

- 1) Hydraulic fundamentals
  - a. Pascal's law
  - b. Fluid Power energy formulas
    - i. Horsepower
    - ii. Pressure-Force
    - iii. Speed -GPM
    - iv. Heat generation
    - v. Efficiency calculations
- 2) Actuators
  - a. Cylinders
    - i. Single acting
    - ii. Double acting
      1. Double Rod
    - iii. Telescopic
    - iv. Design considerations
      1. rod loading
      2. pressure intensification
      3. regeneration
  - b. Hydraulic motors
    - i. High speed
      1. Piston
      2. Vane
      3. Gear
    - ii. Low speed high torque
      1. Geroter
      2. Radial piston
    - iii. Design Considerations
      1. series circuits
      2. over-running loads
      3. variable displacement

## Level 1 Hydraulics for Engineers (continued)

### 3) Valves

- a. Pressure control
  - i. Relief valves
    - 1. Direct operated
    - 2. Pilot operated
  - ii. Pressure reducing valves
  - iii. Counterbalance and load holding valves
  - iv. Other pressure valve applications
- b. Directional control valves
  - i. Spool types
    - 1. Motor or float centers
    - 2. Closed Center
      - a. Asymmetrical spools
    - 3. special spools
  - ii. Operator types
    - 1. Lever
    - 2. Remote hydraulic
    - 3. Proportional electronic
  - iii. Integrated pressure controls in mobile valve sections
- c. Flow Controls
  - i. Fixed orifice
  - ii. Variable flow controls
    - 1. Flow controls with integral check valves
    - 2. Pressure compensated flow controls
  - iii. Meter-in vs. meter-out
- d. Cartridge valves
  - i. Screw-in cartridges
  - ii. DIN slip in cartridges

### 4) Pumps

- a. Fixed displacement
  - i. Gear pumps
  - ii. Vane pumps
- b. Variable displacement
  - i. Piston
  - ii. Pressure compensated control
  - iii. Load Sense controls
  - iv. HP or Torque limiting control

## Level 1 Hydraulics for Engineers (continued)

- 5) Plumbing and Proper conductor selection
  - a. Recommended fluid conductor sizing
  - b. Flexible hose construction
    - i. Pressure ratings
    - ii. Bend radius
    - iii. Routing considerations
  - c. Rigid plumbing
    - i. Hydraulic Tubing
    - ii. Pressure rating
      - 1. Flare
      - 2. Compression
    - iii. Connections types
  - d. Fitting types
    - i. Flat Face O-ring
    - ii. SAE 37 degree flare
    - iii. Pipe threads
      - 1. NPT
      - 2. BSPT
    - iv. O-ring Boss
      - 1. SAE
      - 2. Metric
- 6) Reservoir Design
  - a. Sizing recommendations
  - b. Inlet and outlet considerations
  - c. Pressurized vs. atmospheric
- 7) Filtration
  - a. Cleanliness levels
  - b. Filter locations
    - i. Pressure
    - ii. Return
    - iii. Off line
    - iv. Breathers
- 8) Hydrostatic Transmissions
  - a. Principles of Hydrostatic transmissions
  - b. Application considerations

### Instructor

Neil Skoog is a Certified Fluid Power Specialist providing training, design, service, and sales support with over 40 years of field experience in the Fluid Power Industry. Neil is a former Adjunct Professor at Edison State Community College, Piqua Ohio. He has served on the Board of Directors for the International Fluid Power Society. Neil has conducted numerous training courses throughout North and South America on a wide variety of topics and skill levels. He holds several US Patents for various hydraulic components, systems, and concepts.