engineering adventures

Worksheet HW1 & Training Record Hydrostatic Skid-Steer Drive System		Hydraulic Projects
Email:	Course:	Provider:

Expected Outcomes: (4-8 hours)

This course is delivered in three distinct sections. Each module is targeted at different user groups and abilities.

Level 1: Drive a skidsteer excavator - will teach beginners what hydraulic equipment does
Level 2: Skidsteer excavator hydraulic systems - will demonstrate the various technologies
Level 3: Hydrostatic circuit - will explain the circuit, maintenance, and diagnostics to hydraulic technicians.

Previous Knowledge Required:

Level 1: No previous knowledge or experience.
Level 2: No experience required but it would be helpful. Students should explore further pump and valve training to understand in greater depth.
Level 3: Student should also complete worksheets HD1 'Hydraulic pumps and motors' and HV1 'Hydraulic control valves' to enhance their equipment knowledge. A full understanding of the fundamental hydraulic principles and maintenance procedures will be required to gain the most benefit from this module.

Certificate of Achievement:

Click the email button (shown left, that will appear within each app) to post your results, once the training module has been completed. Enter your email or the email for your external training provider. e4training.com will also receive a copy of the results to include in the certificate assessment process.

Module 1 - Learn to operate a skid-steer excavator

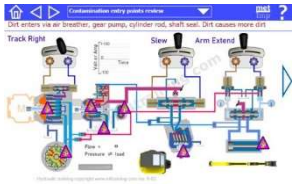
Expected outcome 1: (10-20 mins)
To engage students' interest in mobile equipment and to understand the primary functions.

Objectives 1: To operate three separate hydraulic systems.

1. Steering system, left and right wheel drive.
2. Cab slew system. Right and left.
3. Boom extend and retract.

Exercise 1: To drive between a path of boxes, hitting as few as possible. The number of boxes hit is counted on the right hand side of the screen.
See www.e4training.com/hydraulic_projects/skidsteer3.php?skiddrive

Date, score & time: Tick when posted ☐



Expected outcome 2.1: (60-120 mins)
To understand the basic concepts for how each function works and start to explore some of the design and operating issues that are likely to occur. Become familiar with common hydraulic equipment terminology.
See
www.e4training.com/hydraulic_projects/skidsteer3.php?skidsystem

Objectives 2.1: Interact with the animations to identify and understand the following design concepts:

1. Closed circuit, hydrostatic, drive system
   - A ramped electrical signal is generated proportional to the joystick lever angle.
   - The electrical signal operates a proportional pressure control which gradually changes the pressure on the swashplate piston.
   - The swashplate piston moves against a spring to change the angle of the pump swashplate.
   - The displacement of the pump changes with swashplate angle. The higher the angle the more the outlet flow.
   - Hydrostatic drive pumps can operate with the swash going over-center, thus providing the flow in forward and reverse directions.
   - The Low-speed high-torque piston motor, has fixed displacement, therefore turning the wheels at a speed relative to the flow.
   - The motor can work in both directions
   - There are no valves within the closed pump and motor circuit, this provides an efficient drive system with few energy losses, and gives the system its name ‘closed circuit’.
2. Load sensing, open circuit slew and lift system
   - The second piston pump provides flow when the slew or lift systems are operated.
   - The load demand from either system is fed back to the pump as a pressure signal via the shuttle valves. The highest load pressure signal reaches the pump control valves.
   - The load sensed by the pump control applies a proportional pressure signal to the swash plate piston.
   - The swash plate piston moves against a spring to change the swash plate angle.
   - The swash plate controls the pump displacement and therefore pump output flow.
   - The pump output pressure will be typically 18 bar (260 psi) higher than the feedback signal meaning there is a small power loss used as the energy to control the pump etc.
3. Fixed displacement gear pump for makeup and pilot pressures.
   - The third pump provides a small constant flow into the pilot system
   - The arm extend/retract system uses this to pressure to supply the pilot pressure reducing valves.
   - All unused flow passes into the low pressure hydrostatic circuit line to makeup for the flow lost through pump and motor leakage, plus provide some excess flow for cooling.
4. Slew system with closed center, directional valve
   - An on/off, positive and negative electrical signal is activated as the joystick lever is moved.
   - The electrical signal switches the position of the directional valve via direct acting electrical solenoids.
   - The directional valve is either fully open in one direction or the other, or restricting all ports in the center, inactivated position.

- The fixed displacement, bent axis, piston pump rotates in either direction, at a speed dependent on the flow rate.
- The flow rate is controlled by the small orifice restriction above the directional valve.
- The main energy loss in this circuit is only the pressure drop across the orifice.

5. Arm lift system with proportional flow control valve and cylinder
   - A ramped electrical signal is generated proportional to the joystick lever position.
   - The electrical signal operates either of two proportional pressure reducing valves which give an output pressure proportional to the electrical input signal.
   - Applying a pressure to either side of the spool valve moves the spool an amount proportional to the pressure signal.
   - As the proportional valve spool moves it opens and increasingly large orifice at each port.
   - The changing orifice sizes restricts the flow to that required to move the cylinder at the desired speed.
   - The cylinder actuator moves in either direction depending on whether the flow enters the annulus or bore side.

Exercise 2.1 : Operate each of the three systems in turn. Identify how and where the above controls operate.

Module 2.2 - Key performance and reliability issues

Expected outcome 2.2: (60-120 mins)
To be aware of the key performance and reliability issues within a skid-steer system.

Objectives 2.2: Explore a range of performance and reliability issues by clicking on the equipment icons for more information. Reinforce this knowledge by dragging the icons to the equipment you think is important.

1. Contamination entry points. Contamination cause 80% of all failures.
   a. DISPLAY: Icons appear over the dirt entry points e.g air breather, gear pump, cylinder rod, shaft seal. Dirt in piston pumps causes more dirt.
   b. PRACTICE: Drag the icons over the dirt entry or generation points. (Max score 7)
2. Potential contamination failure points
   a. DISPLAY: Micronic dirt particles hold poppets valves open and block the gaps in spool valves to stops them moving smoothly
   b. PRACTICE: Drag the icons over the parts that are likely to fail first. Although they can all fail. (Max score 7)
3. Spool leakage or flow loss points
   a. DISPLAY: Pump case leakage increases with wear and can show as warmer pipes. Changes in spool or pilot leakage may indicate issues.
   b. PRACTICE: Drag the icons over the flow loss areas to demonstrate you understand where and why they occur. (Max score 6)
4. Heat sources due to high pressure drops
   a. DISPLAY: Fluid power uses the energy dissipated in pressure drops to control flow rates or services. These energy losses create local hot spots in the valves and pipework.
   b. PRACTICE: Place the icons where you believe the hot spots will be. Heat appears where the losses are. Pumps will also have internal losses and get hot. (Max score 6)
5. Fluid power equipment controls movement so can be dangerous
   a. DISPLAY: Risk points include lowering or slowly dropping loads, uncontrolled slew movements due to gravity on slopes, brakes or flexible hose failures.
   b. PRACTICE: Discuss the need to always turn off and isolate equipment and always leave in a safe condition with loads supported and safe. (Max score 4)

6. Air ingress points (Max score 1)
    a. DISPLAY: Air bubble in the fluid will damage the performance and components. Air can enter fluid via pump suction line leaks or highly agitated fluid reservoirs.
    b. PRACTICE: Calculate how often the fluid is recirculated with a flow rate of 30 L/min and a 40L reservoir and two 2L total volume cylinders, extended and retracted.

Exercise 2.2 : Drag the different icons to the components which you believe are most significant. Positive scores or squashed tomatoes will confirm if students are correct or not.

Module 3.1 - Hydrostatic drive system closed circuit schematic

Expected outcome 3.1 : (45-60 mins)

To be able to read and understand a typical hydrostatic drive circuit diagram.

Objectives 3.1 : Interact with the animations to identify and understand the following design concepts:
1. Learn to read the hydraulic component symbols.
    a. DISPLAY: Move the mouse over or click on each component to identify each component and read what it does in the title text.
    b. PRACTICE: Drag the pressure gauge icon over the circuit to identify all pressure control valves
    c. PRACTICE: Drag the flow icon over the circuit to identify all flow control valves
    d. PRACTICE: Drag the dirty fluid icon over the circuit to identify all air and fluid filters
2. Build the circuit by moving each component to the correct location. The title text explains more details about the components.

Exercise 3.1 : Identify the different types of components from the schematic symbol. Drag the circuit components into their correct location

Complete

Module 3.2 - Typical maintenance and diagnostic tasks

Expected outcome 3.2 : (60-120 mins)
To understand and experience some basic hydraulic maintenance and diagnostics tasks.

Objectives 3.2 : To identify typical maintenance checks and machine failures then reinforce the concepts learnt by practicing with the interactive tools provided:
1. Understand some normal maintenance work that is required.
    a. DISPLAY: Mouse over or click on each component to identify what typical maintenance checks might be required.
    b. PRACTICE: Drag the test equipment icons over the components that should checked regularly. Suggestions are displayed for 4 seconds.
    c. PRACTICE: Move the test equipment icons over the components that should checked under planned maintenance periods. Suggestions are displayed for 4 seconds.
2. Understand some normal commissioning and setup procedures.
    a. DISPLAY: Mouse over or click on each component to identify commissioning procedures.

3. Diagnose some typical equipment failures. Drag the instruments over each component to diagnose what the problem might be. Written answers should explain the reasoning and concur with those provided in the detailed text.
    a. A clunking noise and vibration occurs at the flushing valve when changing drive direction
    b. System exhibits a high reservoir and case drain temperature
    c. High pitched aeration/cavitation cracking sounds near main pumps

Exercise 3.2 : Drag the different test equipment icons to the components which you believe are most significant or will highlight the fault data required.

Complete ☐

Module 3.2 – Answers to diagnostic tasks

Answers

a) Reservoir cleanliness is high 20/18/16. Flushing valves is likely to be sticking. Flush reservoir with external filter pack. Check/change air and fluid filters. Address any sighs of pump wear. Establish why fluid is dirty and improve procedures accordingly.
b) Charge pump relief valve is operating too close to the flushing relief valve meaning less flow is going through the cooler. Re-adjust relief valves to stop flow across charging relief valve.
c) High aeration in reservoir. Air bubble collapsing causes cracking noise. Small air leak in gear pump suction line means fluid drains from pipes when stationary, causing noise/damage at start up. Soapy water can highlight air leaks in suction lines.

Complete ☐

Related Worksheets:

See www.e4training.com/hydraulic_courses/worksheets1.php for additional training worksheets.

And Finally:

Complete this worksheet and keep for your records. Submit the written coursework to e4training.com or your training course provider. Application result postings will be collated automatically by the course provider; e4training.com will also receive a copy of the results to include in the certificate assessment process.