

STUDENT FEEDBACK FORM

Student: Matthew Rawlings

Assessment: Pneumatics and Hydraulics 1

Course: HNC Instrumentation Engineering

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
Engagement with a wide range of literature, including sources retrieved independently. Selection of relevant and credible sources. No recognised referencing system applied. Some basic numbering references applied to external information used in the writing.	30	17.5
2. Knowledge and Understanding Skills		
Competent knowledge of the basic underlying concepts and principles of fluid power systems. Exhibits very good understanding in most research areas. Good use of sectional component images and symbols. Used figures are referred to in the writing. Calculations are mostly correct and a good level of understanding is demonstrated.	60	40.5
3. Cognitive and Intellectual Skills	0	
4. Practical Application Skills	0	
5. Transferable Skills for Life and Professional Practice		
Work is accurate, coherent, fluent, well-structured and organised. Work is relevantly linked to current legislation. Report presentation is an area for improvement.	10	6.5

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Late Submission Penalties (tick if appropriate)

Up to 1 week late (40% Max)

Over 1 week late (0%)

64.5 %

Matthew Rawlings Hydraulics and Pneumatics Assignment

by Matthew Rawlings

Submission date: 20-Jan-2022 03:15PM (UTC+0000)

Submission ID: 169761540

File name:

14836_Matthew_Rawlings_Matthew_Rawlings_Hydraulics_and_Pneumatics_Assignment_247757_926796119.docx
(794.96K)

Word count: 2625

Character count: 15294

64.5 overall grade

HNC INSTRUMENTATION ENGINEERING

PNEUMATICS AND HYDRAULICS

MATTHEW RAWLINGS

150589@pembrokeshire.ac.uk

□ Professional cover page for a technical report

Table of Contents

Introduction.....	3
Task 1	3
1).....	3
2).....	5
3).....	6
4).....	8
Task 2	10
Bibliography	13
References & Images	13

□ Content

Figure 1 - Single Acting Cylinder	4
Figure 2 - Double Acting Cylinder	4
Figure 3 - Directional Control Valve	5
Figure 4 - Piston and Cylinder	6
Figure 5 - Positive Displacement Gear Pump.....	7
Figure 6 - Rotary Vane Pump	8
Figure 7 - Pressure Relief Valve	8
Figure 8 - Pressure Regulator	9
Figure 9 - Pressure Regulator	9
Figure 10 - Nomogram	11

□ *Correct*

Introduction

Hydraulics and Pneumatics are widely used power transmission systems. This paper discusses the uses, applications and advantages and disadvantages of the use of both. Calculations are made for a pneumatic system which is used in an industrial environment. The paper explores devices used in both power transmission systems.

□

Task 1

1)

In operation, both processes are fairly similar, using pressure to give an output. Hydraulic systems use liquid such as oil whereas pneumatic systems use gases which typically is air. Pneumatic systems use a system including a compressor and a series of airlines to connect devices. Hydraulic systems also use a series of pipes and hoses to connect devices but use a pump to provide power to the system. Though the outcome of the two power transmission systems is similar, they operate at very different pressures. Typically, pneumatic systems operate at a much lower pressure, an example is *"This pressure, of between 3 and 7 Bar, prevents the fluid foaming and provides a boost pressure at the pump inlet."*¹ Referring to a pneumatic piston acting as a seal. In hydraulic systems, typical values are as follows *"A free-floating piston inside a hydraulic cylinder has a 1000 PSI of fluid pressure applied to one side of the piston, and 850 PSI of pressure applied to the other side of the piston."*² 1000 psi is equal 69 bar which is a significant difference. Pneumatics and Hydraulics have multiple applications in industry in mechanical operations and other systems. They are reliable forms of power transmission in industry. Hydraulic systems work at higher pressures so are able to operate heavier systems. Hydraulic systems are used in vehicles such as cars, airplanes, forklifts and other lifting equipment. □
Pistons and brakes are most common in these examples. In industry hydraulics is used for heavy applications and valves. Large valves use hydraulics as a means of operation as many sites do not have pneumatic facilities which can operate an actuator.

A hydraulic cylinder or piston is a common example of a hydraulic component. A hydraulic cylinder used hydraulic fluid as its power source in order to extend and retract. Cylinders come as double acting, single acting and telescopic cylinders. Firstly, single acting cylinders are spring return. □

¹ Assets.publishing.service.gov.uk. n.d. *Hydraulic Systems*. [online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/857240/Volume_04_Aircraft_Systems.pdf#:~:text=Reservoirs%20are%20usually%20pressurized%20either%20with%20nitrogen%20or,buid%20up%20due%20to%20heating%20or%20system%20malfunction. [Accessed 11 December 2021].

² Kuphalt, T., 2021. *Calculate Hydraulic System Fluid Pressure - InstrumentationTools*. [online] Inst Tools. Available at: <https://instrumentationtools.com/hydraulic-system-fluid-pressure/#:~:text=A%20free-floating%20piston%20inside%20a%20hydraulic%20cylinder%20has,The%20piston%20itself%20is%202.75%20inches%20in%20diameter>.

SINGLE ACTING CYLINDER

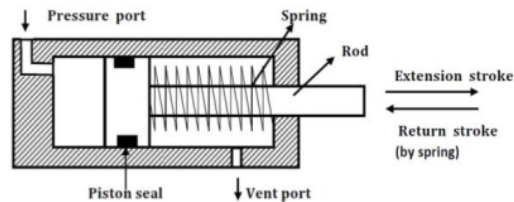


Figure 1 - Single Acting Cylinder

Shown in Figure 1 is a single acting cylinder. As seen, there are two ports, one is a pressure port where hydraulic fluid pushes the piston, extending the rod. When pressure is relieved, fluid exits through the vent port, returning to the source. The seal in the piston reduces chance of leaking. Double acting cylinders use two strokes in order to fully operate, using a directional control valve in the loop to operate. □

DOUBLE ACTING CYLINDER

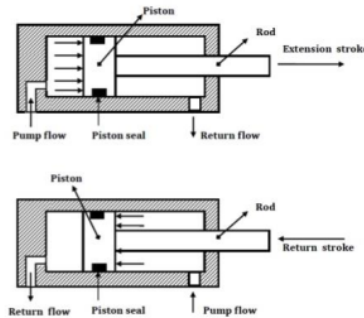


Figure 2 - Double Acting Cylinder

Seen in Figure 2 there are two ports but no spring. A double acting cylinder uses hydraulic fluid to extend and retract. A directional control valve, 3 position, 4 port can be used to change the position of this valve to the desired position, switching flow to do so. □

Pneumatics is also widely used in industry. It is used to operate valves at a smaller scale. Solenoid valves/Directional control Vales are used in pneumatics to control air flow. These valves are commonly used to switch air on and off a piston, linear actuators or rotary actuators. There are multiple types and configurations of these valves including, 4 port/ 2 position/ solenoid operated valve and 4 port/ 3 position/ solenoid actuating spring centred valve.

As mentioned, control valves are used to stop or allow compressed air to the appliances and components in the loop. They are operated multiple ways, one of which is with pilot air which means

that when pressure is applied to either side of the valve, the internal shuttle moves and changes the output. □

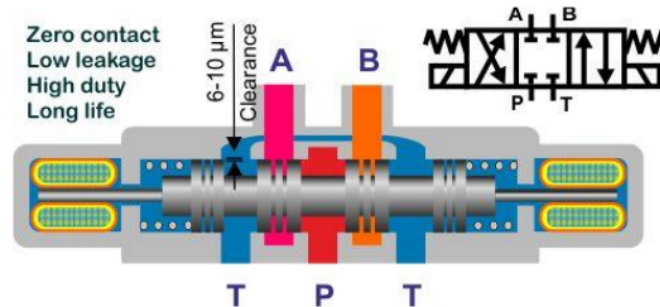


Figure 3 - Directional Control Valve

Figure 3 shows a DCV, A and B are the outputs which will change depending on the position. 'T' refers to the tank or hydraulic reservoir and 'P' is the pressure input.

Though pneumatics and hydraulics are useful in industry, they hold health and safety complications. With correct hazard identification and management, these can be avoided and eliminated. Fluid power systems hold the majority of hazards. Firstly, stored pressure and potential energy is a large hazard, which has potential to cause severe injuries. This pressure can escape through leaks, split hoses or when taking a system apart. Split hoses can be avoided by checking all hoses before using the equipment, by doing this, any splits or damage to the hose can be detected and rectified. Leakages can be detected once hoses are confirmed safe the system can be lightly pressurised to confirm this. Leakages pose similar hazards to damages, skin penetration, eye injury or loss and skin irritation. When taking a hydraulic system apart, it is important to drain the system, ensuring there is no stored pressure. Hose disconnection is another safety hazard which is posed when hoses are not correctly fitted. At high pressures, when disconnected can strike the operator, whip-checks are used to hold the hose so it can not harm the operator. Hydraulic pistons/cylinders pose a risk of crushing, this can occur when untrained personnel operate equipment. Similar to hydraulic systems, all pneumatic equipment used must be inspected before use to ensure that there are no imperfections. Entanglement and crushing are another risk of pneumatic cylinder when extending and retracting. This is controlled by providing appropriate training to employees. Safety regulations must be followed and adhered to when operating hydraulic and pneumatic equipment. All regulations come under HASAWA 1974, Health and Safety at Work Act 1974. HASAWA is an Act of British Parliament where all health and safety is managed, employees and employers have multiple duties under this act. A legislation under HASAWA which is applicable is PUWER 1998, Provision and Use of Work Equipment Regulations 1998. PUWER ensures that equipment is suitable for use, in a safe condition, accompanied by suitable health and safety measures such as interlocking guards and emergency stops. PSSR 2000, Pressure Systems Safety Regulations is a legislation which covers the safe design and use of pressurised systems. The aim of the regulation is to prevent injury as a result of failure of a pressurised system. □

2)

There are many ways of compressing air for a pneumatic system and conditioning methods to prepare it for use. Reciprocating compressors are commonly used in industry for compressing air and other products. Reciprocating pumps will use an electric motor as a source of rotation. The motor is connected to the compressors shaft via a coupling. Multiple cylinders and pistons are placed accurately along the shaft for efficiency. □

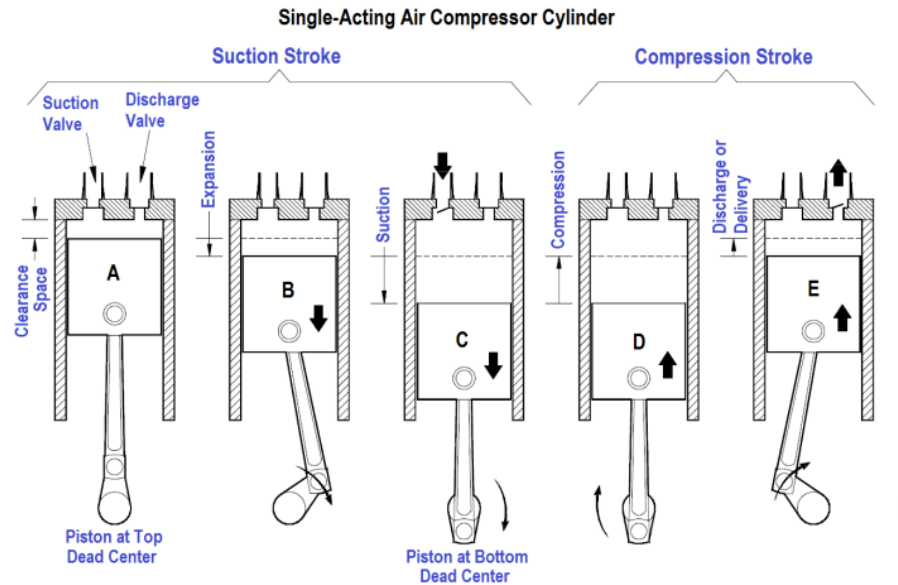


Figure 4 - Piston and Cylinder

Figure 4 shows the action of a reciprocating compressors cylinders in operation. There are two strokes, suction and compression. As seen, the suction stroke pulls free air in through the suction valve when the piston is coming down from the top of the cam rotation, by doing this, the gas is expanded so it can be compressed in the next stroke. Following compression, the compressed air exits the cylinder via the discharge valve, this air is either stored or used. Air is conditioned in pneumatic systems to keep it clean, preventing dirt entering components, causing damage and wearing internals. In order to avoid this, air is conditioned for use, filters are commonly used in industry as dust can get into airlines when stationary for long periods. Filters use fibres and mesh structures to trap and catch dirt and debris to avoid contaminating air.

3)

There are multiple types of positive displacement pumps used in hydraulic systems in order to move oil around a system using the theory of displacement. A common type of positive displacement pump is a gear pump which uses the teeth of two gears to displace hydraulic fluid. This type of pump has fine tolerances which allows the fluid to be transported between the gear teeth and the pump casing, avoiding leakages and back flow. As shown in the Figure 5, there are two gears, one of which will be driven by a motor and the other by the driven gear. The motor operated gear is called either the master or the driver and the other gear is called the idler, slave or driven gear.

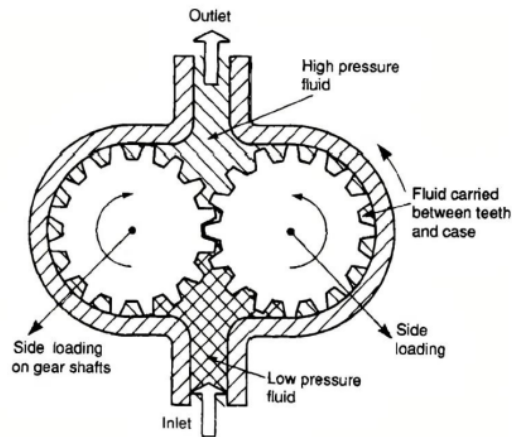


Figure 5 - Positive Displacement Gear Pump

A partial vacuum is pulled at the inlet as the gears turn which draws hydraulic fluid into the pump to be transported. This type of gear pump is used in multiple hydraulic power applications including lifting machinery, lifting aids and vehicles. Gear pumps can produce “pressures of up to 3000psi”³ due to the close tolerances and robust, rigid design. Different alloys and compositions of metals make gear able to handle corrosive substances such as sulphuric acid, however, in this case it will move hydraulic oil. Though it is able to handle aggressive liquids, if a liquid is soiled or contaminated with solids, the gears will begin to wear and become less efficient. Examples of other typical applications include chemical additives and mixing, acids and caustics, solvents and alcohols.

A vane pump is a type of rotary positive displacement pump which is also used to move hydraulic oil around a system. Similar to the gear pump it is driven by a motor, coupled to the shaft of the pump. Vane pumps consist of multiple components, more than that of a gear pump, achieving a similar operation. Vane pumps consist of a slotted rotor which are spring loaded which sits non-concentric inside its casing.

³ <https://www.michael-smith-engineers.co.uk/resources/useful-info/gear-pumps#:~:text=A%20gear%20pump%20is%20a%20type%20of%20positive,its%20gears.%20How%20does%20a%20gear%20pump%20work%3F> advantages and limits of gear pump and applications

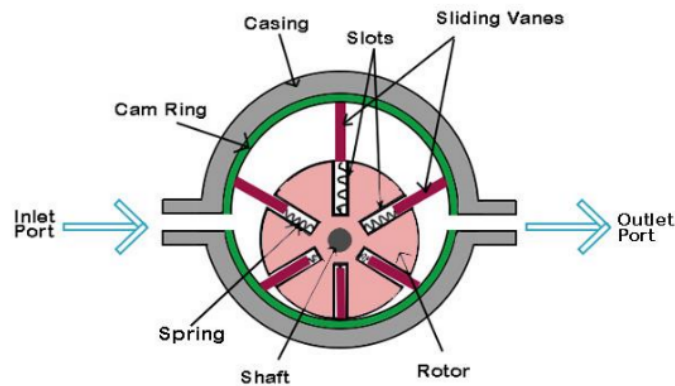


Figure 6 - Rotary Vane Pump

As seen in Figure 6, the sliding vanes are spring loaded within the rotor and extend as the rotor moves with the shaft, turned by a motor. This type of pump operates with fine tolerances. Once the pump has been run up to speed, the pump created a slight vacuum, drawing fluid towards the pump. Fluid enters the pump via the inlet port. In this case, hydraulic oil gets trapped between the rotor, vanes and cam ring so as the pump turns, it is transported to the outlet port where it can be used in the system. Once the fluid has been transported from a 'pocket' in the pump to the outlet port the vanes are forced back into the slots back the cam ring. This happens as the slotted rotor is non-concentric within the pump casing. Vane pumps are advantageous in industry as they provide a constant uniform discharge with little to no pulsations which avoids upsetting process and components downstream. The pump delivers a uniform output as it is able to draw a good vacuum at the inlet port which maintains a through flow as long as there is a continuous supply. Though it has multiple advantages, the vane pump has multiple components which makes it more susceptible to wear and failure. Its many mechanical parts mean that maintenance is more complicated when failure occurs. Failure may occur when dealing with contaminated fluids containing solids.

4)

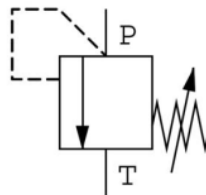


Figure 7 - Pressure Relief Valve

Shown, in Figure 7 is the symbol for a pressure relief valve in hydraulics, pneumatics is similar to this as the arrows are not shaded. This is a pressure safety device which relieves the pressure on a system in the event of an over pressure. 'P' is the input to the valve or the line pressure. Commonly, these valves, stems off from a mainline so there is no pressure difference.

The dotted line represents the input pressure which operates the relief mechanism. Once the line pressure is greater or equal to the setpoint of the PRV or PSV, the mechanism is operated and the

pressure is released, protecting the system and the operator. The pressure is released to 'T' which represents the tank or hydraulic reservoir in this case. □

In the righthand side of the image is a spring which shows that this pressure relief device is adjustable. Pressure regulators are always used in pneumatic systems to determine the input pressure to the system. Shown is a regulator which is a device used to control the pressure in a pneumatic system.



Figure 9 - Pressure Regulator □

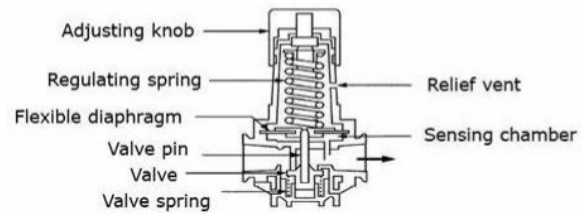


Figure 8 - Pressure Regulator □

Figure 8 shows the internal components of an adjustable pressure regulator. When the adjusting knob is operated, the pressure will either increase or decrease depending on the direction turned. For example, decreasing the pressure will move the diaphragm downwards, moving the valve pin closer to the valve, decreasing air pressure subjected to the system. The regulating spring and valve spring keep the diaphragm and valve pin in place to avoid unwanted pressure change. □

A little brief in comparison with your other discussion points.

Task 2

State 1
 P1 101.3 KPa
 V1 21
 T1 293 K

State 2
 P2 550 KPa ★ *kPa should be written like this.*
 V2
 T2 313 K

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$V_2 = \frac{P_1 V_1 T_2}{T_1 P_2} = \frac{101.3 \times 21 \times 313}{550 \times 293} = 4.13 \text{ m}^3/\text{min}$$

Rated Output = $4.13 \text{ m}^3/\text{min}$ □ *Stage 1 compression*

★ *Your 4.13 should have gone into V1*

State 1
 P1 800 KPa
 V1 6.5
 T1 345 K

State 2
 P2 ★ *P2 is given in the assignment brief*
 V2 6.431
 T2 299 K ★ *V2 is a second compression and should be a lower value than 4.13*

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$P_2 = \frac{P_1 V_1 T_2}{T_1 V_2} = \frac{800 \times 10^3 \times 6.5 \times 299}{345 \times 6.431} = 700.77 \times 10^3$$

Output Gauge Pressure = $700.77 - 101.3 = 599.47 \text{ KPa}$

□ *Reasonable value for pressure*

$$\frac{m}{v} = \frac{P}{RT} = \frac{599.47 \times 10^3}{287 \times 299} = 8.17 \text{ kg/m}^3$$

Air Density = 8.17 kg/m^3 □ *Density, correct units*

$$\Delta P = \frac{\rho}{2} (v_1^2 - v_2^2)$$

$$A_1 = \frac{\pi \times 0.0072^2}{4} = 0.0041 \text{ m}^2$$

$$A_2 = \frac{\pi \times 0.0022^2}{4} = 0.00038 \text{ m}^2$$

$$V_1 = \frac{0.45}{8.17 \times 0.0041} = 13.43 \text{ m/s}$$

$$V_2 = \frac{0.45}{8.17 \times 0.00038} = 144.95 \text{ m/s}$$

$$\Delta P = \frac{\rho}{2} (13.43^2 - 144.95^2) = -85.09 \times 10^3 = -85.09 \text{ KPa}$$

Pressure Change = -85.09 KPa

□ *Good application of Bernoulli's formula to solve for decreasing pressure.*

$$599.47\text{KPa} - 85.09\text{KPa} = 514.38\text{KPa}$$

$$\text{Available Pressure} = 514.38\text{KPa} \quad \square \text{ Correct}$$

$$\frac{514.38}{100} = 5.14 \text{ bar} \quad \square \text{ Showing conversion}$$

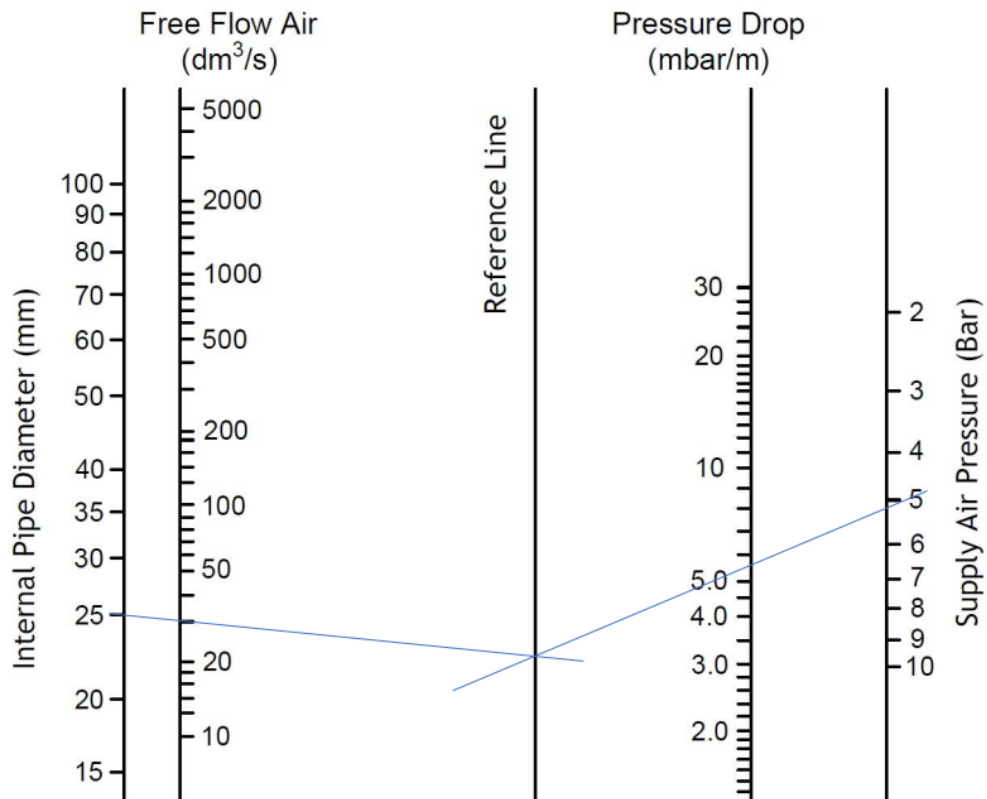


Figure 10 - Nomogram

Well applied

$$\text{Pressure drop} = 5.5 \text{ mbar/m} \quad \square$$

$$5.5 \times 10^{-3} \times 48 = 0.264 \text{ bar} \quad \square$$

$$5.1438 - 0.264 = 4.8798 \text{ bar} \quad \square$$

$$4.8798 \times 100 = 487.98 \text{ KPa}$$

$$\text{Available pressure at end of hose} = 487.98 \text{ KPa} \quad \square \text{ Correct}$$

$$F = P \times a = 487.98 \times 10^3 \times \left(\frac{\pi \times 0.082^2}{4} \right) = 2.58 \text{ KN}$$

$$\text{Force Output} = 2.58 \text{ KN} \quad \square \text{ Correct force}$$

$$m = \frac{F}{A} = \frac{2.58 \times 10^3}{9.81} = 263 \text{ Kg}$$

$$\text{Maximum mass to be lifted} = 263 \text{ Kg}$$

$\square$ A sensible load to be lifted

Bibliography

Hse.gov.uk. 2014. *Safety of pressure systems - L122*. [online] Available at: <https://www.hse.gov.uk/pubns/books/l122.htm> [Accessed 14 December 2021].

Hse.gov.uk. n.d. *Provision and Use of Work Equipment Regulations 1998 (PUWER)*. [online] Available at: <https://www.hse.gov.uk/work-equipment-machinery/puwer.htm> [Accessed 14 December 2021].

Iqsdirectory.com. n.d. *Hydraulics and Pneumatics: Advantages, Types Of, Uses*. [online] Available at: <https://www.iqsdirectory.com/articles/hydraulics/difference-between-hydraulics-and-pneumatics.html> [Accessed 12 December 2021].

Parr, A., 2022. *Hydraulics and Pneumatics a Technician's and Engineer's Guide*. 2nd ed. Oxford: Elsevier, pp.56 - 59.

Rashid, 2021. *Vane Pump - Components, Working, Types, Advantages, and Disadvantages*. [online] Mechanical Walkins. Available at: <http://www.mechanicalwalkins.com/vane-pump-components-working-types-advantages-and-disadvantages/> [Accessed 10 December 2021].

Tameson. 2022. *Directional Control Valve - How They Work* | Tameson.co.uk. [online] Available at: <https://tameson.co.uk/solenoid-valves-for-pneumatic-systems.html> [Accessed 9 December 2021].

Thorat, S., n.d. *Vane Pumps - Types, Working, Diagram, Advantages*. [online] Learn Mechanical Engineering. Available at: <https://learnmech.com/types-of-vane-pumps-advantages-and-disadvantages/> [Accessed 17 December 2021].

VCompInc. 2017. *What are Single Acting & Double Acting Hydraulic Cylinders*. [online] Available at: <https://medium.com/@vcompmissaug/what-are-single-acting-double-acting-hydraulic-cylinders-817d6e6f30a8> [Accessed 5 December 2021].

Walters, R., 1991. *Hydraulics and Electro-Hydraulic Control Systems*. 1st ed. London: Elsevier, pp.18 - 20.

□ A wide range of technical internet sources and books have been considered. ★ This should be a 'Reference List' and you should have in-text referencing throughout your work. It is difficult to see where the sources have been used in your writing. Some additional referencing shown as endnotes on each page.

References & Images

Aimtools. 2021. *Heavy Duty Air Line Pressure Regulator QTY Series*. [online] Available at: <https://www.aimtools.co.uk/products/214235-heavy-duty-air-pressure-regulator> [Accessed 11 December 2021].

Assets.publishing.service.gov.uk. n.d. *Hydraulic Systems*. [online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/857240/Volume_04_Aircraft_Systems.pdf#:~:text=Reservoirs%20are%20usually%20pressurized%20either%20with%20nitrogen%20or,buid%20up%20due%20to%20heating%20or%20system%20malfunction. [Accessed 11 December 2021].

FluidPowerJournal. n.d. *FluidPowerJournal*. [online] Available at: <https://fluidpowerjournal.com/wp-content/uploads/2018/05/outcome.jpg> [Accessed 17 December 2021].

Hydraulicstatic.com. n.d. *Hydraulic Positive Displacement Pump, Gear Pump – Hydraulic Schematic Troubleshooting*. [online] Available at: http://www.hydraulicstatic.com/20091214_hydraulic-positive-displacement-pump-gear-pump.html [Accessed 10 December 2021].

Hydraulicvalvestech.com. n.d. *Valves for the Miniature Hydraulic Market from HVT HydraulicValves Technologie GmbH*. [online] Available at: <https://www.hydraulicvalvestech.com/Typ150.html> [Accessed 13 December 2021].

Kuphalt, T., 2021. *Calculate Hydraulic System Fluid Pressure - InstrumentationTools*. [online] Inst Tools. Available at: <https://instrumentationtools.com/hydraulic-system-fluid-pressure/#:~:text=A%20free-floating%20piston%20inside%20a%20hydraulic%20cylinder%20has,The%20piston%20itself%20is%202.75%20inches%20in%20diameter>. [Accessed 13 December 2021].

Rashid, 2021. *Vane Pump - Components, Working, Types, Advantages, and Disadvantages*. [online] Mechanical Walkins. Available at: <http://www.mechanicalwalkins.com/vane-pump-components-working-types-advantages-and-disadvantages/> [Accessed 10 December 2021].

Staff, E., n.d. *Reciprocating Compressors*. [online] Inst Tools. Available at: <https://instrumentationtools.com/reciprocating-compressors/> [Accessed 5 December 2021].

VCompInc. 2017. *What are Single Acting & Double Acting Hydraulic Cylinders*. [online] Available at: <https://medium.com/@vcompmississaug/what-are-single-acting-double-acting-hydraulic-cylinders-817d6e6f30a8> [Accessed 5 December 2021].

Matthew Rawlings Hydraulics and Pneumatics Assignment

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

64/100

PAGE 1

Text Comment. 64.5 overall grade

Text Comment. □ Professional cover page for a technical report

PAGE 2

Text Comment. □ Content

PAGE 3

Text Comment. □ Correct

PAGE 4

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

PAGE 5

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

PAGE 10

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. A little brief in comparison with your other discussion points.

PAGE 11

Text Comment. ★ kPa should be written like this.

Text Comment. □ Stage 1 compression

Text Comment. ★ Your 4.13 should have gone into V1

Text Comment. ★ P2 is given in the assignment brief

Text Comment. ★ V2 is a second compression and should be a lower value than 4.13

Text Comment. □ Reasonable value for pressure

Text Comment. □ Density, correct units

Text Comment. □ Good application of Bernoulli's formula to solve for decreasing pressure.

PAGE 12

Text Comment. □ Correct

Text Comment. □ Showing conversion

Text Comment. Well applied

PAGE 13

Text Comment. □

Text Comment. □

Text Comment. □

Text Comment. □ Correct

Text Comment. □ Correct force

Text Comment. □ A sensible load to be lifted

PAGE 14

Text Comment. □ A wide range of technical internet sources and books have been considered. ★ This should be a 'Reference List' and you should have in-text referencing throughout your work. It is difficult to see where the sources have been used in your writing. Some additional referencing shown as endnotes on each page.

PAGE 15

Text Comment. □ Good use of page numbering