A LEVEL DESIGN ENGINEERING

6.6 PNEUMATICS

Learning objectives

- ❑ What are pneumatic systems?
- ❑ What are the pros and cons?
- ❑ What are the common applications?
- ❑ What are the types of pneumatic cylinder?
- ❑ How can pneumatics be used to increase mechanical advantage?
- ❑ How are pneumatic systems controlled?

Key words:

Pneumatics, cylinders, single acting, double acting, stroke, instroke, outstroke, solenoid valve

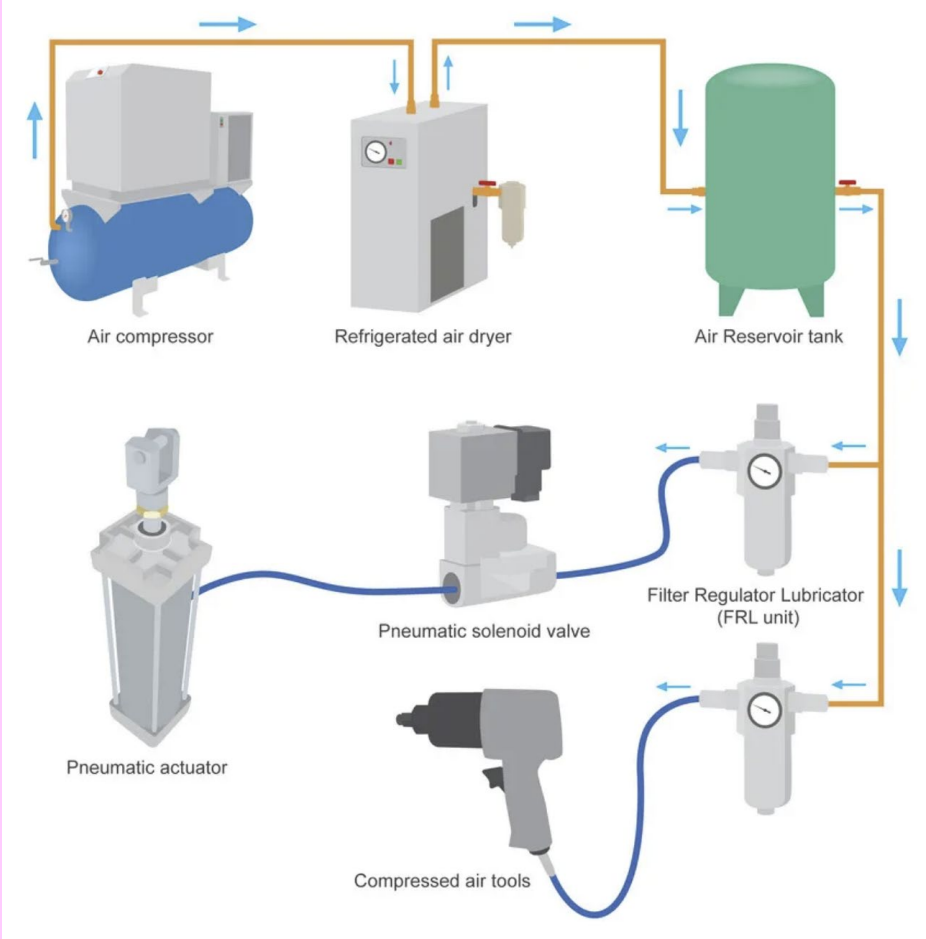
Learning objectives:

- ❑ What are Pneumatic systems?
- ❑ How are pneumatic systems controlled?
- ❑ How can pneumatic systems be used to increase mechanical advantage?

Explanation

What are pneumatic and hydraulic systems?

A **pneumatic system** is a collection of interconnected components using compressed air to do work for automated equipment.



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Explanation

What are the applications of pneumatic systems?

-Automatic doors on busses and trains

-Breaking systems on trains and lorries

What are the advantages/disadvantages of using these systems?

-Pneumatic systems can distribute the energy easily
-Compressed air lines easy to route
-Provides mechanical advantage
-Can provide long stroke length

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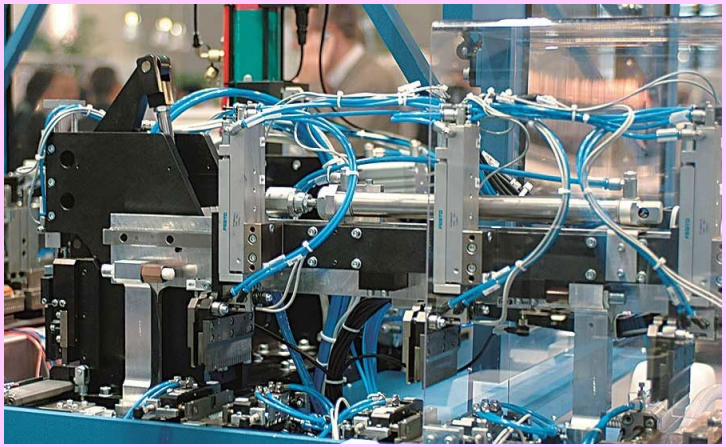
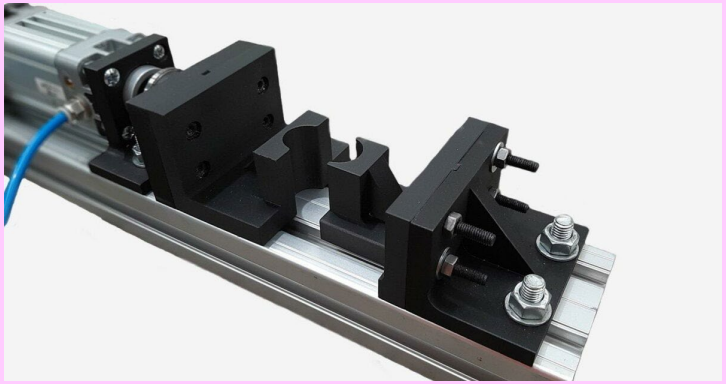
Explanation

How are pneumatics used in industry?

-Operating clamps
-Opening gates
-Moving objects





Learning objectives:

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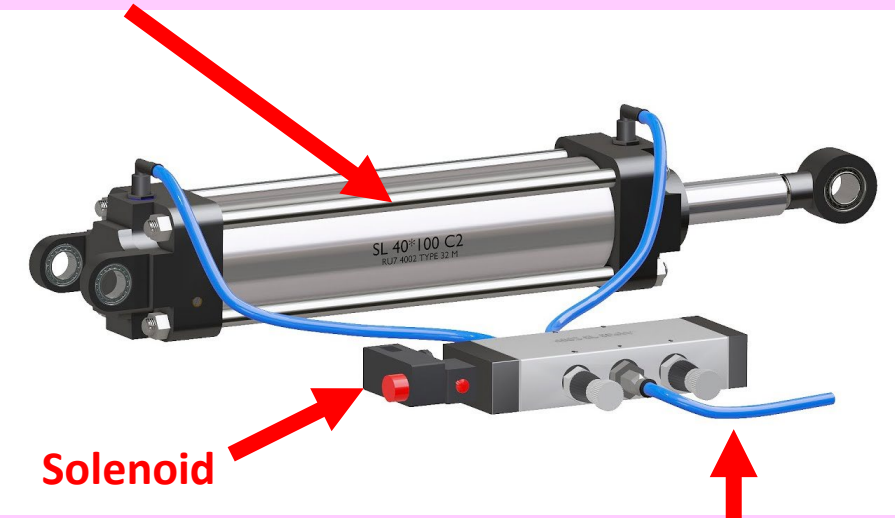
Explanation

How are pneumatic systems controlled?

Double acting cylinder (DAC)



The flow of compressed air in and out of the cylinder is controlled with a solenoid valve

Learning objectives:

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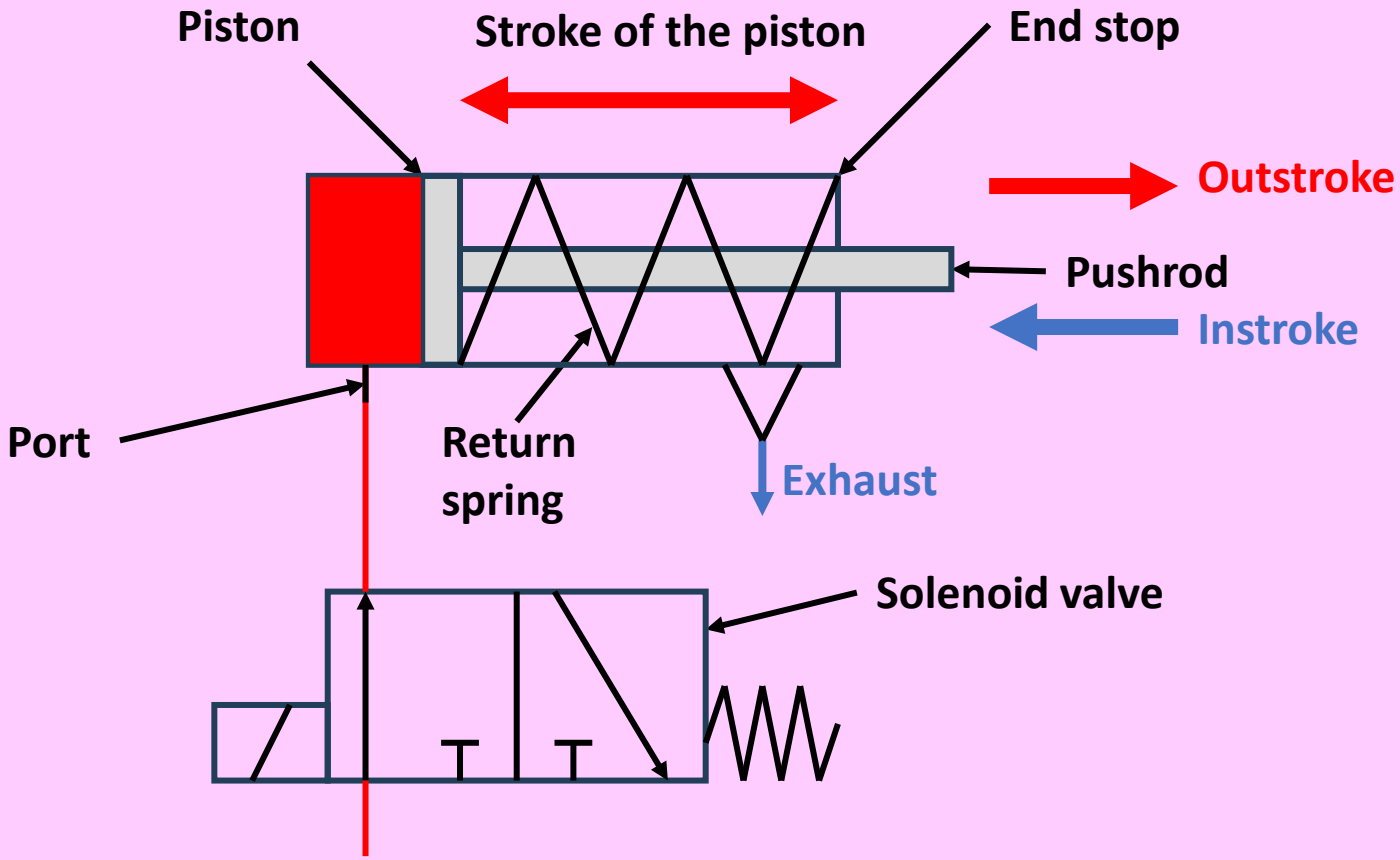
Explanation

What are the key terms associated with pneumatics?



Learning objectives:

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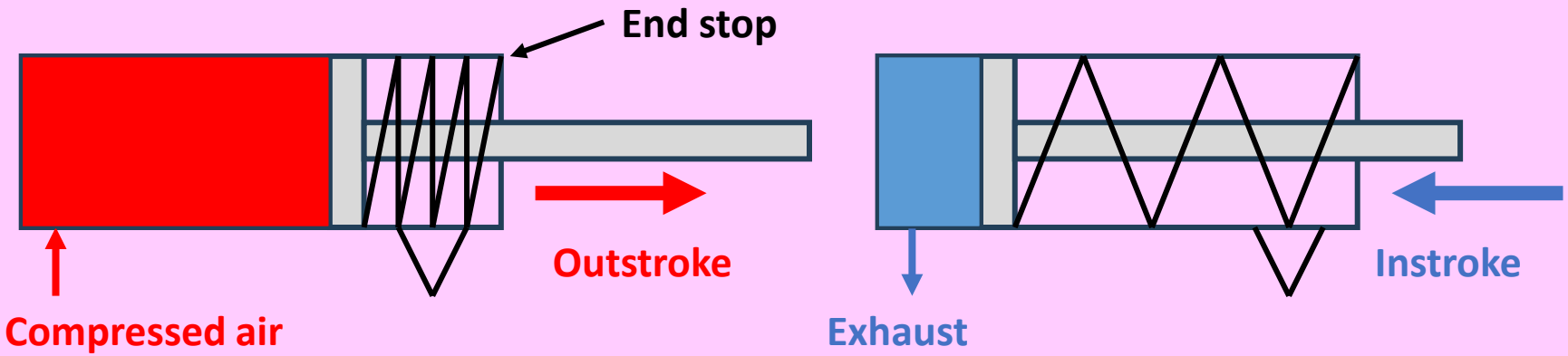
Explanation

What are the types of cylinder?

Single Acting Cylinder (SAC)



Compressed air enters the inlet pushing the piston to its end stop.

The return spring pushes the piston back when the compressed air is removed.

What are the pros and cons of a Single Acting Cylinder?

-The outstroke is strong

-The instroke is weaker and limited by the force of the return spring.

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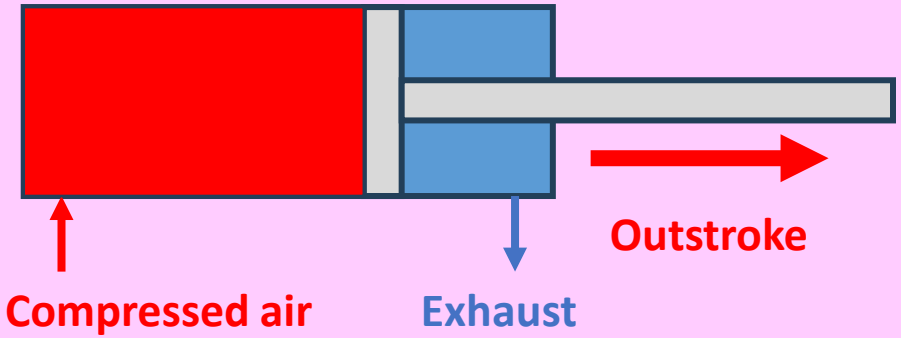
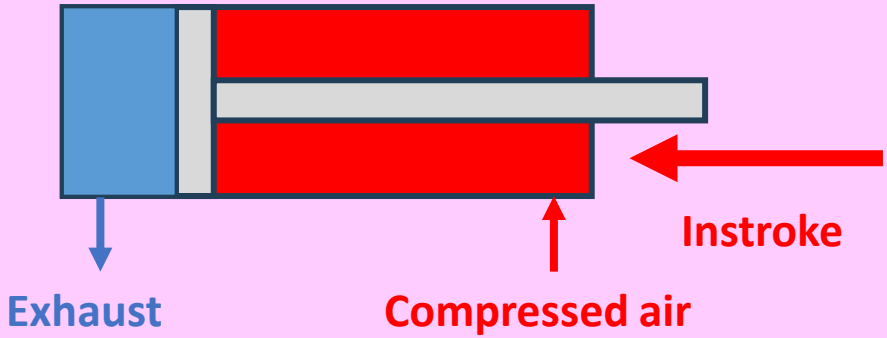
What are the types of cylinder?

Double Acting Cylinder (DAC)



Compressed air enters the inlet pushing the piston to its end stop on the outstroke



The compressed air feed switches ports and the piston is back on the instroke

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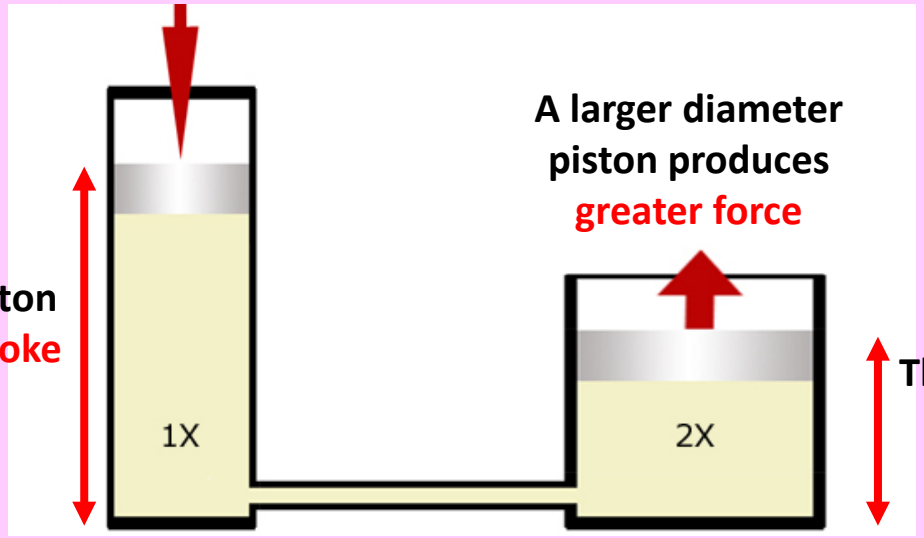
Explanation

How can cylinders be used to increase mechanical advantage?

The piston on the left has a smaller surface area than the piston on the right.

A smaller diameter piston produces less force



A larger diameter piston produces greater force

The smaller piston has a longer stroke

The larger piston has a shorter stroke

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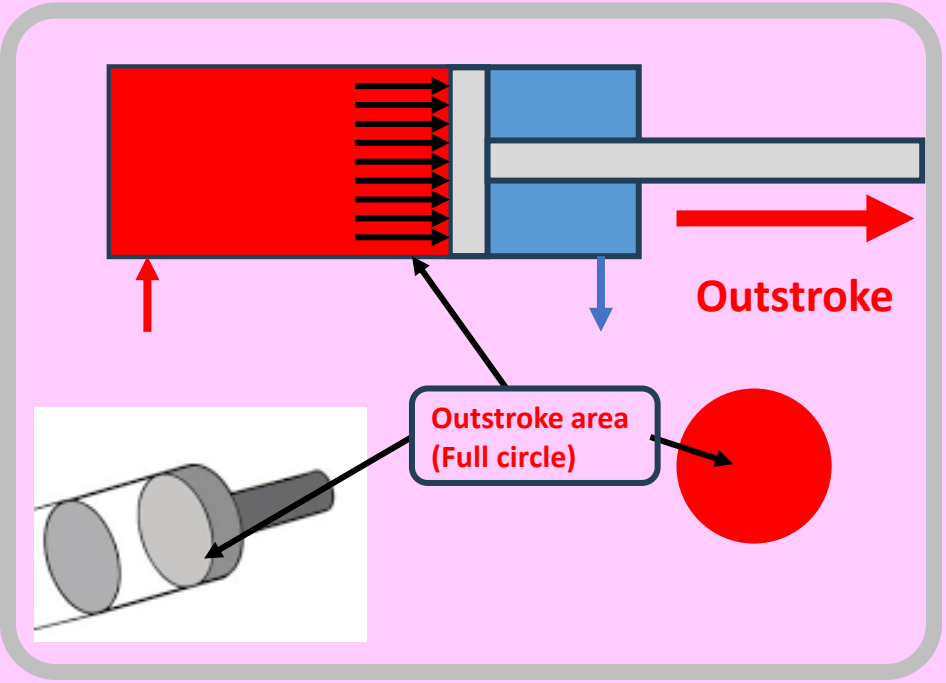
Explanation

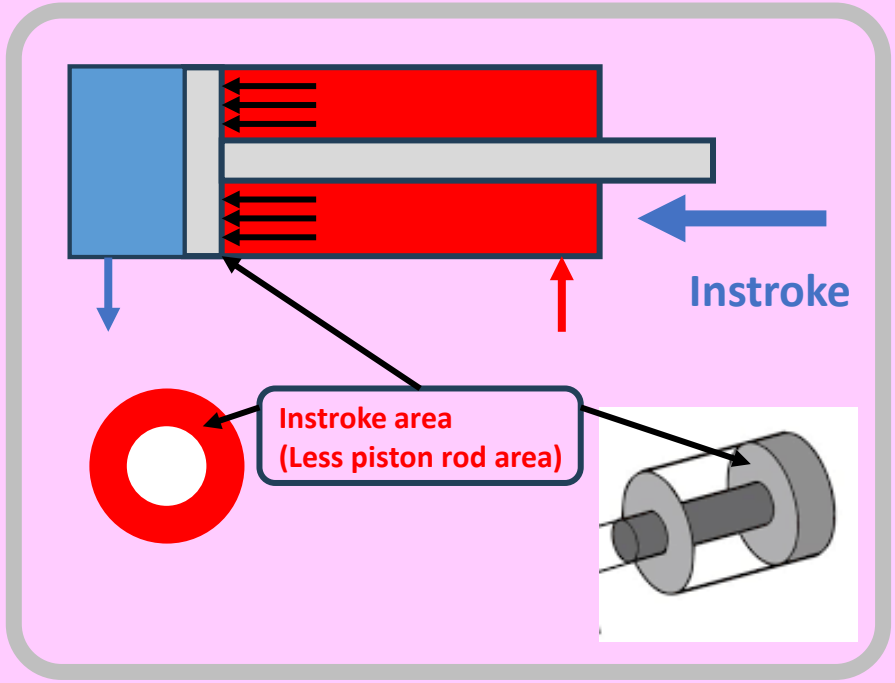
How do outstroke and instroke differ?

The outstroke of Double Acting Cylinder is stronger than the instroke

The compressed air acts on the full surface area of the piston on the outstroke.



The compressed air acts on a smaller surface area on the instroke due to the pushrod.



Learning objectives:

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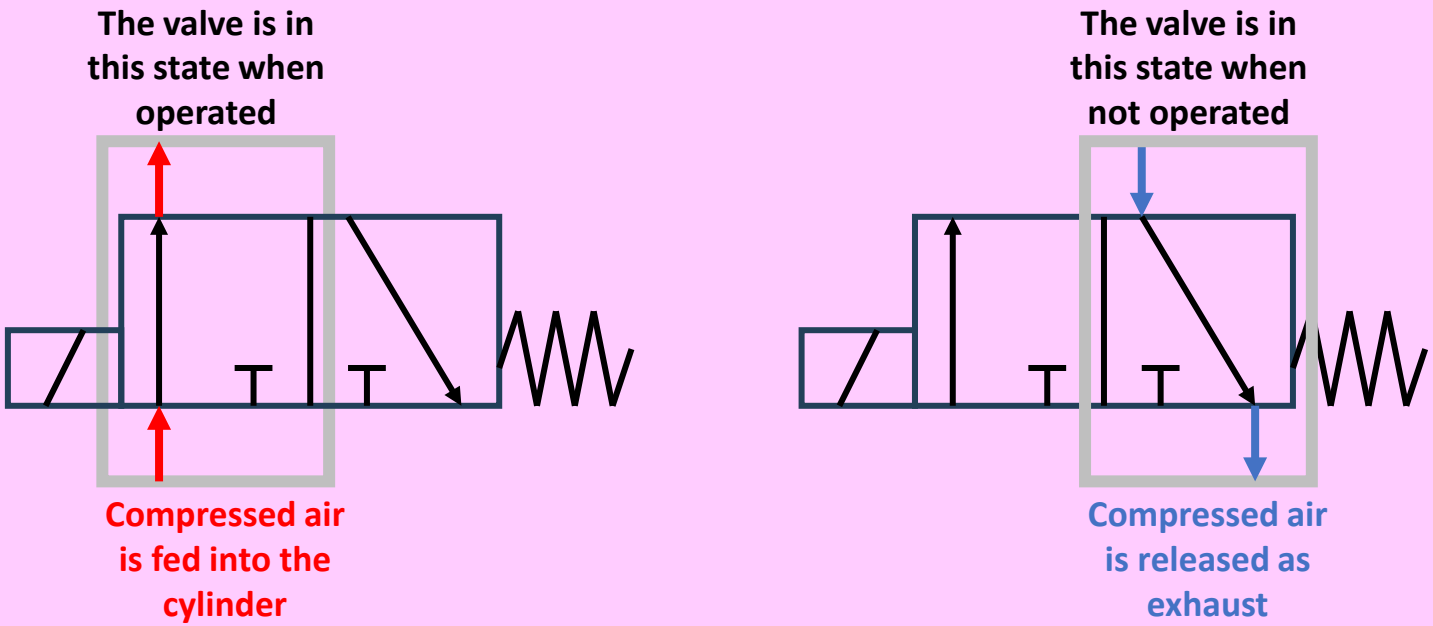
Explanation

How is a solenoid used to control a pneumatic piston?

3/2 Solenoid used with Single Acting Cylinders



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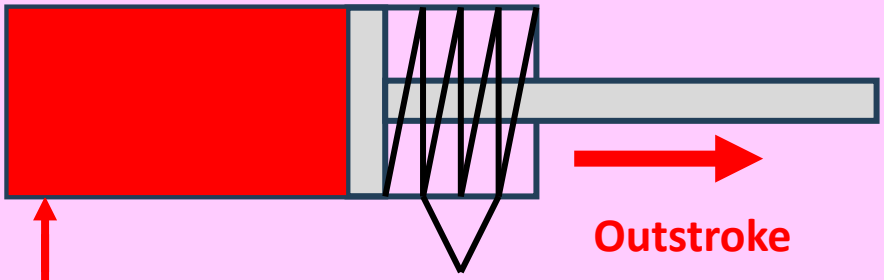
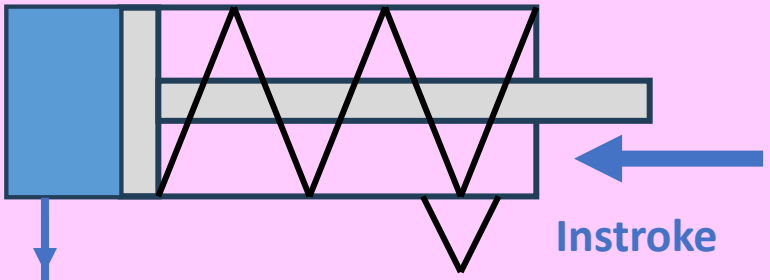


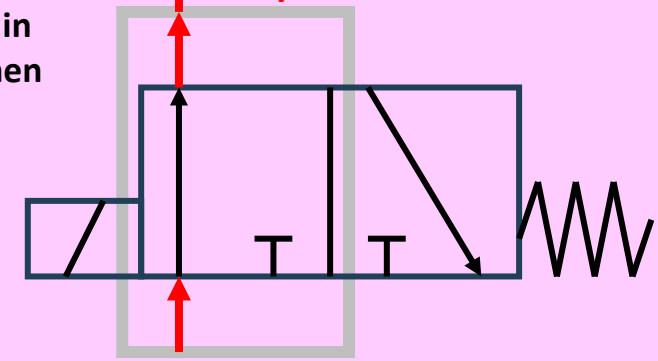
Outstroke



Instroke

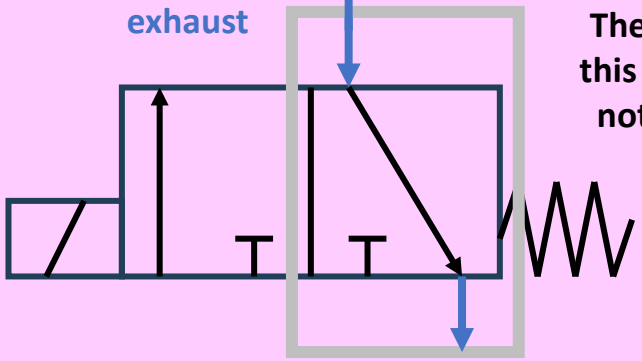
Compressed air is fed into the cylinder

The valve is in this state when operated



Compressed air is released as exhaust

The valve is in this state when not operated



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Explanation

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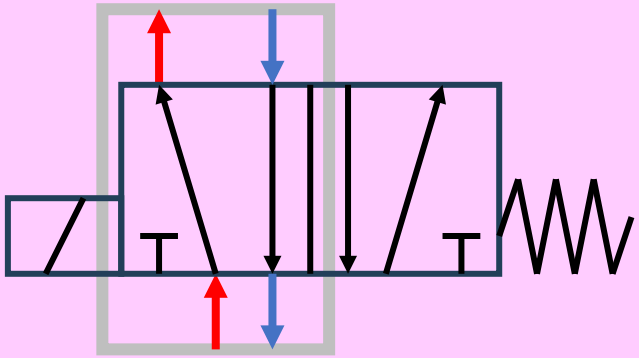
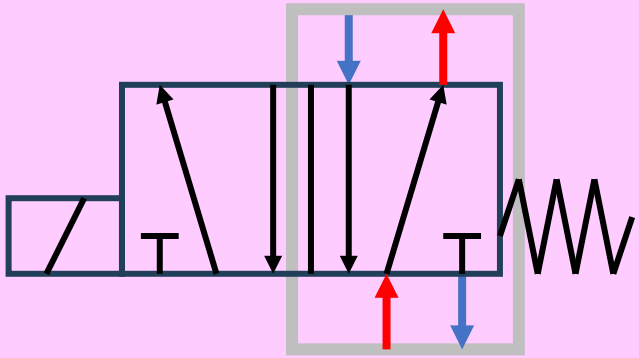
5/2 Solenoid used with Double Acting Cylinders

The valve is in this state when operated



Compressed air is fed into the cylinder in one direction

The valve is in this state when not operated



Compressed air is fed into the cylinder the reverse direction

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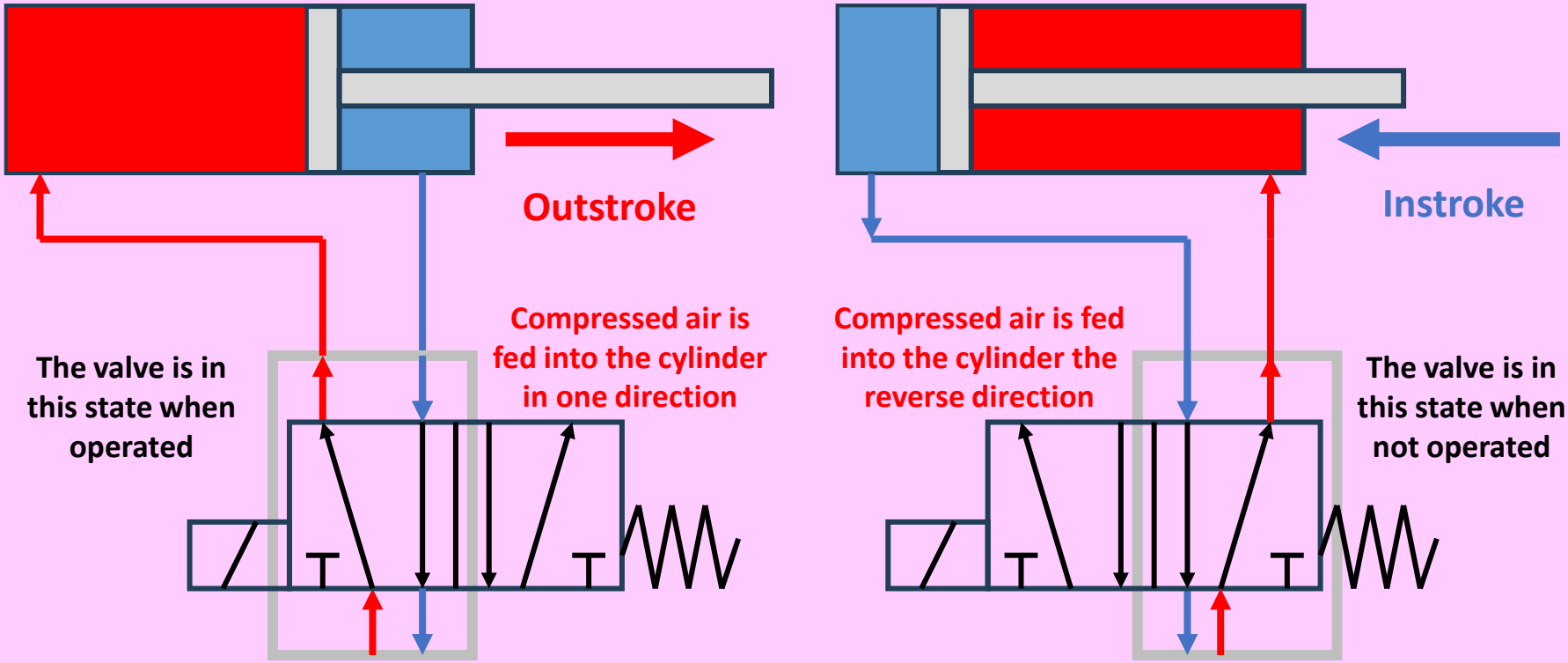
Explanation

How is a solenoid used to control a pneumatic piston?

5/2 Solenoid used with Double Acting Cylinders



Learning objectives:

- ❑ What are Pneumatic systems?
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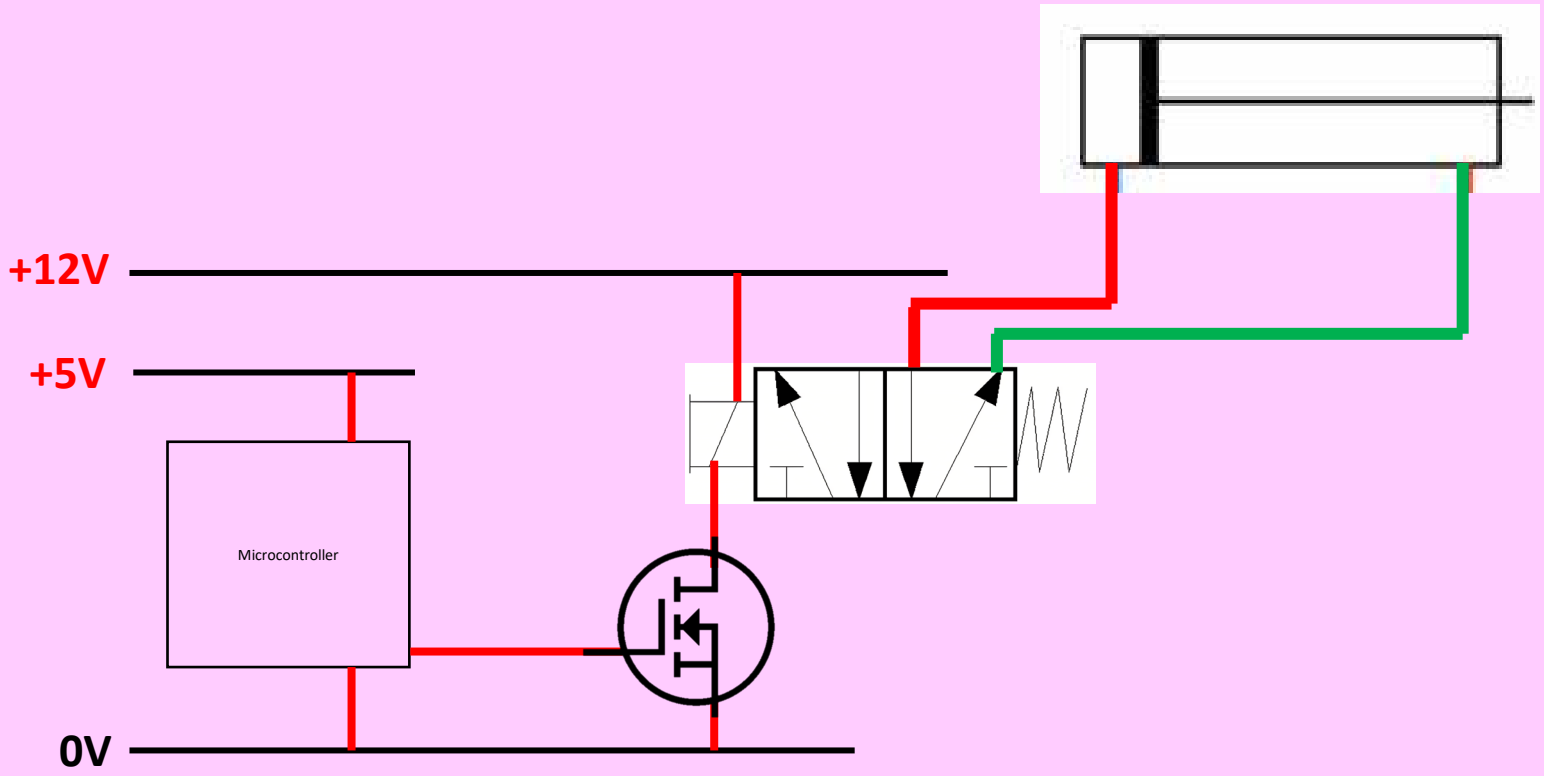
Explanation

How can pneumatic cylinders be controlled using electrical systems?



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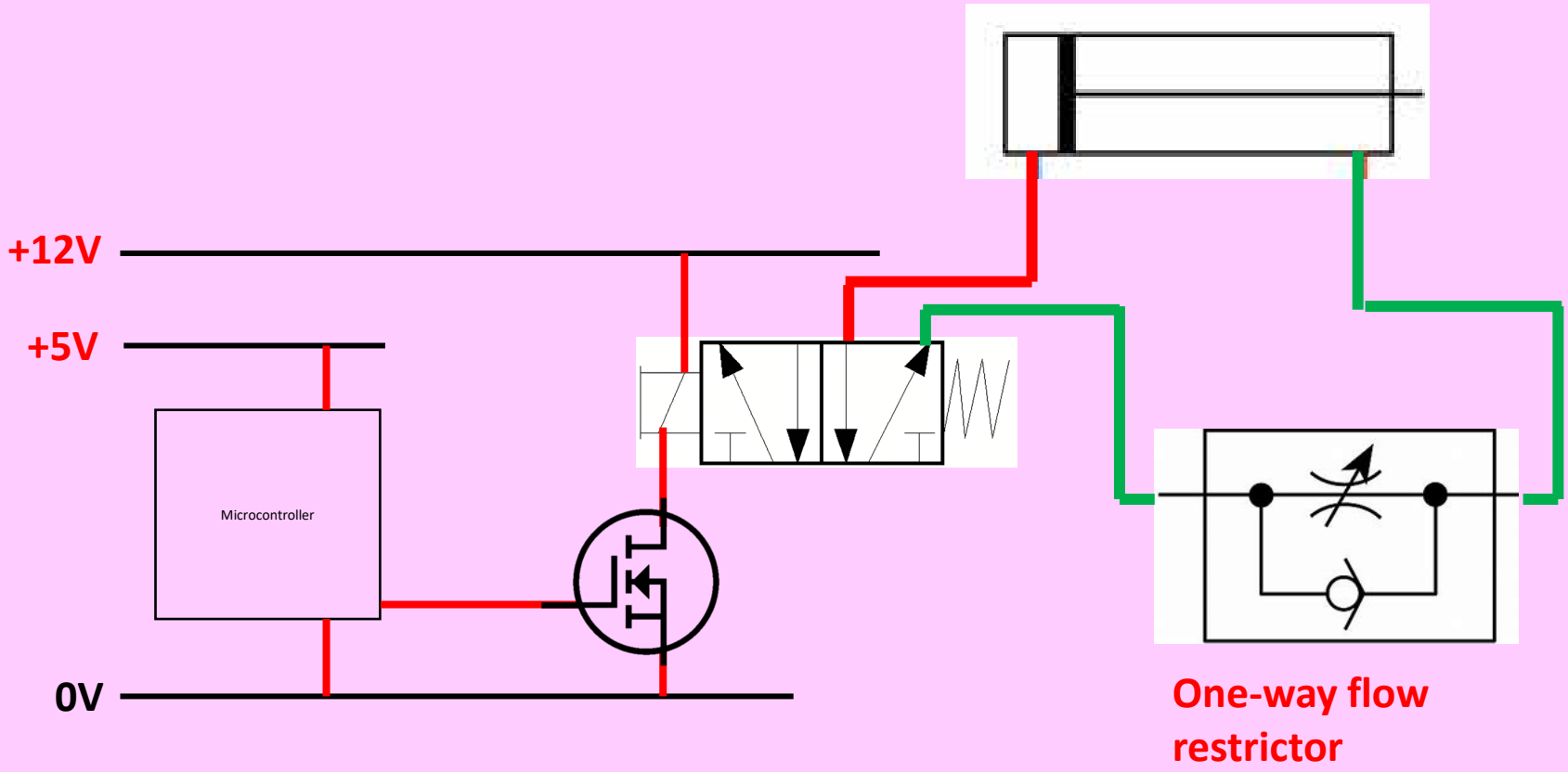
Explanation

How can pneumatic cylinders be controlled using electrical systems?



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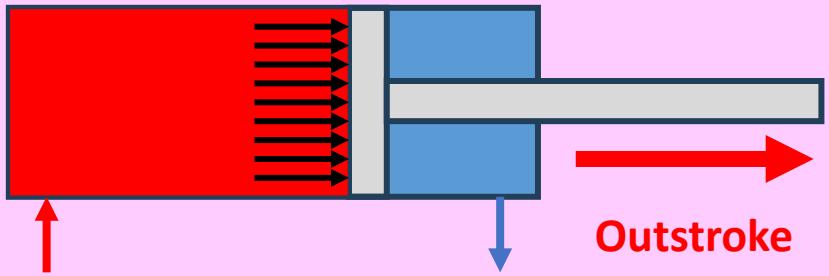
Explanation

How do we calculate the force of a cylinder?

Force = Pressure x Area **F=PA**

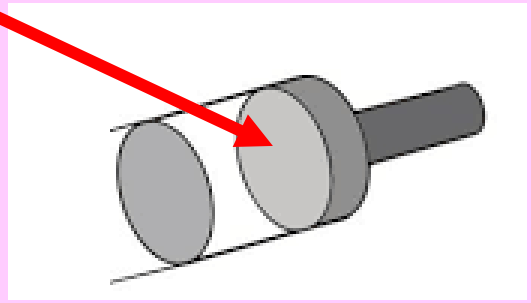


Force = Newtons (N)

Pressure =Newtons per square meter (Nm^{-2})

Area = Cross sectional area (m^2)

Area= πr^2



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Explanation

How can we compare the force generated by two cylinders?

Two pneumatic cylinders are fed from the same compressed air line feed of 1 bar (100,000 Nm^{-2}). Cylinder 1 has a radius of 0.1m and Cylinder 2 of 0.2m. What force would each produce?

Area= πr^2

Area= $\pi 0.1^2$

Area= $0.0314m^2$

F=PA

F=100,000 x 0.0314

F=3141.59 N

Area= $\pi 0.2^2$

Area= $0.125m^2$

F=PA

F=100,000 x 0.125

F=12,566.37 N

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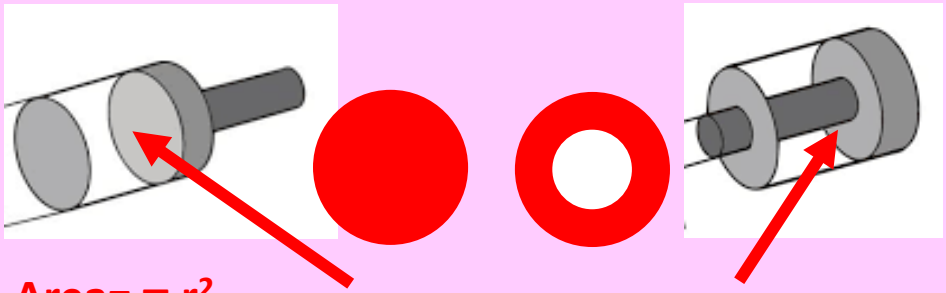
Explanation

Instroke vs outstroke force… how do they differ?

A double acting cylinder is fed by an air pressure of 100,000 Nm^{-2} .
The cylinder has a radius of 0.2m and the piston rod a radius of 0.05m.
How would the outstroke and instroke forces differ?



Outstroke area (Full circle)

Instroke area (Less piston rod area)

Area= π r^2

Area= π 0.2^2

Area= 0.125m^2

F=PA

F=100,000 x 0.125

F=12566 N

Area of piston rod = π 0.05^2

= 0.0078m^2

Area of piston = 0.125 - 0.0078

= 0.1178m^2

F=PA

F=100,000 x 0.125

F=11781 N

Difference of 785 N

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