

## Industrial Hydraulic Principles (IHP) – Topical Outline + Extras

- What is a hydraulic powered and controlled machine – the basic components
- Understanding hydraulic energy & hydraulic power – Heat production of hydraulic systems
- Relationship of force, area and pressure – Pressure to develop force and tonnage
- Relationship of torque, displacement and pressure for hydraulic motors
- Relationship of fluid flow, GPM and actuator speed
- Hydraulic component symbol interpretation (on-going throughout the seminar)
- Reading and interpreting hydraulic schematics – techniques (on-going throughout the seminar)
- Basic fluid power calculations related to fluid pressure, fluid flow, actuator velocity/rpm, hydraulic power and heat production
- How hydraulic speed control works (throttle valve principle)
- Hydraulic shock, how it is caused and requirements to control actuator acceleration and deceleration
- Understanding relief valves – direct operated, pilot operated and venting options – piloting and draining options and they effect the function and application
- System relief circuits, multiple system pressure relief circuits, port relief circuits, cross port relief circuits
- Lab exercise – comparing pressure relief characteristics between 3 different relief valves, Lab exercise – setting system pressure
- Lab exercise – externally piloted relief valve w/ venting option  
Lab exercise - multiple system pressure
- Understanding directional control valves – direct operated and pilot operated types – spool – spool types and their uses – 2 position vs. 3 position valves – piloting and draining options and how they affect the function and application
- Throttle valve speed control – how flow control valves control speed – compare and contrast meter-in vs. meter-out
- Lab exercise – directional control operation
- Lab exercise – meter--in vs. meter out speed control
- Lab exercise – understanding pilot operated directional control valves
- Demonstration - Regenerative circuits
- Pressure reducing valves, application and operation
- Load sensing with hydrostats (pressure reducing valves)
- Lab exercise – pressure reducing valves
- Lab exercise – load sensing
- Multi-function valves, function and application
- Sequence circuits, counterbalance, unloading applications
- Lab exercise – counterbalance
- Hydraulic cylinder and hydraulic motors – how to identify cylinder piston seal failures
- Hydraulic pumps – fixed displacement, variable displacement types – basic pump control
- Pressure compensated pumps with spike pressure relief valves
- Lab exercise – setup of a pressure compensated pump and safety relief circuit
- Introduction to electro-proportional hydraulic pressure control valves and directional control valves – understanding the process control function of proportional valves (*time permitting & discretion of the instructor*)
- PLC interface with and control of fluid power systems (**scheduled seminars @ AMT's ITTC only**)
  1. Understanding the PLC structure – processor, analog and discrete I/O
  2. Controlling pump drive motors – stagger starting, start/stop motor control, monitoring pump discharge pressure, monitor pump running/turning

3. Control of electro-proportional hydraulic directional control valves with analog voltage or current output modules

4. Typical hydraulic system faults and typical program

- Overload detection
- Filter alarm at startup
- Low fluid level
- High/low tank temperature
- Suction valve permissive

**EXTRA 20+ ideas you will take back to work and use:**

1. Why system pressure should not be set higher than necessary
  2. Which hydraulic circuits use relief valves that are set to a 'full-flow' setting and which circuits are set to a cracking pressure setting and how to set the relief valve for each.
  3. Reasons why electric motors driving hydraulic pumps shut down on overload
  4. Why hydraulic systems get hot and how to correct the problem
  5. What causes actuator-related hydraulic shock
  6. Why 'shock' is destructive and how to eliminate
  7. Understand hydraulic valve and pump symbols for the purpose of 'reading' schematics
  8. Learn the 12 basic hydraulic control circuits and how they work
  9. What is the proper directional control for various cylinder and hydraulic motor circuits
  10. Why directional control valve solenoids fail
  11. Why directional control valve spools stick and how to fix the problem
  12. How hydraulic speed control really works
  13. When we should use meter-in speed control systems
  14. When we should use meter-out speed control systems
  15. When does a hydraulic cylinder require load control and how it is set up
  16. When does a hydraulic cylinder require load holding
  17. What are the 4 most important hydraulic applications that must use a 'float' center directional control valve and not use a 'closed' center directional control valve
  18. Hydraulic pumps produce unyielding flow. Therefore, system pressure must be controlled.
  19. How do pressure compensated pumps actually control system pressure
  20. How to set any pressure compensated pump and spike pressure relief combination
  - \*21. PLC interface with fluid power systems - Analog voltage signals to control electro-proportional hydraulic valves – understanding the origin of the proportional valve commands from within PLC processor register data
  - \*22. PLC interface with fluid power systems - What are the basic PLC control program instructions for hydraulic axis operation – reading and interpreting a typical PLC program for industrial hydraulic systems
- \*(scheduled seminars @ AMT's ITTC only & at the discretion of the instructor)**