QUIZ1 sol

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Quiz 2 Solutions
Week 5

1. A hydraulic cylinder with diameter 0.75 inch and a stroke length of 12 inches is used to lift a 20 lb carton. Calculate the required oil pressure. [45.3]

$F = pxA$

$20\,lbs = p \times \frac{\pi}{4}(0.75in)^2 \quad p = 45.3\ psi$

2. Hydraulic fluid flows at velocity of 200 in/min through a conduit with an internal diameter of 2 inches. Determine the flow rate in GPM. Be aware of your units! [2.7]

$Q = VxA = 200\frac{in}{min} \times \frac{\pi}{4}2in^2 = 628.3\ in^3/min$

$628.3\frac{in^3}{min} \times \frac{ft^3}{12^3 in^3} \times \frac{1min}{60sec} \times \frac{449gpm}{1ft^3/s} \quad Q = 2.7gpm$

3. What is the pressure head of oil in a vertical pipe if the pressure reading is 10 psi and the liquid is Gasoline with a specific weight of 42.2 lb/ft^3)? [34.1]

$p = \gamma H \quad 10psi = \frac{42.2\,lb}{ft^3} \times H$

$H = 10\frac{lbs}{in^2} \times \frac{144in^2}{1ft^3} \div \frac{42.2\,lb}{ft^3} \quad H = 34.1ft$

4. Calculate the Hydraulic HP of a hydraulic parts sorter that operates at 2500 psi and a flow rate of 45 gpm. [65.6]

$HP = p(psi) \times Q(gpm) \div 1714 = 2500psi \times 45gpm \div 1714 \quad HP = 65.6\ hp$

5. Bernoulli's Energy Equation tells us that
   a. energy everywhere in a hydraulic system is the same
   b. All the energy put in by the pump is used to move the load
   c. The energy between any 2 points is balanced when considering added and lost energy [correct]
   d. Friction losses do not need to be considered

6. A hydraulic cylinder is used to lift a load of 2,500 lbs. The maximum system pressure of 1500 psi. What cylinder size is required? (in other words, what is the diameter of the cylinder required?) [1.5]

$F = pa$

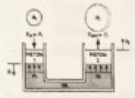
$2500\,lbs = 1500psi \times a \quad a = 1.667in^2 = \frac{\pi}{4}D^2 \quad D = 1.51in$

7. A hydraulic fluid has a specific weight of 55 lb/ft^3. What is its specific gravity? [0.9]

$SG = \frac{\gamma}{\gamma_{water}} \quad SG = \frac{55\,lb/ft^3}{62.4\,lb/ft^3} \quad SG = 0.9$

8. The load on a 2-in.-diameter hydraulic cylinder increases from 10,000 lb to 15,000 lb. Due to the compressibility of the oil, the piston retracts 0.1 in. If the volume of oil under compression is 10 in^3, what is the bulk modulus of the oil in units of kpsi? Enter only a whole number. [~~159~~ 51]

$\beta = \frac{-\Delta p}{\frac{\Delta V}{V}} = \frac{-(10000-15000)lb \times \frac{1}{\frac{\pi}{4}2in^2}}{\frac{(\frac{\pi}{4}2in^2 \times 0.1in)}{10in^3}} \quad \beta = 50.6\ kpsi$



9. Consider the hydraulic lifter shown where A1 = 3.2 in^2 and A2=9.1 in^2, and the applied force Fin=125 lbs. What is the output force F2? [355.5]

$\frac{F_2}{F_1} = \frac{A_2}{A_1} \quad F_2 = 125lbs \times \frac{9.1in^2}{3.2in^2} \quad F_2 = 355.5\,lbs$

10. Consider the hydraulic lifter shown where A1 = 3.2 in^2 and A2=9.1 in^2, and the applied force Fin=125 lbs. How far must Piston 1 be pushed to lift Piston 2 by 3 in? [8.5]

$\frac{F_1}{F_2} = \frac{S_2}{S_1} \quad S_1 = \frac{9.1in^2}{3.2in^2} \times 3in \quad S_1 = 8.5in$

11. A hydraulic pump which can be adjusted for different amounts of flow are called;
   a. Variable displacement pump [Correct]
   b. Fixed displacement pump
   c. Depends on type of pump
   d. a pump that can be adjusted

12. An external gear pump has the following dimensions: Inside teeth diameter = 1 in, Outside teeth, diameter = 2 in, Teeth width = 0.75 in. Calculate the volumetric displacement of this pump. [1.8]

$V_D = \frac{\pi}{4}(D_o^2 - D_i^2) \times L$ $\quad V_D = 1.8\ in^3/rev$

$= \frac{\pi}{4}(2in^2 - 1in^2) \times 0.75in$

13. A pump with a volumetric displacement of 4 in^3/rev runs at 3600 rpm and produces 1500 psi. The actual flow rate is 59 gpm. What is the volumetric efficiency of this pump? Enter a whole number percentage. [95]

$Q_T = V_D \times N \div 231$

$= \frac{4in^3}{rev} \times \frac{3600 rev}{min} \div 231$

$Q_T = 62.34\ gpm$

$\eta = \frac{Q_A}{Q_T}$ $\quad \eta = 95\%$

$\eta = 59gpm \div 62.34$

14. Which pump type is best suited for the following situation? The pump operates is a dirty and noisy environment, with moderate pressure and flow requirements.
    a. Gear [Correct]
    b. Vane
    c. Piston

15. Which pump type is best suited for the following situation? The hydraulic circuit requires high pressure and high flow rate and must operate under rough conditions for many years.
    a. Gear
    b. Vane
    c. Piston [Correct]

16. A pump has a displacement volume of 6 in^3. It delivers 24 gpm at 1000 rpm and 1000 psi. If the prime mover input torque is 1100 in • lb, what is the theoretical torque required to operate the pump in in-lbs? [95]

$T_T = \frac{V_D \times P}{2\pi}$ $\quad T_T = \frac{6in^3 \times 1000psi}{2\pi}$

$T_T = 955$

17. A hydraulic press is used to apply 500 lbs of force to press fit an assembly. The cylinder has a 2" piston and 1.5" rod, and a 16" stroke length. What flow rate (in gpm) is required to extend the press in 6 seconds? [2.2]

$Q = a \times V$

$= \frac{\pi}{4} 2in^2 \times \frac{16in}{6sec} \times \frac{1ft^3}{1728in^3} \times \frac{449 ft^3/s}{1gpm}$ $\quad Q = 22\ gpm$

18. A hydraulic press is used to apply 500 lbs of force to press fit an assembly. The cylinder has a 2" piston and 1.5" rod, and a 16" stroke length. What flow rate (in gpm) is required to retract the press in 0.75 seconds? [13] 26

$Q = aV$

$= \frac{\pi}{4}(2in^2 - 1.5in^2) \times \frac{16in}{0.75sec} \times \frac{1ft^3}{1728in^3} \times \frac{449 ft^3/s}{1gpm}$ $\quad Q = 26$

19. What would happen to the speed of a cylinder during extension, if piston diameter is increased while keeping pressure and pump gpm constant?
    a. increase
    b. decrease [Correct]
    c. stay the same
    d. it depends on the fluid type

20. Speed is pressure dependent in hydraulic systems.
    a. True
    b. False [Correct]

21. What type of DCV is best suited for a single acting cylinder?
    a. three-way, two-positions, spring return [Correct]
    b. two-way, normally passing
    c. four-way, three-position, closed center
    d. shuttle valve

22. How much pressure is required to 'turn on' a one-directional valve (check-valve)?
    a. full system pressure
    b. about 10-20 psi [Correct]
    c. depends on the flow rate
    d. about 100-200 psi

23. In 4 ports, 3 position closed center DCV
    a. pump line is blocked and pump's flow must go over the relief valve
    b. the outlet lines to the cylinder are blocked, so the cylinder will be held firmly in position
    c. the pump is always operating under load
    d. all of these [Correct]
    e. none of these

24. A tandem center condition stops actuator's motion, but allows pump flow to return to tank while a system is idling.
    a. True [Correct]

a. True [correct]
b. False

25. A cylinder is configured with a flow control valve to meter-out during extension. The cylinder is a 2" bore and 1" rod. The pump flow rate is 5 gpm with a pressure reducing valve set to 1500 psi. The load is 500 lbs. If the extension speed is to be limited to 10 in/s, what pressure would be measured on the retraction side of the cylinder, during extension? Enter a whole number. [1791]

$P_1 A_1 - F_{load} = P_2 A_2 \qquad Q = A_2 V_{cyc}$

$1500 psi \times \frac{\pi}{4} 2in^2 - 500 lbs = P_2 \times \frac{\pi}{4}(2in^2 - 1in^2)$

$P_2 = 1788 psi$