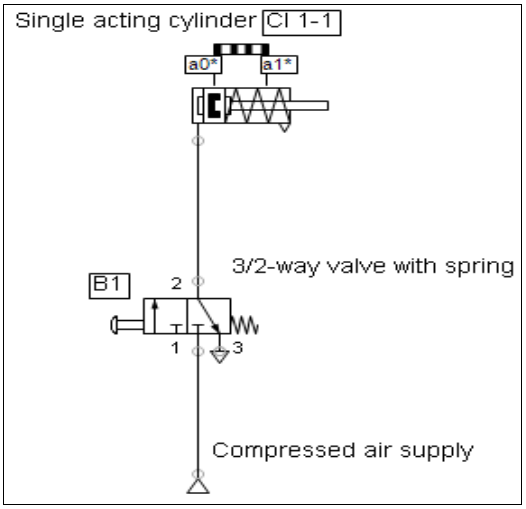

Fig 3: First pneumatic circuit with cylinder (Cl 1-1)

Compressed air supply are the main component of a pneumatic air circuit [2].

In the table below shows three component devices used in the first pneumatic scheme.

Table 2: The devices of the first pneumatic installation

Description	Number of components
Compressed air supply	1
3/2 way solenoid valve with spring	1
Single acting cylinder (Cl 1-1)	1

If operator will press B1 button, this button belong of the 3/2 way solenoid valve with spring [3].

Then, both piston rods moves from point a0* to point a1*. After that, those both piston rods returns from point a1* to point a0*, because the3/2 way valve has a spring, as in Fig 4.

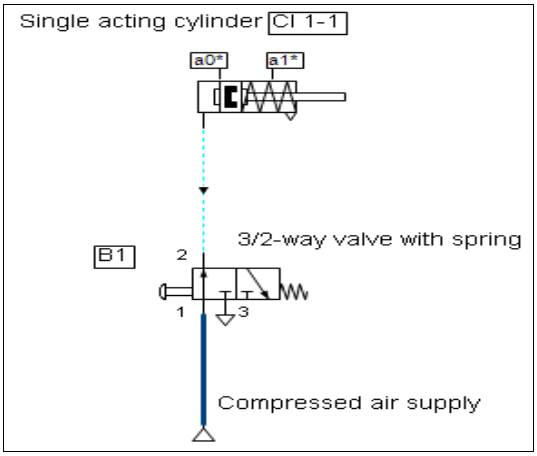

Fig 4: Pneumatic circuit using single-acting cylinder (Cl 1-1). Simulation

The state diagrams given show variation of the following functionality and principal parameters of the single-acting cylinder (Cl 1-1) [4].

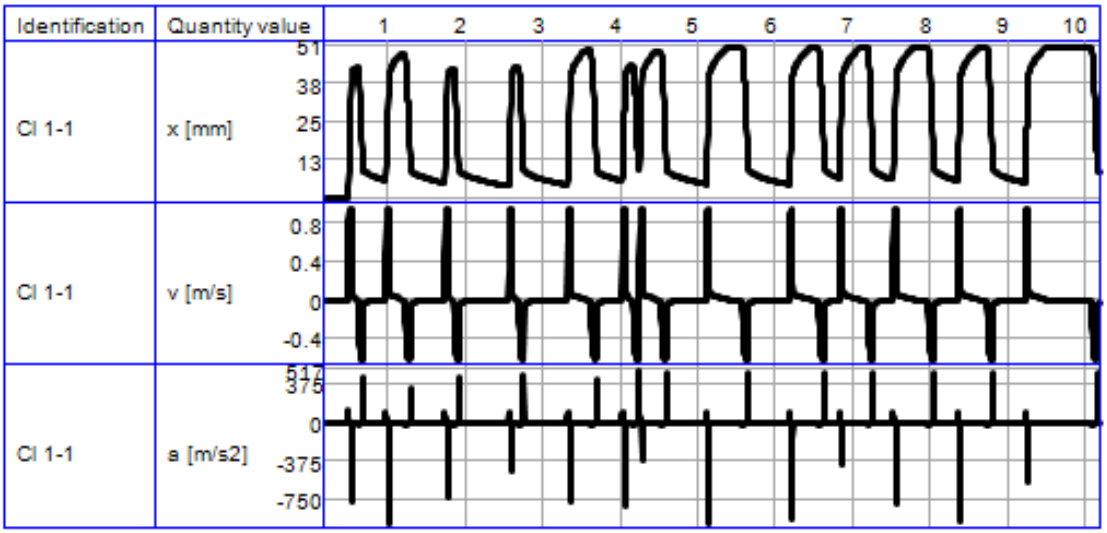

Fig 5: The state diagrams of single acting cylinder

Likewise, this parameters are: position (x), velocity(v) and acceleration (a), as in Fig 5.

The following pneumatic circuit is made of two cylinders that have air supply, as shown in Fig 6 below.

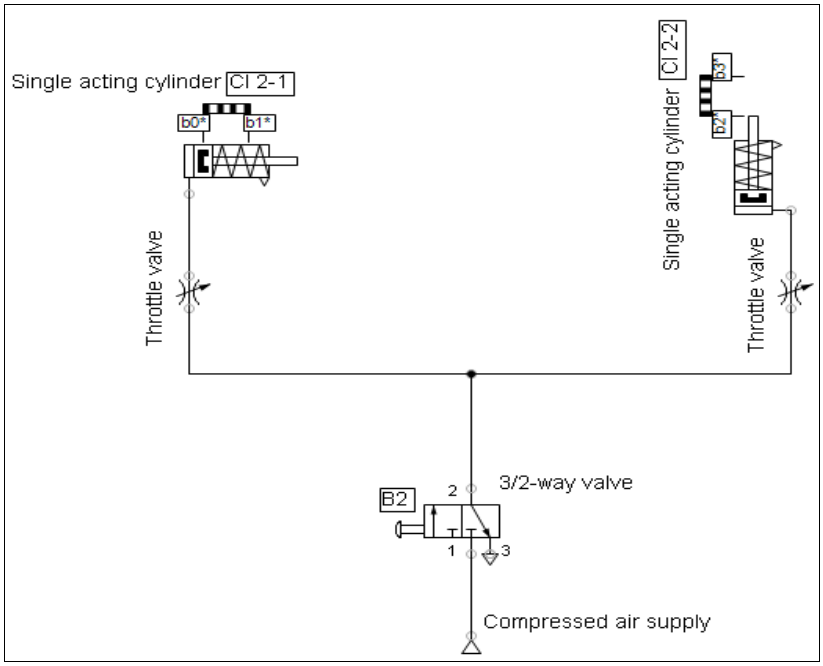

Fig 6: The second pneumatic circuit with two cylinders

In the table below shows seven component devices used in the first pneumatic scheme.

Table 3: The devices of the second pneumatic scheme

Description	Number of components
Compressed air supply	1
Air filter	1
3/2 way solenoid valve	1
Thtrottled valve	2
Single acting cylinder (Cl 2-1 and Cl 2-2)	2

The operator presses B2 button, this button belong of the 3/2 way valve [5].

Then, both piston rods moves, there the first piston rod moves from point b0* to point b1* and second piston rod moves point b2* to point b3*.

If the operator presses B2 button again, then, those both piston rods returns [6].

Such as, the first piston moves from point b1* to point b0* and respectively the second piston moves from point b3* to point b2* because the 3/2 way valve has not a spring, as shown in Fig 7 below.

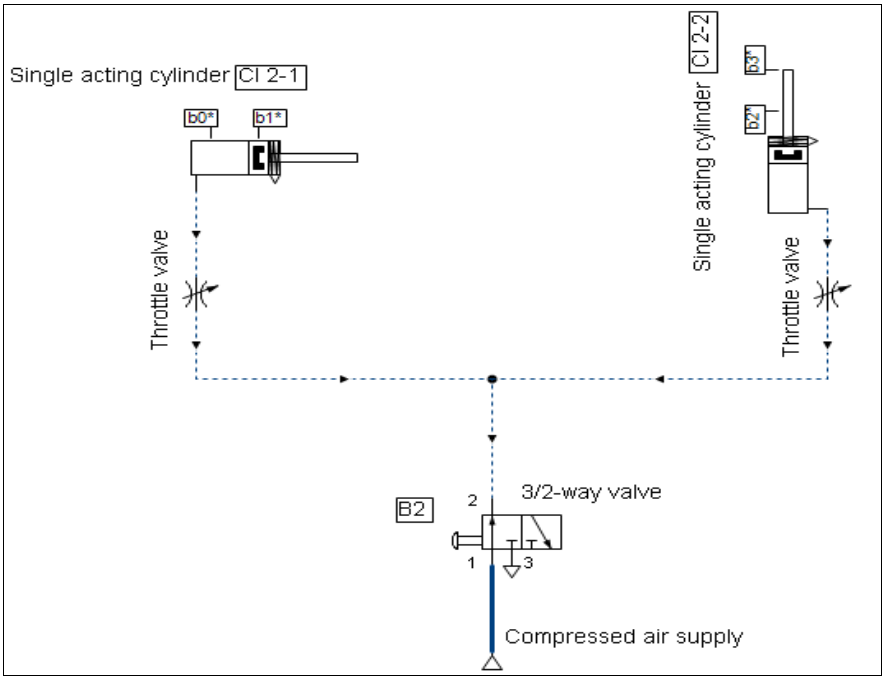

Fig 7: Pneumatic circuit with two cylinders. Simulation

The electro-pneumatic circuit with a single-acting cylinder has a lower energy consumption, as in Fig 8.

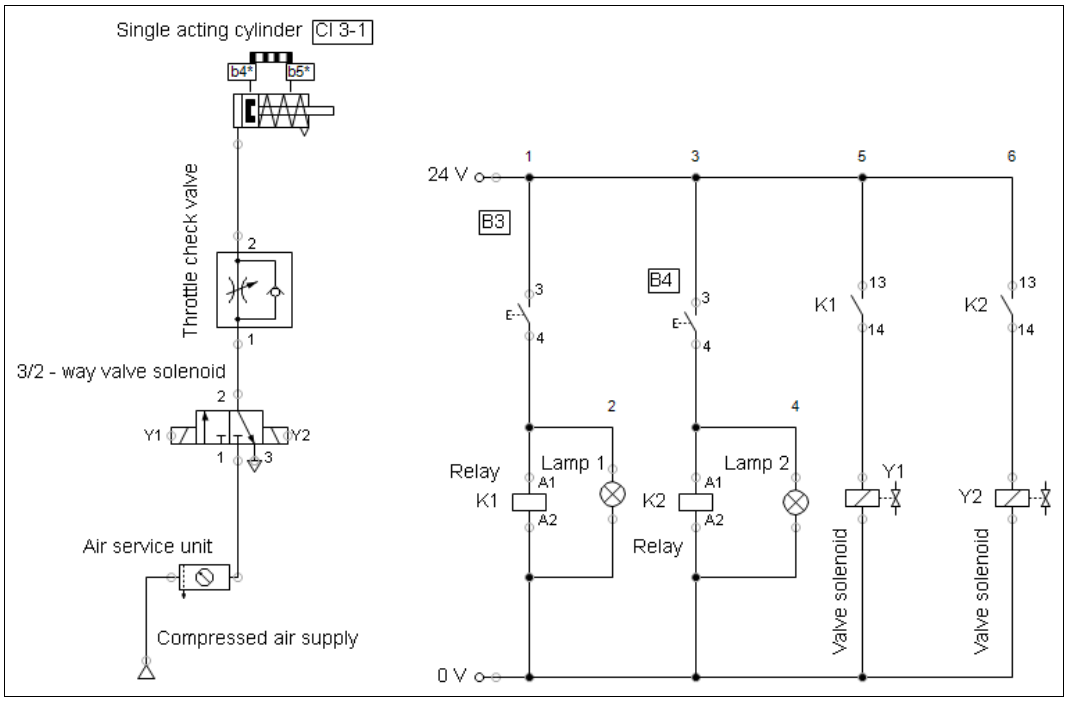

Fig 8: Electro-pneumatic circuit with cylinder (Cl 3-1)

Table 4: The devices of the second pneumatic scheme

Description	Number of components
Compressed air supply	1
Air service unit	1
3/2 way solenoid valve	1
Thtrottle check valve	1
Single-acting cylinder (Cl 3-1)	1
Relay	2
Lamp	2
Valve solenoid	2

The operator presses B3button, butt this is on the belong of the 3/2 way valve solenoid [7].

Then, both piston rods moves. Thereby, the piston rod moves from point b4* to point b5* and lamp 1 shows a yellow signal, as in Fig 9.

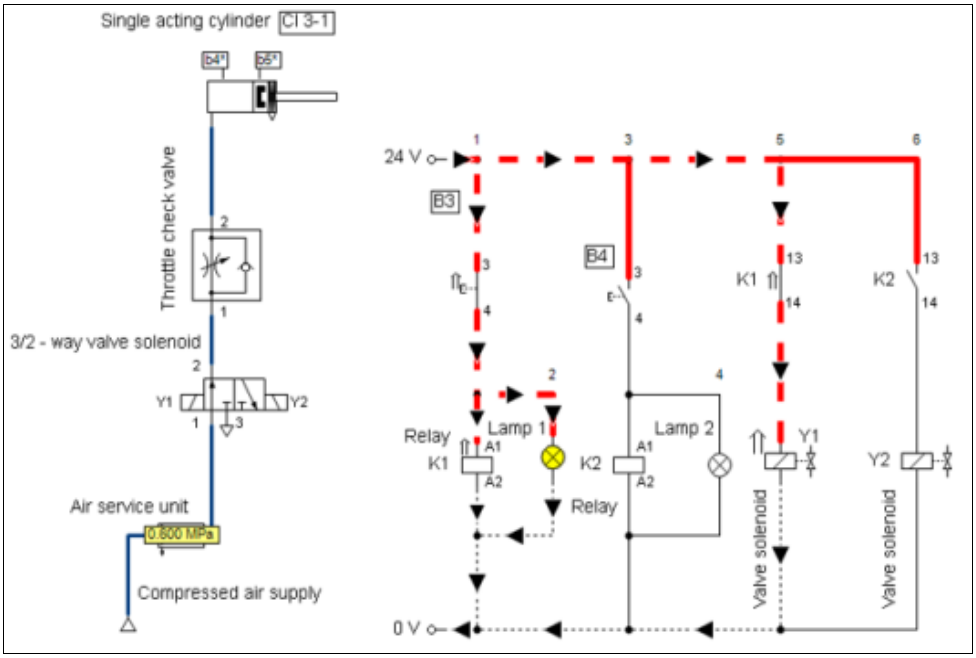

Fig 9: Electro-pneumatic circuit with cylinder (Cl 3-1). Simulation I

If operator presses B4button,then the piston rod returns [8].

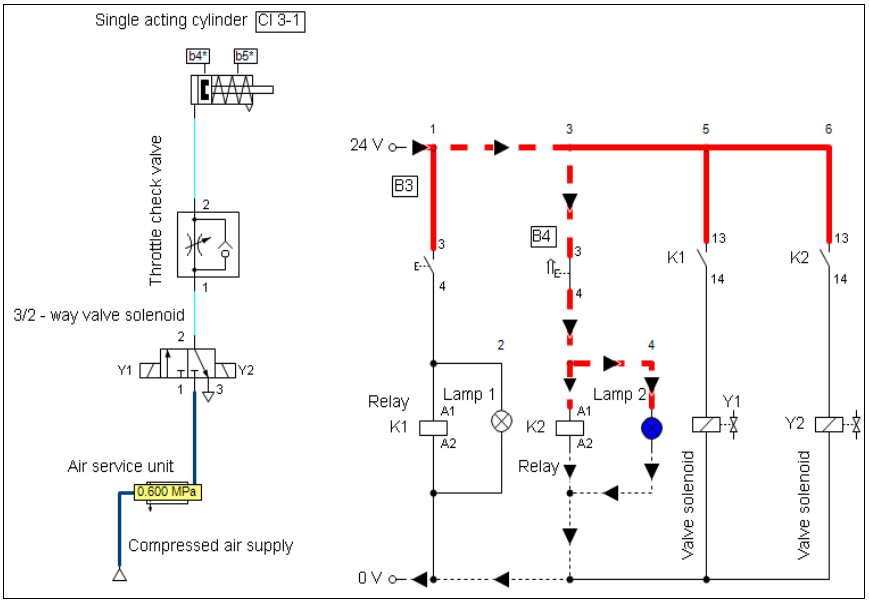

Fig 10: Electro-pneumatic circuit with cylinder (Cl 3-1). Simulation II

The piston rod moves from point b5* to point b4* and lamp 2 shows a blue signal, as in Fig 10 above.
In the pneumatic circuit, airflow efficiency has an important role, as shown in Fig 11 below.

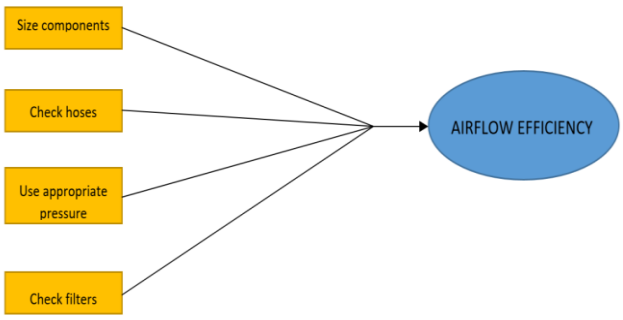

Fig 11: Components of air flow efficiency

But for single there is eight ways to measure efficiency,as shown in Fig 12 below.

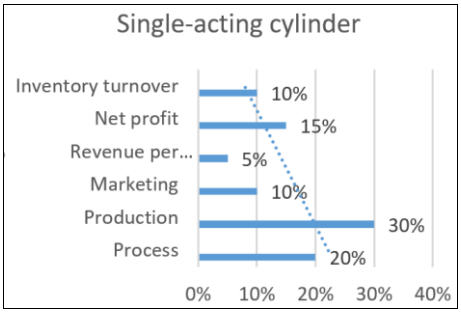

Fig 12: Ways to measure efficiency of single-acting cylinder

3. Conclusions

The schemes shown above allows the experimental verification of an single acting cylinder. The advantage of a pneumatic circuit with single acting cylinder is:

- Safety.
- Low cost.
- Ease of cleaning.
- Source availability.
- Quiet operation.

In fact, the pneumatic scheme has single acting cylinder and it can be ussed for the students practics. In the future we will work and make an project of an electro-pneumatic scheme with single acting cylinder.

4. References

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