DIESEL MECHANIC

MINING QUALIFICATIONS AUTHORITY

CODE: HYD - 2

TEST THE PUMP IN A CIRCUIT

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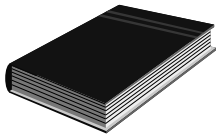


SOURCE REFERENCES

Demonstration by a competent person, e.g. a Training Officer.

FESTO – Basic Level Textbook

OBJECTIVE

You will be learning towards the outcome “Test the pump in a circuit”. Whilst learning towards the outcome you will be required to achieve the following:

- Test and determine the volumetric efficiency of the hydraulic pump.
- Know the types of pumps commonly used in hydraulics.
- Know the difference between a variable and fixed displacement pumps.

On completion of this module, the learner must be able to:

- Test and determine the volumetric efficiency of the hydraulic pump. The flow of fluid through the pump at the rated pressure ±100 kPa, must be measures within ±0.5 litres / min of the correct reading.
- State the types of pumps commonly used in hydraulics.
- State the difference between a variable and fixed displacement pumps.

During this process you must adhere to certain specified requirements as listed in the Module.

ASSESSMENT AND EVALUATION CRITERIA

You will be assessed, when you are confident that you may achieve the outcomes as listed, to determine your competence as measured against the required criteria. This assessment will be in line with accepted best practices regarding assessment.

- A theoreticaland practical assessment will be set during the module and must be completed without using reference.
- The learner will be required to answer all the questions without any reference.
- There must not be any damage to the pump or to the test unit.

HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM

HYD - 2

TEST THE PUMP IN A CIRCUIT

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS (BY RESPONSIBLE PERSON)
1. Construct a hydraulic circuit.	• Improper or careless handling of hydraulic components and pipes can lead to damage of equipment.	• Always handle components and pipes correctly, and with great care. • Wipe components and panel clean after use and store components.
2. Use of hydraulic oil in a pressurised circuit.	• Circuit under pressure.	• Ensure circuit is depressurised before removing components or pipes
3. Insure work area is safe	• Oil in eyes and laceration of skin. • Slip and fall.	• Wear correct PPE. • Ensure working area is clean and safe. • Wear correct safety boots.

NOTE:Before doing the practical work contained in this module, the learner must study the content of the above HIAC form again and then sign the statement below.

The above risks, which will be encountered in this module, are fully understood and will be controlled during the practical work.

Signature of learner: _____

Signature of Training Officer: _____

Date: _____

1. INTRODUCTION

ITEM / TASK: Pump vs. Motor.

DESCRIPTION:

A. The pump is the heart of the system and it maintains the fluid flow. A pump is a device that transfers oil from point “A” to point “B”.
B. The pump in a hydraulic system, also known as a hydraulic pump, converts the mechanical energy in a drive unit into hydraulic energy. The pump draws in the hydraulic fluid and drives it out into a system of lines.
C. Hydraulic motors are components in the working section. They are drive components (actuators). They convert hydraulic energy into mechanical energy and generate rotary movements.
D. Hydraulic motors have the same characteristic values as pumps. However, in the case of hydraulic values we speak of capacity rather than displacement volume.

2. PUMPS AND MOTORS

ITEM / TASK: Classification of pumps.

DESCRIPTION:

Pumps are classified according to their type and displacement.

A. **Type**

There are several types of pumps used in hydraulics. The most commonly used are:

a. gear pumps
b. vane pumps
c. piston pumps

a. **Gear pumps**

Many people wrongly believe that the oil travels through the meshing gears. In fact, the oil is trapped between the teeth of the gears and travels around the periphery of the case of the pump until it comes to the delivery port. If you were to put your tie in the pump and it is pulled through, you would be looking at the delivery port. (Fig 1 on the next page)

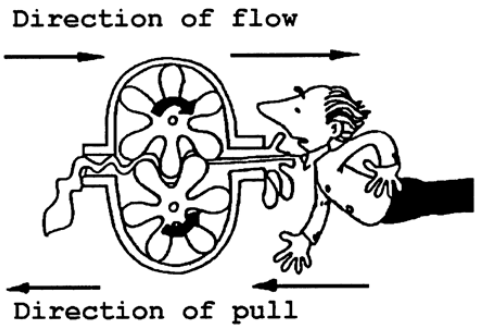


FIG 1.

When the gears rotate as shown in Fig 2, they come out of mesh on the left-hand side. This causes an ever increasing space as the teeth move further apart and forms a partial vacuum. The oil at the inlet port is forced into the pump by atmospheric pressure.

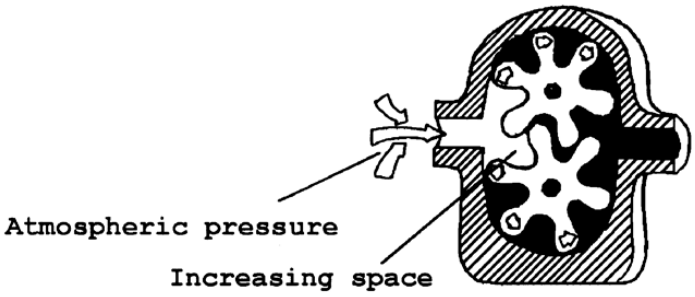


FIG 2.

While the gears continue rotating, the oil is trapped between the gear teeth and the pump casing, and is carried to the right-hand side of the pump. (Refer to Fig 3)

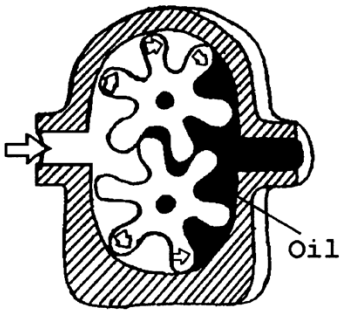


FIG 3.

When the gear teeth on the right-hand side start to mesh they cause the space to decrease continuously. The oil is now forced through the discharge opening into the system. (Fig 4 on the next page)

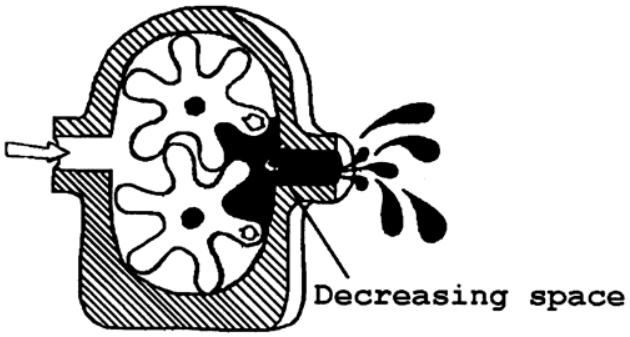


FIG 4.

Some gear pumps are fitted with pressure plates as shown in Fig 5. An internal passage leads from the discharge cavity to the outside of each plate. As theoil pressure increases, the plates pushed tighter against the sides of the gears. Thus the plates seal tightly when the pump is loaded and relaxed a little when there is no load.

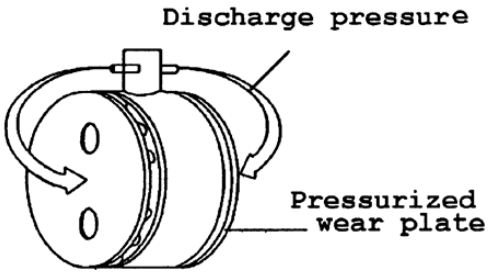


FIG 5.

b. **Vane pump**

The vane pump consists of a housing, rotor and vanes. (Fig 6)

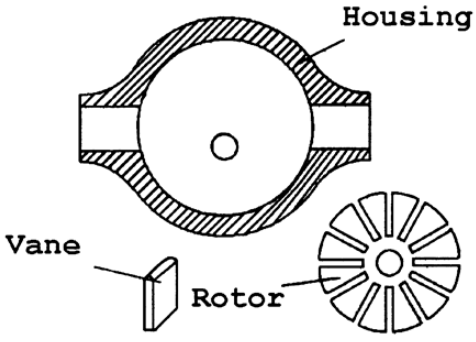


FIG 6.

The rotor is fitted off-centre in the housing and is driven by a shaft. The vanes are forced in and out of the slots as the rotor rotates. Refer to Fig 7 on the next page.

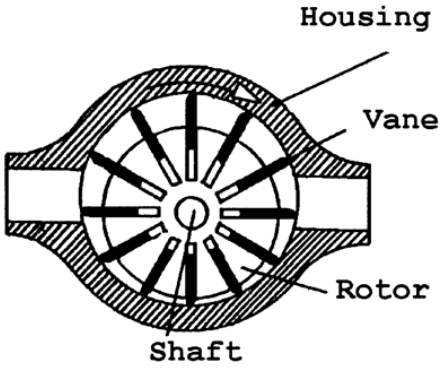


FIG 7.

A chamber is formed between two successive vanes, the rotor and the casing. (Fig 8)

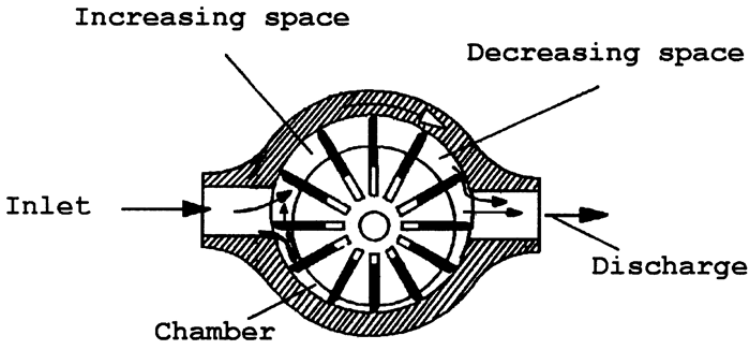


FIG 8.

The chamber increases in size at the inlet side as the rotor rotates. This creates a low pressure and the chamber is filled with oil from the tank. The oil is carried by the vanes to the discharge side. At this point the chamber decreases in size and forces the oil through the discharge passage.

c. **Piston pump**

A step by step description of the construction of a piston pump is given in order to explain best its operation.

When the lever to the piston is moved back and forth, the piston also moves back and forth within its cylinder. (Fig 9 on the next page)

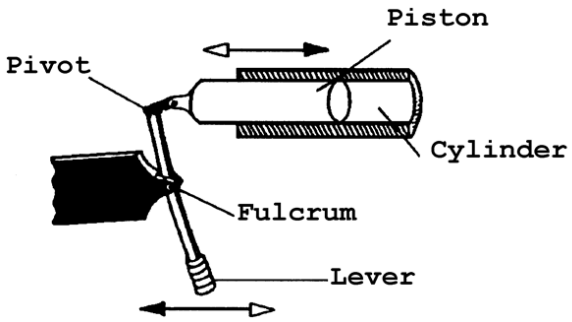


FIG 9.

Now the piston is fitted to a fixed inclined plane, instead of a lever. It is obvious that when the cylinder is moved up and down in a straight line via the inclined plane, the piston will also move back and forth in the cylinder. (Refer to Fig 10)

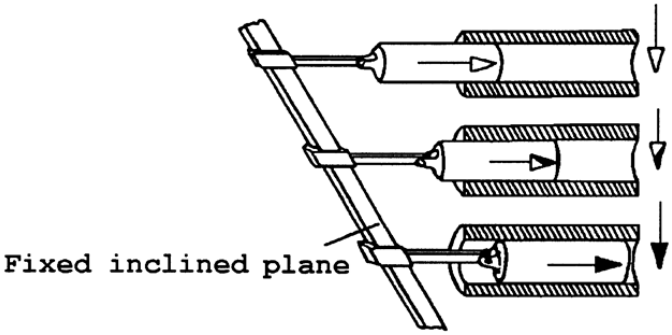


FIG 10.

When the pistons are fitted to an incline ring, or swash plate as it is usually called, a drive shaft is fitted to the larger cylinder. When the cylinder is rotated by the drive shaft, the pistons are forced in and out of the cylinder as they slide around the swash plate. (Fig 11)

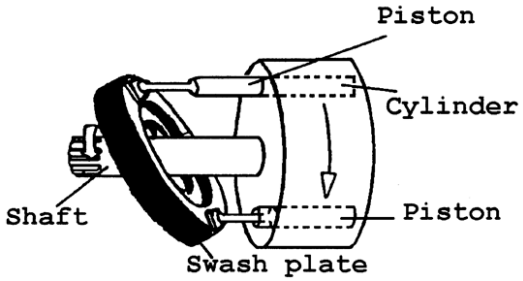


FIG 11.

A plate, known as the valve plate (Fig12 on the next page) is fitted in front of the cylinder to direct the inlet and discharged oil. During half of a revolution, oil is drawn from the tank. During the second half, oil is forced into the system.

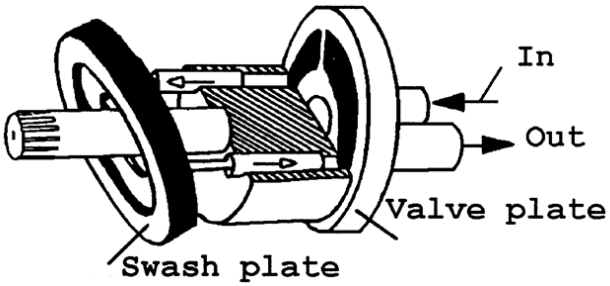


FIG 12.

B. **Displacement**

Displacement is the volume of oil moved or displaced during each cycle of a pump.

Hydraulic pumps can be classified under two types of displacement, namely:

a. fixed displacement pumps, and
b. Variable displacement pumps.

a. **Fixed displacement**

Fixed displacement pumps move the same volume of oil with every cycle. This volume can only be changed when the speed at which the pump is driven is changed.

All pumps described so far in these notes are fixed displacement pumps.

The symbol for a fixed displacement pump with one direction of flow (Fig 13) and two directions of flow (Fig 14) is shown below.

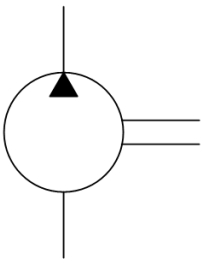


FIG 13.

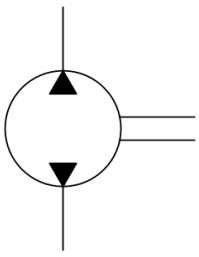


FIG 14.

b. **Variable displacement**

Variable displacement pumps can vary the volume of oil they move with each cycle, without changing the speed of the pump.

Piston pumps have a feature which allows them to change the amount of flow. This is done by changing the angle of the swash plate.

The displacement of the pump therefore is varied without the speed of the pump being changed. In Fig 15, the swash plate is returned to neutral position (0°). When the cylinder assembly rotates there is no flow because the pistons are not moving back and forth in the cylinder.

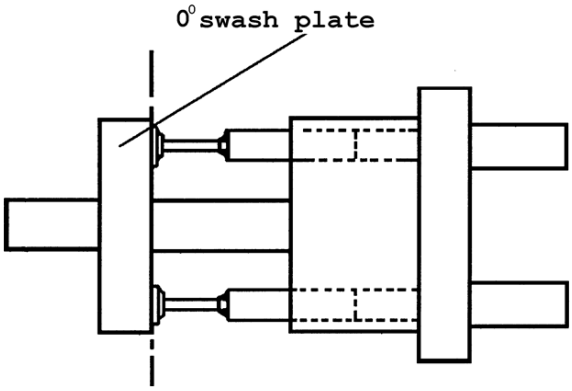


FIG 15.

In Fig 16 the swash plate is at an angle of 18°. (The greater the angle, the greater the flow). The fluid is now moved by the reciprocating pistons.

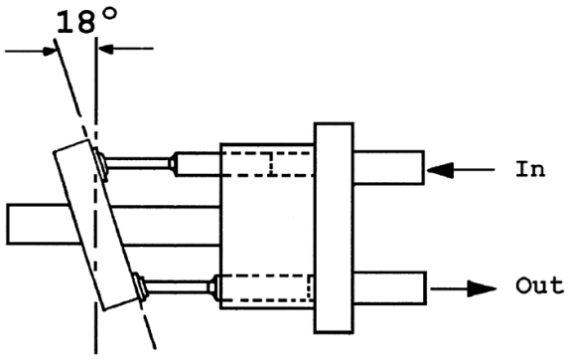


FIG 16.

The position of the swash plate can be controlled manually by a lever on the outside of the pump, or by a small cylinder called a servo. (Refer toFig 17)

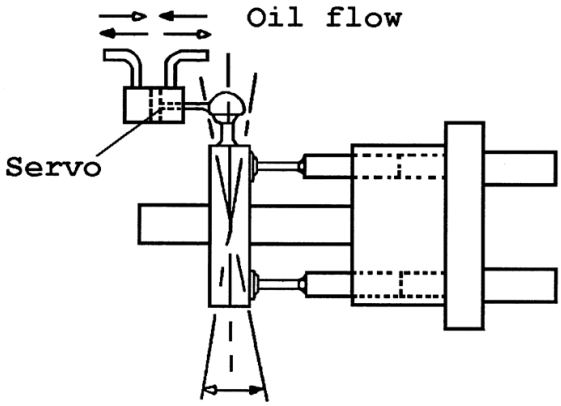


FIG 17.

The symbol for a variable capacity hydraulic pump with one direction of flow manually controlled is shown in Fig 18.

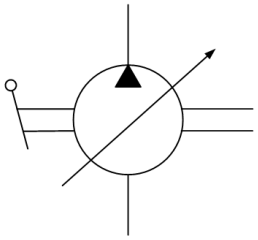


FIG 18.

NB: The arrow through the pump indicates that it is variable.

The symbol for a variable capacity hydraulic pump pressure controlled via a servo valve is shown in Fig 19.

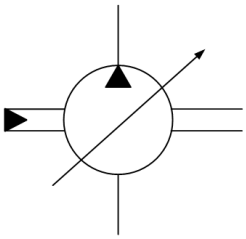


FIG 19.

The symbol for a variable capacity hydraulic pump, regulated by constant pressure (Pressure compensated) is shown in Fig 20.

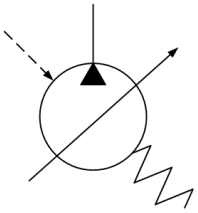


FIG 20.

The symbol for an electric motor is shown in Fig 21.

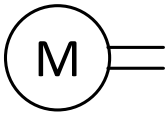


FIG 21.

DO THE SELF TEST AND PRACTICE ON THE NEXT PAGES BEFORE CONTINUING WITH THE REST OF THE MODULE.

SELF TEST 1

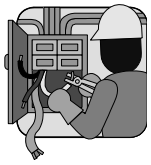
1. What types of pumps are commonly used in hydraulic systems?

2. What is the difference between a variable displacement pump and a fixed displacement Pump?

Refer to your notes to check your answers.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



PRACTICE

Neatly draw the following symbols:

Description	Symbol
Fixed displacement pump with one direction of flow.	
Fixed displacement pump with two directions of flow.	
Variable capacity hydraulic pump with one direction of flow, manually controlled.	
Variable capacity hydraulic pump controlled by a servo valve.	
Variable capacity hydraulic pump regulated by constant pressure. (Pressure compensated)	

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

3. RATING A PUMP

ITEM / TASK: Factors.

DESCRIPTION:

When testing a pump there are three factors to consider, namely:

a. pump delivery
b. pressure, and
c. Speed.

a. **Pump delivery**

Most hydraulic pumps are rated by volume flow. This is usually expressed in litres per minute (l/min).

b. **Pressure**

Volume flow is not the only factor used to rate a pump. It must be accompanied by a figure stating the minimum amount of pressure that the pump can operate at while still producing the required volume capacity. When the pressure is increased the internal leakage, called the "slip", is also increased and the usable volume decreases.

Internal slip is the oil that leaks from the high pressure side of the pump, through the gears or vanes to the low pressure side. The more wear in the pump the greater the internal slip will be.

c. **Speed**

The flow of a fixed displacement pump is in proportion to its speed. Therefore, the faster the pump is driven by the motor, the more fluid will be pumped.

The following is an example of how a pump is rated.

50 litres/min at 13 800 kPa and 1440 rpm.

The rating of the pump is normal given on the pump.

4. TESTING UNIT

ITEM / TASK: Testing equipment.

DESCRIPTION:

A pump is tested with a unit which consists of a flowmeter, a temperature gauge, a pressure gauge and a loading valve, which is a variable flow control valve. (Fig 22)

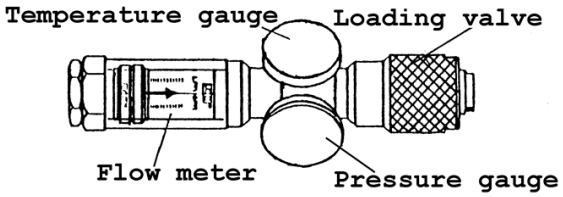


FIG 22.

5. TESTING A PUMP

ITEM / TASK: Testing procedure.

DESCRIPTION:

A. Connect the test unit in the circuit as shown in the schematic diagram. (Fig 23)

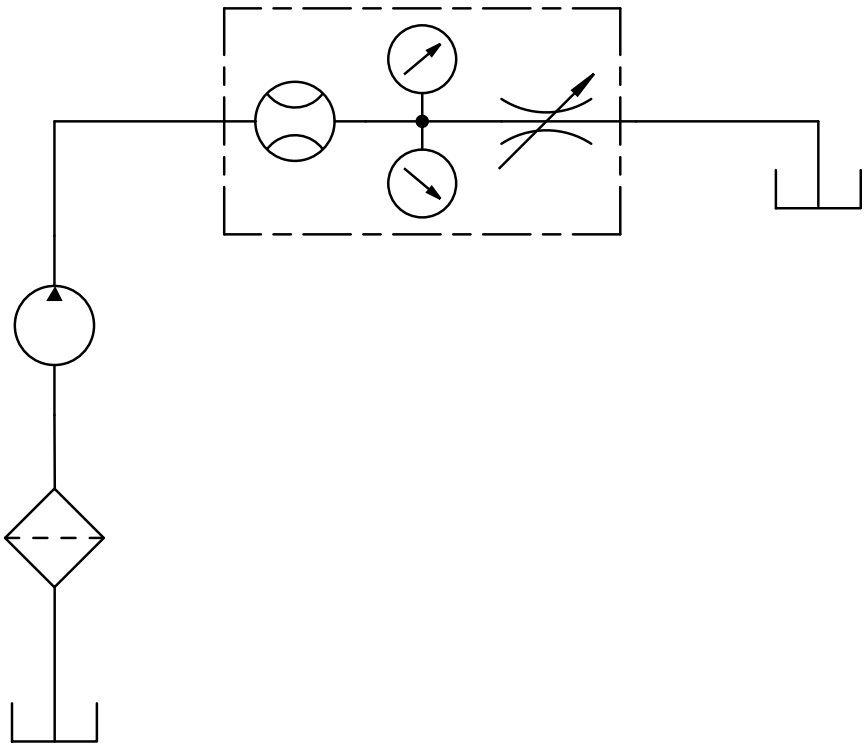


FIG 23.

The symbol for an integrated flowmeter (test unit) is shown in Fig 24.

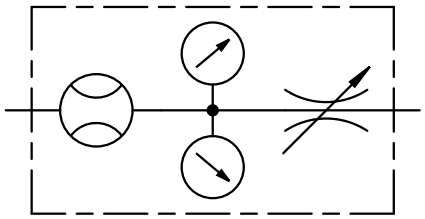


FIG 24.

The symbol for a strainer or filter is shown in Fig 25.

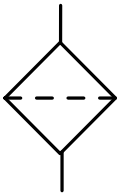


FIG 25.

NB:

The flow of the oil through the test unit must always be in the same direction as indicated by the arrow on the flowmeter.

B. Release the loading valve completely so that the oil will flow freely through the test unit.
C. Determine the rating of the pump from its nameplate or from specifications given in the workshop manual.
D. Start the pump.
E. If it is mounted on an internal combustion engine, adjust the engine until it runs at the rated speed.
F. Let the pump run until the oil has reached its working temperature, approximately 80°C.
G. Take the flow reading and record it on a piece of paper.

NB:

This reading must not be lower than the rated flow. If it is, it indicates that there is a restriction in the suction line of the pump, e.g. a blocked filter.

H. Slowly close the loading valve until the rated pressure of the pump is indicated on the pressure gauge.
I. Take and record the flow reading.
J. Compare this flow reading with the rated flow to determine the efficiency of the pump.

Example:

Test unit reading : 40 litres/min.

Rated flow : 50 litres/min.

$$\text{Volumetric efficiency of the pump} = \frac{40}{50}$$

$$= 80\%$$

6. CAVITATION

ITEM / TASK: Causes.

DESCRIPTION:

A. Cavitation in a pump is dangerous because it can result in damage to the pump.

B. The two main causes of cavitation are oil starvation and air present in the oil. Cavitation can be recognised by an audible rattling or hammering sound coming from the unit.

C. Ask the instructor to induce cavitation in the unit so that you can recognize it if you encounter it in future, and to explain how to rectify it.

DO THE SELF TEST AND PRACTICE ON THE NEXT PAGES
BEFORE ATTEMPTING THE ASSESSMENT.

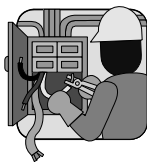
SELF TEST 2

1. What are the three factors to consider when testing a pump?

Refer to your notes to check your answers.

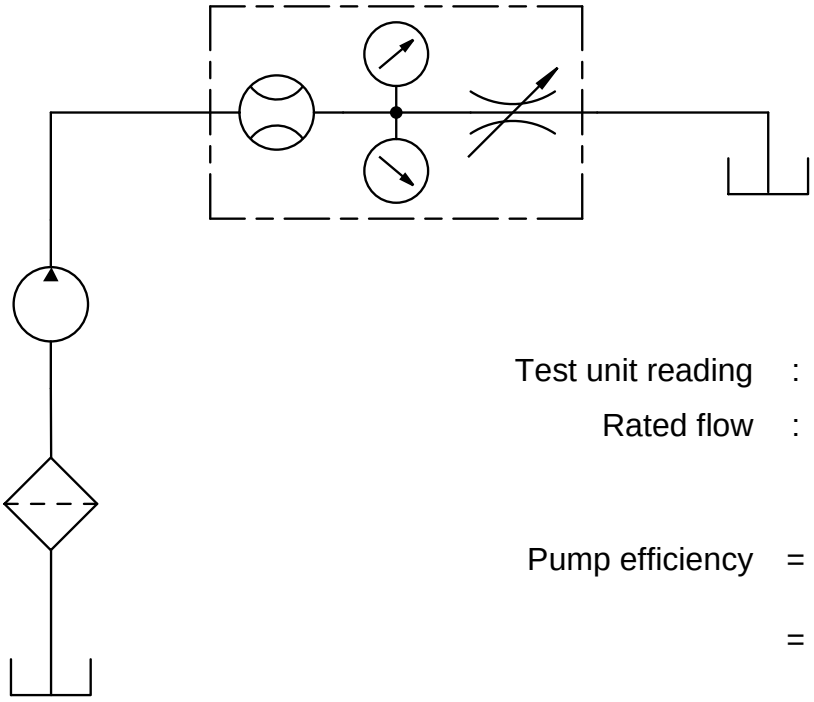
Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



PRACTICE

Connect the test unit into the hydraulic trainer as shown in the schematic diagram and determine the efficiency of the pump.



Test unit reading : _____

Rated flow : _____

Pump efficiency = _____

= _____

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

REMEMBER ALWAYS WORK SAFE

Once you have passed the entirepractices, you are now at liberty to request a Formative Assessment from your Assessor.