SAULT COLLEGE

of Applied Arts and Technology

Sault Ste. Marie

COURSE OUTLINE

INDUSTRIAL HYDRAULICS

MCH 216-3

r G V i S G d   June, 1978 by B, Graham

MECHANICAL TECHNICIAN

<u>INDUSTRIAL HYDRAULICS</u>

MCH 216-3

TEXT

    Industrial Hydraulic Manual - Viewers

REFERENCES

    Mobile Hydraulics Manual - Vicjfers

INDUSTRIAL HYDRAULICS

MCH 216-3

COURSE OBJECTIVES:

The student will have a sound understanding of the basic principles
of hydraulics; the operation of major hydraulic components; the
disassembly and assembly of major hydraulic components, the use
of manufacturer's service and maintenance literature, the reading
of hydraulic circuit diagrams, and the trouble shooting of simple
hydraulic circuits.

    2*2 periods - lecture
    1*5 periods - lab

EVALUATION METHODOLOGY

    35% lab - (dis-assembly and assembly of components and circuits
               on panel boards.)
    65% tests - tested on each section of course.

Topic Number	Suggested Periods	Topic Description	Reference
1	6	FUNDAMENTALS!	

-Pascal * s Law \
-pressure exerted by a column of oil
   or water,
-cause of pressure.
-H.P. equation
-frictions in piping, etc.

| 2 • | 4 | RESERVOIRS & FILTERS & OIL | |

-purpose of reservoirs
-design of reservoirs
-types of filters
-mesh and muron rating
-viscosity

| 3 | 5 | VANE PUMPS | |

-types of pumps
-hydrstatic and hydrodynamic
-assembly of nurers -"round",
    "square" & "intravan" pumps,
-volumetric efficiency
-malfunctions

RELIEF & PRESSURE REDUCING VALVES

-operation of relief valve & pressure valve
-construction of relief valve & pressure valve
-assembly of relief valve & pressure valve
-malfunctions of relief valve & pressure valve
-high vent spring
-venting relief valve

DOUBLE & TWO STAGE PUMPS

-difference between above pumps
-assembly of above pumps
-functions of dividing valve into two
    stage pumps
-malfunctions of above pumps.

DIRECTIONAL CONTROLS

-purpose
-major classifications
-2 & 4 way valves
-adaption of valves
-center condition of 3 portion valves.
-function and operation of D64, D63 and
    D65 vicher valves
-pilot valves
-deceleration valves

Topic Number	Suggested Periods	Topic Description	Reference
7	6	R TYPE VALVES	
		-types of valves and assembly for each type	
		-malfunctions of each type	
		COMBINATION PUMPS	
		-definition	
		-operation and assembly of various types of combination pumps	
		-malfunctions	
		PISTON PUMPS & MOTORS	
		-types	
		-operation	
		-pressure ranges	
		-assembly	
		-malfunction	
		-fixed & variable types	
		-open & closed circuit system	
10	3	FLOW CONTROLS	
		•types	
		-factors affecting flow	
		-applications of flow control valves	
		-malfunctions	
11	4	CIRCUIT LAB	
		-connecting 10 basic circuits on Vichers panel boards-	

PART - I: BASIC INFORMATION

GENERAL OBJECTIVES:

    To have a sound understanding of the basic principles of hydraulics,

SPECIFIC OBJECTIVES:

1. To be able to state "Pascal[1]s Law".

2. To be able to state that hydraulics is a means of power
   transmission.

3. To be able to state that oil is the most commonly used medium
   as is it serves as a lubricant and is practically non-ccmpressible.

4. To be able to state that oil weighs *55* to 58 lbs, per cubic foot.

5. To be able to state that the pressure at the bottom of a one foot
   column of oil is approximately 0.4 psi and to be able to find the
   pressure at the bottom of any column of oil.

6. To be able to state that there must be a pressure drop across an
   orifice or restriction to cause flow through it,

7. To be able to state that liquid is pushed, not drawn, into a
   pump by atmospheric pressure. (14,7 psi).

8. To be able to state that a pump's purpose is to create flow, not
   pressure and only positive displacement types are used in
   industrial hydraulics,

9. To be able to state that pressure is caused by resistance to flow.

10. To be able to state that oil takes the course of least resistance.

11. To be able to state that a pressure gauge indicates the work load
    at any given moment. Gauge reading does not include atmospheric
    pressure.

12. To be able to state that the force exerted by a cylinder is
    dependent upon pressure applied and piston area. (area =
    diameter squared x 0.7354),

13. To be able to state that the speed of a piston as a cylinder is
    dependent upon its size (piston area) and the rate of oil flow
    into it.

14. To be able to state that the flow velocity through a pipe varies
    inversely as the square of the inside diameter - i.e. doubling
    the 1.1), increases the area by four times.

15. To be able to state that the friction of a liquid in a pipe varies as the square of the velocity.

16. To be able to find the actual area of a pipe needed to handle a given flow using the formula:

$$Area = \frac{C.P.M. \times 0.3208}{Velocity\ (Ft./sec.)} \text{ or } Velocity\ (Ft./sec.) = \frac{C.P.M.}{3.117 \times area}$$

17. To be able to state that in standard pipe, the actual inside diameter is larger than the normal size quoted.

18. To be able to state thai, steel and copper tubing size indicates the outside diameter.

19. To be able to state that a) single wire braid hose corresponds to tubing in nominal size, i.e., $\%^{T}$ tube = #12 hose; !)doub!e wire braid hose has same. I.D. as O.D. of tube.

20. To be able to find the H.P. required to move a given –solume at a known pressure using formula:

    H.P.= G.P.M. x Pressure x 0.000583

    $$H.P. = \frac{G.P.M. \times P.S.I.}{1714}$$

21. To be able to list the following relationships:

    one H.P. - 33000 ft./lbs. per minute

    = 746 watts

    — 42.4 B^'Min.

22. To be able to list the following formula:

    a) $Torque\ (in,lbs,) = \dfrac{63025 \times U.?.}{R.P.M.}$

    b) $H.P. = \dfrac{Torque\ (in.lb.) \times R.P.M.}{63025}$

23. To be able to find the amount of oil required to move a piston through a given distance by multiplying the piston area in inches by the stroke length in inches and divide this by 231 to find the capacity in gallons.

PART - II: RESERVOIRS, FILTERS, STRAINERS AND OILS

GENERAL 03JECTIVES:

To have a sound understanding of hydraulic reservoirs, filters, strainers and oils.

SPECIFIC OBJECTIVES:

1. To be able to state the reservoir should be 2 to 3 tines the pump capacity.

2. To be able to state that the air filter should be 5 times the pump volume.

3. To be able to state that the oil temperature should be: about 60° to 70° F. above rooriL (ambrent) temperature in a reservoir.

4. To be able to state the basic requirements of a reservoir construction, breather, baffle Plate, line connections and fillings.

5. To be able to define a) Filter, b) Strainer

6. To be able to define ^{M}Mesh" and Micron Rating.

7. ^{T}o ^{K}e ?Me to state the three positions for filter::.

8. To be able to list three types of filtering materials.

9. To be able to list the two types of filter elements.

10. To be able to list the three basic types of filters.

lit To be able to state what three basic properties hydraulic oil must have.

12. To be able to define Viscosity*

13. To be able to state the temperature and cleanliness requirements of hydraulic oil.

PART - III: PUMPS - GENERAL

GENERAL OBJECTIVES:

To have a sound understanding of the types of pumps and their particular design and construction used in industrial hydraulics.

SPECIFIC OBJECTIVES:

1. To be able to list the two types of pumps
   a) Positive (Hydrostatic)
   b) Kon-Positive (Hydrodynamic)

2. To be able to state that industrial hydraulics uses positive displacement pumps, either fixed or variable displacement,

3. To be able to list four types of positive displacement pumps,

4. To be able to correctly disassemble and assemble a V:"ckers "Round" pump, and reassemble for opposite shaft rotation,

5. To be able to list threr. items that affect a round pump[1]s delivery.

6. To be able to correctly disassemble and assemble a Vickers "Square[11] pump and reassemble for opposite shaft rotation,

7. To be able to correctly disassemble and assemble a Vickers Intravane pump and reassemble for opposite drive shaft rotation.

8. To be able to define Volumetric Efficiency.

PART IV: RELIEF VALVES AND PRESSURE REDUCING VALVES

GENERAL OBJECTIVES;

     To have a sound understanding of the operation and repair of
a balanced piston relief valve and pressure reducing valves.

SPECIFIC OBJECTIVES:

   1. To be able to describe the operation of a simple type
       relief valve.

   2. To be able to define "Cracking Pressure"*

   3. To be able to sketch a balanced piston relief v^.lve
       and describe the operation of the various components.

   4. To be able to describe the construction and opeiation
       of a remote control relief valve.   *

   5. To be able to describe the purpose of a vent connection
       on a relief valve.

   6. To be able to define a "High Vent Spring".

   7. To be able to describe five malfunctions of a balanced
       soool relief valve and their '•medics*

   8. To be able to state the difference between a relief
       valve and an unloading valve.

   9. To be able to disassemble and assemble a Vickers balanced
       spool relief valve correctly.

  10* To be able to sketch a pressure reducing valve (Vicker's
       design) and describe the operation of the various com-
       ponents.

  11. To be able to describe five malfunctions of a pressure
       reducing valve and state their remedies.

  12. To be able to assemble ana disassemble a Vickers pressure
       reducing valve correctly.

PART - V: DOUBLE & TWO STAGE PUMPS

GENERAL OBJECTIVES:

    To have a thorough understanding of the operation and malfunctions
of double and two stage pumps,

SPECIFIC OBJECTIVES:

   1. To be able to diagramatic sketch af a double pump*

   2. To be able to assemble and disassemble a double pump correctly*

   3. To be able to state the function of a two stage pump and draw
       a diagramatic sketch of it.

   4. To be able to describe the functions of a dividing valve*

   5* To be able to draw a circuit diagram of a two sta^c pump
        showing how the dividing valve operates.

   6* To be able to state that leakage in small pumps are externally
       drained because of heat, while the larger ones are internally
       drained.

   7. To be able to state that when adjusting a two stage pump
       adjust *Zl'.i* head bolts in the he~d end cartrdige.

   8*

PART - VI: DIRECTIONAL CONTROLS

GENERAL OBJECTIVES:

To have a sound understanding of the operation and malfunctions of directional control valves.

SPECIFIC OBJECTIVES:

1. To be able to define flow control valves.

2* To be able to list five major classifications of directional valves.

3. To be able to define the function of a check valve*

4* To be able to list four types of check valves and their applications.

5» To be able to descr5b^ the functions of a 2-way arc 4-way valves.

6* To be able to describe the operation of and draw schematics of t
   a. Rotary forr-vay valves
   b. Spool type two-way valves
   c. Spool type four-way valves

I* To. be able to list five methods of operating directional valves.

8. To be able to state what is meant by "spring centered" "spring offset" and "no spring".

9. To be able to describe or draw schematics to show the following vicker's center conditions, type 0, type 1, type 2, type 3, type 4 or 8 type 9.

10. To be able to describe the function and operations of the following Vickers valves: a) DG4 series, b) D63 and Dg5 series.

11. To be able to describe where pilot pressure sources are available

12. To be able to describe the function and operation of a pilot choke, pilot piston, and a deceleration valve.

13. To be able to state the difference between a two land and a three land spool.

14. To be able to state the direction of oil flow inside a two or three land spool directional valve*

To be able to state that a pilot valve for a spring centered valve must be a type 6.

To be able to comprehend circuit diagrams of various type directional valves.

To be able to correctly assemble and disassemble simple type directional valves.

PART - VIII: "R" Type Valves

GENERAL OBJECTIVES:

    To have a sound understanding of the operation and maintenance of Vickers "R" valves.

SPECIFIC OBJECTIVES:

    1. To be able to describe the operation of the various components
        of an "R" valve.

    2» To be able to list the five applications an "R" val\e can be
        used in and the component relocation(s) required fo-- each type.

    3. To be able to list the main disadvantage of using ar. "R" valve as
        a relief valve.

    A. To be able to sketch a schematic of a circuit that rhe "R" valve
        would be used in for each application listed is objective #2.

    5. To be able to correctly assemble and disassemble a Vickers "R"
        valve and assemble it to suit any of objective #2 requirements.

PART - VIII: COMBINATION PUMPS

<u>GENERAL OBJECTIVES</u>:

     To have a thorough understanding of the operation and maintenance
of combination pumps.

<u>SPECIFIC OBJECTIVES</u>:

     1. To be able to define combination pumps.

     2. To be able to list the various components of a combination
         pump.

     3. To be able to describe the operation of a type #3 pump during
          low pressure advance and high pressure low volume acvance.

     4. To be able to state the problems with the unloading valve
         section is set to high or too low.

     5* To be able to describe the operation of a combination type 33
         pump, and type 6 pump.

     6» To be able to correctly assemble and disassemble a Vickers
         type 3 combination'pump.

PART - IX: PISTON PUMPS & MOTORS

GENERAL OBJECTIVES:

To have a thorough understanding of the operation and maintenance of piston pumps and motors*

SPECIFIC OBJECTIVES:

1« To be able to state the pressure range that piston pumps are used in.

2- To be able to state the two basic types of piston pumps, a) Radial, b) Axial.

3- To be able to state that axial pumps can be bent-axis type or in-line type.

4. To be able to describe the operation of a radial piston pump.

5. To be able to describe the operation of a fixed displacement in-line pump.

6. To be able to describe the operation of a variable displacement in-line pump.

7. To be able to describe the operation of a bent-axis piston pump •

8« To be able to state that most piston pumps and motors has 7 or 9 pistons, to smooth off pressure fluctuation.

9. To be able to state that for variable volume pumps

   a) Output varies as pump angle
   b) Output varies as shaft speed.

10. To be able to draw a sketch of an open circuit hydraulic system.

11. To be able to draw:-

   a) a simple closed circuit system
   b) a simple closed circuit system with replenishing checks
   c) a simple closed circuit system with replenishing checks and across the line relief valves
   d) a simple closed circuit system with replenishing relief valve.

To be able to state that piston pumps and motors are externally drained.

To be able to state what a H.A.S, drive is and list A applications where it can be used.

To be able to sketch a valve plate showing the dwell portion and precompression and decompression grooves.

To be able to define "Valve plate separation" or "Cylinder block lift" and its cause and solution.

To be able to state the difference in valving between a piston pump and motor.

To be able to state for a fixed displacement motor:
        a) constant torqne
        b) variable speed

To be able to state for a variable displacement motor:
        a) variable torque
        b) variable speed

To be able to describe the operation of pressure compensators on in-line and bent-axis piston pumps and motors.

To be able to state that during field repairs of piston pumps and motors, shallow grooves in the valve plate and cylinder block can be removed and new pintle seals (bent-axis) can be installed.

To be able to correctly assemble and disassemble a Vickers in-line piston pump and motor and a Vickers bent-axis piston pump.

PART - X: FLOW CONTROLS

<u>GENERAL OBJECTIVES</u>:

    To know the operation and maintenance of flow control valves.

<u>SPECIFIC OBJECTIVES</u>:

    1. To be able to list four factors affected the flow of oil.

    2. To be able to state th-it when the work load increases or
        decreases the size of the opening must adjust according to
        maintain a fixed flow through an orifice.

    3. To be able to list three applications of a flow control
        valve-

    4. To be able to explain the operation and function ol a Vickers
        FRG type (by-pass) flow control valve and its application.

    5. To be able to explain the operation and function of a Vickers
        FCG type (restrictor) flow control valve and its application.

    6. To be able to state that there must be at least 150 psi pre-
        ssure drop across a meter valve or the valve will become
        unstable and stick*

    7« To be able to state the disadvantage of a flow control valve
        used in a Bleed-Off application.

    8. To be able to state three applications of each of the following:

                        a) Meter-In Circuit
                        b) Meter-Out Circuit
                        c) Bleed-Off Circuit

GENERAL OBJECTIVES:

To know how to read hydraulic circuit drawings and follow through a trouble shooting procedure.

SPECIFIC OBJECTIVES:

1. To know how to obtain the following information from a hydraul drawing. .
    a) Component list
    •b) Operation cf total and branch circuits
    c) Valve setting and types

2« To be able to follow through a trouble shooting procedure of given basic hydraulic circuits when adequate information on operating problems i? given.