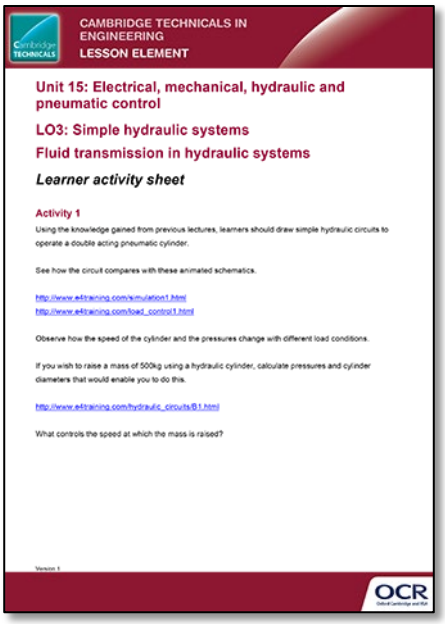
Unit 15: Electrical, mechanical, hydraulic and pneumatic control

LO3: Simple hydraulic systems

Fluid transmission in hydraulic systems

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Fluid transmission in hydraulic systems' *activity which supports Cambridge Technicals in Engineering Level 3.*


CAMBRIDGE TECHNICALS IN ENGINEERING
LESSON ELEMENT

Unit 15: Electrical, mechanical, hydraulic and pneumatic control

LO3: Simple hydraulic systems

Fluid transmission in hydraulic systems

Learner activity sheet

Activity 1

Using the knowledge gained from previous lectures, learners should draw simple hydraulic circuits to operate a double acting pneumatic cylinder.

See how the circuit compares with these animated schematics.

http://www.e4training.com/simulation1.html
http://www.e4training.com/load_control1.html

Observe how the speed of the cylinder and the pressures change with different load conditions.

If you wish to raise a mass of 500kg using a hydraulic cylinder, calculate pressures and cylinder diameters that would enable you to do this.

http://www.e4training.com/hydraulic_circuits/B1.html

What controls the speed at which the mass is raised?

Version 1

OCR

The Activity:

This activity offers an opportunity for English skills development.

This activity offers an opportunity for maths skills development.

Suggested timings:

Activity 1

Using the knowledge gained from previous lectures, learners should draw simple hydraulic circuits to operate a double acting pneumatic cylinder.

Notes: Learners should draw a circuit that contains as a minimum a pump, valve (2 or 3 way spool valve) and double acting cylinder, correctly linked with pipes and reservoir. Additionally the learners may have introduced other features such as filters, pressure relief valves etc.

See how the circuit compares with these animated schematics.

http://www.e4training.com/simulation1.html
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Observe how the speed of the cylinder and the pressures change with different load conditions.

If you wish to raise a mass of 500kg using a hydraulic cylinder, calculate pressures and cylinder diameters that would enable you to do this.

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What controls the speed at which the mass is raised?

Notes:

Students should be observing that these vary with physical principles of:

Force = pressure x area

Power = pressure x volume flow rate (Q)

In other words, the force exerted is a function of fluid pressure and cylinder piston diameter, the speed of operation is a function of the volume flow rate which is determined by the pump size.

Activity 2

Pipe sizing is important in hydraulic circuits to prevent pressure drops or cavitation.

Look at the following hydraulic pipe calculator and observe how different line sizes affect velocities and the pictorial nomogram.

http://www.e4training.com/hydraulic_calculators/

Learners should compare this with calculations made using the nomogram illustrated in the lecture
http://www.insanehydraulics.com/library/hosesizing.html

Exercise:

Design a hydraulic circuit to raise a mass of 500 kg 0.15 metres in 2 seconds, using a hydraulic cylinder with a piston diameter of 50mm.

What volume flow rate and pressure do we need from the pump?
Determine suitable sizes of hydraulic pipes for the circuit?

Notes:

Force required to raise the mass = $m \times g = 500 \times 10 = 5000N$

Power required = $E / t = F \times h / t = 5000 \times 1.5 / 2 = 375Watts$

Area of piston = $\pi \times r^2$ and Pressure = $force / area$

So Pressure = $F / \pi \times r^2 = 5000 / \pi \times 0.025^2 = 2.55MPa$

Power = $pressure \times volume\ flow\ rate$

So $Q = power / pressure = 375 / 2.55MPa = 147x10^{-6}\ m^3/s$

or $Q = \pi \times r^2 \times h / t = \pi \times 0.025^2 \times 0.15 / 2 = 147 \times 10^{-6}\ m^3/s$

volume flow rate in litres/min = $Q \times 1000 \times 60 = 8.8l/min$

Using these values the pump needs to be able to deliver a pressure of at least 2.55MPa at a volume flow rate of 8.8l/min. If we use the nomogram and the recommended maximum velocities for fluid we get the following pipe sizes.

- Pressure line 4.8mm dia
- Return line 7.9mm dia
- Suction line 12.7mm dia

In practice we may choose to make the pressure and return lines both a minimum of 7.9mm diameter.