HARTFORD ENGINEERING, LLC

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Project: Whittier Barge Slip #2 Project #: 08-1183
Contract/Client: PND
Design Topic: Hydraulic reservoir capacity calculation
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Given: Whittier Barge Slip #2 Modification. This option utilizes 2(ea) 15" bore x 209" stroke hydraulic lifting cylinders with 12" OD, 8" ID rods. Each cylinder is supplied by its own reservoir.

Find: Calculate the minimum Hydraulic Reservoir capacity required to support each system. Calculate Horsepower necessary to extend cylinder.

Solution:

Calculation variables

Lift Cylinder Bore (d_{cyl}): $d_{cyl} := 15in$

Lift Cylinder Rod Diameter (od_{rod}): $od_{rod} := 12in$

Lift Cylinder Rod Inside Diameter (id_{rod}): $id_{rod} := 8in$

Lift Cylinder Stroke (l_{cyl}): $l_{cyl} := 209in$

Working Pressure of system (P_w): $P_w := 1500psi$

Length of supply lines (l_{pipe}): $l_{pipe} := 600ft$

Pump Flow (Q_p): $Q_p := 92.8\frac{gal}{min}$ Note: Bucher QX82-200 pump

Pump efficiency (η): $\eta := 95\%$

Maximum fluid velocity (V_{fluid}): $V_{fluid} := 16\frac{ft}{sec}$

Calculate minimum supply line diameter (d_{pipe}):

$$d_{pipe} := \sqrt{\frac{4}{\pi}\cdot\frac{Q_p}{V_{fluid}}}$$ $d_{pipe} = 1.539\,in$

Note: use $d_{pipe} := 1.625in$

Calculate total volume of oil in each system when retracted (V_{ret}):

$$V_{ret} := \frac{\pi}{4}\cdot\left[\left(d_{cyl}^{2} - od_{rod}^{2} + id_{rod}^{2}\right)\cdot l_{cyl} + d_{pipe}^{2}\cdot l_{pipe}\right]$$ $V_{ret} = 168\,gal$

Calculate total volume of oil in each system when extended (V_{ext})

$$V_{ext} := \frac{\pi}{4}\cdot\left[\left(d_{cyl}^{2} + id_{rod}^{2}\right)\cdot l_{cyl} + d_{pipe}^{2}\cdot l_{pipe}\right]$$ $V_{ext} = 270\,gal$

Calculate reservoir capacity needed to supply each cylinder (V_{res}):

$$V_{res} := \max\left[\left(V_{ext} - V_{ret}\right)\cdot 1.5, 2min\cdot Q_p\right]$$ $V_{res} = 186\,gal$

Initial system fill requirement (Vi_{nit}):

$$V_{init} := V_{ret} + V_{res}$$ $V_{init} = 353\,gal$

Conclusion: Use 250 gallon reservoirs and supply with 375 gallons of fluid ea.

Calculate Power needed to extend cylinder (HP_{req}):

$$HP_{req} := \frac{Q_p\cdot P_w}{\eta}$$ $HP_{req} = 85\,hp$