Understanding Mobile Hydraulics.

SYSTEM COMPONENTS

SIMPLE HYDRAULIC SYSTEM

- Reservoir
- Ram
- Handle
- Pump
**COMPONENTS**
- Reservoirs
  - Dissipate heat store fluid
- Strainer/filters
  - Clean fluid
- Prime movers
  - Electric motors, internal combustion engines
- Pumps
  - Gear, vane, piston
- Valves
  - Relief valve for protection of hydraulic components
  - Flow control
  - Directional control

**PRIME MOVERS**
- Electric motors
  - AC or DC
- Internal combustion engines
  - Gas engines
  - Diesel engines

**POWER TAKE OFF**

**RESERVOIRS**
- Filler/Breather
- Sight gauge
- Return port
- Baffle
- Suction port
- Magnetic drain plug

**RESERVOIR CONSTRUCTION**
- Baffle
  - Between the inlet side of the pump and the returning fluid
- Filler/Breather
  - Allows air to escape, removes large debris when fluid is being added
- Drain port
  - Place to drain fluid; magnetic plug catches steel particles floating in the fluid
- Temperature/sight gauge
  - Monitor fluid level & temperature
- Return port
  - Located on the middle of the reservoir, one on each side
- Suction port
  - Located on the lower side one on each side
FILTERS

- Suction
- Return
- Pressure

Sources Of Contamination

1. In-built dirt
2. New oil
3. Cylinder rods
4. Repair
5. Atmosphere
6. Generated

Relative size of objects

<table>
<thead>
<tr>
<th>Object</th>
<th>Microns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red blood cell</td>
<td>100</td>
</tr>
<tr>
<td>Bacteria</td>
<td>100</td>
</tr>
<tr>
<td>Milled flour</td>
<td>40</td>
</tr>
<tr>
<td>Lower limit of visibility</td>
<td>30</td>
</tr>
<tr>
<td>Human hair</td>
<td>70</td>
</tr>
<tr>
<td>Grain of Table salt</td>
<td>50</td>
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</tbody>
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Placing Filters

- **Main system contamination control**
  - Ingression prevention
  - All air entering the reservoir needs to be filtered
  - All fluids entering the system should be filtered
  - Pressure line
    - The pump produces contamination, this will help prevent silting
    - Fluid that passes over the relief does not get filtered
  - Return line
    - Return line is an excellent location however the filter should still see about 20% of system flow per minute.
Flushing New or Rebuilt Systems

- Dislodge the dirt and transport it to the filter
- Dislodging and transporting contaminates is best accomplished by using low viscosity fluid at a high velocity.
- Flow fluid through all of the lines and all of the components
- To be sure fluid flows through all of the components. The valves should be actuated several times. Lines may also need to be connected around components to pass the high velocity flow.
- Capture the dirt with a high efficiency filter
- The flushing target cleanliness code should be two ISO codes below the target cleanliness level for system operation.

Filter Ratings

- **Nominal Rating** is an arbitrary Micrometer or Micron value indicated by the filter manufacturer. Due to the lack of reproducibility, this is depreciated.
- **Absolute Filtration Rating**: The diameter of the largest hard spherical particle that will pass through a filter under specified test conditions. This is an indication of the largest opening in the filter element.
- **Filtration Ratio (Bn)**: The ratio of the number of particles greater than a given size (n) in the inlet to the number of particles greater than the same size (n) in the filter outlet.

HYDRAULIC FILTERS

- Designed to filter out the larger contaminants prior to the pump
- Rated in mesh
- Usually threaded into the reservoir
- In most applications it will be necessary to drain the reservoir before the strainer can be serviced
- Low PSI bypass
RETURN LINE FILTERS

- There are two types of return line filters
- In-line
  - Installed in-line with the return flow, usually as close to the reservoir as possible
  - Arrow to indicate direction of flow
  - 15-25 PSI check valve & gage port
  - Spin on type
- In-tank
  - Mounted in the reservoir on the top
  - Allows changing the filter without losing fluid
  - Costs more money

COMMON INTANK FILTER

HIGH PRESSURE FILTER
- Plumbed between pump outlet and valve inlet.
- Can withstand system pressure.
- Added protection for valve, which is most expensive component and hardest to troubleshoot.

FILTER ELEMENTS
- Replace elements annually (or more often if known contaminants are prevalent)
- 10 Micron vs. 25 Micron
  - 10 micron recommended (1/4 size of head of pin)
- Nominal (Cellulose) vs. Synthetic
  - Synthetic recommended
- Has twice the dirt holding capacity as paper
- Both filter down to 10 microns, but synthetic can do it for twice as long on same element
PUMPS

- Pump types
  - Positive displacement
  - Variable
- Pump classifications
  - Gear
  - Vane
  - Piston

GEAR PUMPS

- Produce high volumes of oil
- Good speed capabilities
- High tolerance to contamination
- Relatively efficient
- Operate at lower RPM's
- Least expensive to manufacture
- Usually operate in an open center circuit
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**PUMP ROTATION**

- CCW rotation
- Left hand
- Belly down

**VANE PUMPS**

- Higher efficiencies than gear pumps
- Quiet
- Low contamination tolerance

**DIRECTION OF FLOW**

THrust Plate View

This diagram indicates the direction of flow from the reservoir through the pump. If the pump is rotating in a CCW rotation, the oil is carried around the perimeter of the pump, so the oil is compressed at the outlet side it becomes flow. The work (resistance to flow) creates the pressure in the system and the pump will also see the same pressure.

**GEAR PUMP COMPONENTS**

GEAR PUMP

- Shaft Gear Pump
- Lip Seal
- Thrust Plates
- Ball Bearing
- Drive Spindle
- Oil Seal Bearing
- Drive Gear
- Meter Gear
- Gear Housing
- Relief Valve
- Port Exit Cover
- Relief Pressure

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VANE PUMPS

- Higher efficiencies than gear pumps
- Quiet
- Low contamination tolerance
PISTON PUMPS

- Two types
- In-line
- Bent axis
- Variable or Fixed displacement
- High pressure
- Low contamination tolerance
- Higher filtration required

PISTON PUMP THEORY OF OPERATION

- Piston Shoe Retainer holds the shoes in place.
- Piston Shoe rides on film of oil and will crack in its absence (debris then takes out the rest of the pump in a short time.)
- Case Drain sh located as close to top as possible. Use same size hose as port is (5/8). Fill at start-up. For leakage/relieves pressure. Case should be less than 30 psi and less than 10% of flow.
- Valve Plate directs the flow.

Pistons: Odd number, so one always just ready to draw while another is just ready to push out, otherwise they would work against each other. More flow (displacement) more pistons (5, 7, 9, 11).

Swash Plate is adjusted by servo piston, which is acting in accordance with load sense signal. As the swash increases in angle, flow increases as the pistons go around.

Compensator has the low & high system settings (Low Press. Standby-By or Differential Press. - & High Press. Setting). Low Press. Effects the sensitivity of a system - too low no move; too high too quick or jumpy. Low usually 250-500 depending on pump. High 3000 – 4500 (4200 is now common for Hook lift applications).

L.S. = 4 Hoses; Pressure Comp. = 3
Pressure compensator would be on high pressure stand by - Good for construction, an example would be a boom truck.
The Eaton 420 Pump has a specially designed seal assembly to protect the pump. Removal of these three bolts will allow access to the shaft seal. The area behind this plate is packed with grease.

**System pressure adjustment**: The system pressure adjustment will be set at 1800 psi, which is the maximum operating pressure of the system.

**Stand-by pressure adjustment**: Stand-by pressure adjustment set @ 350 PSI.

**CONTROL PICTORAL DRAWING**

The Force pump has a specially designed seal assembly to protect the pump. Removal of these three bolts will allow access to the shaft seal. The area behind this plate is packed with grease.

**FASD 34/45 PISTON PUMP**

- **High pressure adjustment**
- **Low pressure adjustment (standby)**
- **Load sense signal line**
- **Pump compensator control**
- **Outlet**
- **Case drain**
Two Main Types of Cylinders

- Single Acting
- Double Acting

Hydraulic Motors

- Advantage of using Hydraulic Motors
  - More versatile than an electric motor
  - Can be reversed easily
  - Starting and stopping under load
  - Horsepower to size ratio is smaller than any other rotary device (high power density)
  - Rated by displacement, torque capacity and maximum pressure limitations
  - Provide low RPM ranges
  - High torque capabilities

Hydraulic Motors

- High Speed
  - Gear
  - Vane
  - Piston
- Low Speed High Torque
  - Swirl or Rocker Piston

Gear Motor

- Lower torque than most of the other hydraulic motors
- High speed capabilities
- High tolerance to contamination
- Relatively efficient
- Least expensive to manufacture
- Low cost
**Geroler Motor**

- Low speed high torque
- Built in 6 to 1 hydraulic reduction
- Used a lot on mobile equipment
- High power density
- Lots of available displacement options

This is the Geroler which is the motoring element

**Piston Motor**

- Produce high volumes of oil
- High pressure capabilities
- Good speed capabilities
- Lower tolerance to contamination than the gear motor
- High efficiency