FACTFILE:
GCE TECHNOLOGY & DESIGN

Rewarding Learning

1.20 CALCULATIONS: PNEUMATICS CALCULATIONS: PART 2

Calculations: Pneumatics calculations: Part 2

Learning outcomes

Students should be able to:

- use given data and information to complete calculations for: force, pressure and area associated with cylinders.

Force, Pressure and Area associated with cylinders

The force produced by a pneumatic cylinder depends on the pressure of the air supply and the area of the piston inside the cylinder itself.

The formula for calculating force if the air pressure and area are known is:

Force = Pressure x Area

Force – Newton (N)
Pressure – N/mm² (1 bar = 0.1N/mm²)
Area - mm² (area of a circle = πr²)

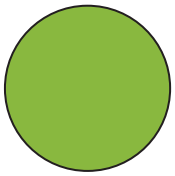
Care must be taken to ensure that the units being used are consistent i.e. if the force is measured in N/mm² then area must be measured in mm².

In a single acting cylinder (SAC) useful force is produced on the outstroke only. The force produced by the spring inside the SAC provides the instroke force.

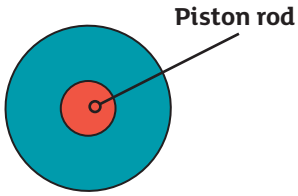
In a double acting cylinder (DAC) useful force is produced in both the outstroke and instroke.

However, the force produced on the instroke is less than that produced on the outstroke as the available area is slightly smaller due to the presence of the piston rod.

Example:
Calculate the forces produced on the outstroke and instroke for a DAC using an air supply of pressure 1 bar with a piston diameter of 20mm and a piston rod diameter of 4mm.



Piston radius
R = 10mm



Piston rod radius
r = 2mm

The area A against which the air supply works on the instroke is given by the equation;

$A = (\pi R^2) - (\pi r^2)$
$A = 3.14 \times (10^2) - 3.14 \times (2^2)$
$A = 314 - 12.56$
$A = 301.44mm^2$

Force produced on the outstroke is given by;

Force = P x A
F = 0.1 x 314
F = 31.4N

Force produced on the instroke is given by;

Force = P x A
F = 0.1 x 301.44
F = 30.144N

Calculating the cylinder diameter

There may be need for you to work out the diameter of a cylinder at some point, in order to do this we follow the calculation below:

$$F = P \times A$$

If we use this to work out the following example we can input the following information; the air supply pressure is 5 BAR and the force to be exerted is equal to 350 N on the outstroke.

$$350 = 0.5 \times A$$

$$A = \frac{350}{0.5}$$

$$\pi r^2 = 700$$

$$r^2 = 222.93 \text{ and } r = 14.93 \text{ mm}$$

Revision Question

1 A double acting cylinder operates with an air pressure of 0.4N/mm² and a piston diameter of 50mm. During operation it produces a force of 753.6N during the instroke. A second double acting cylinder with the same piston rod diameter and an air pressure of 0.5N/mm² produces a force of 2472.75N during the instroke. Calculate the piston rod radius of the second double acting cylinder. Assume π = 3.14.

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