Hydraulics: Rules of thump for system design

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December the 19th, 2015

1 Power

1.1 Quick conversion of power to flow

When a system has a 300[bar] working pressure, a rough estimation to flow can be given:

$$\begin{aligned} P[kW] &= \frac{p[bar] \cdot \phi[L/min]}{600} \\ P[kW] &= \frac{1}{2} \cdot \phi[L/min] \\ \phi[L/min] &= 2 \cdot P[kW] \end{aligned} \tag{1}$$

1.2 Required cooling power

The required cooling power is normally between $\frac{1}{3}$ and $\frac{1}{2}$ of the installed power at the E-motors. For open systems and constant pressure systems it will be slightly higher (although $\frac{1}{2}$ is still large) as for instance closed loop systems (although it often needs $\frac{1}{3}$ of the installed power) due to the efficiency of the system.

2 Pressure

2.1 Influence of temperature

The pressure will drop approximately 100[bar] for each 15[°C].

2.2 Accumulators

When an accumulator is chosen, the following rule of thump can be easy to use:

When the precharge pressure (p_0) is at 65% of the working pressure, the available is approximately 35% of the volume of the accumulator

3 HPU

3.1 Volume of a reservoir

The required volume of the reservoir of an HPU can be easily estimated using the following rules of thump:

- Closed loop system: V [L] = 3 times the maximum flow [L/min]
- Open loop system: V [L] = 4 till 5 times the maximum flow [L/min]

A too small reservoir will not give the oil enough time to let possible air bubbles escape and thus cavitation and will not allow the oil to cool enough before it is back in the system through the pump.

A too large reservoir will be more expensive and will cost more space.

3.2 Installed heating

Tank heating is often installed as offline heating, just to make sure that the oil does not cool down too much. When the oil becomes colder as 20[°C], the oil becomes too viscous for proper performance. Therefore the reservoir will need approximately $25\left[\frac{W}{m^2K}\right]$ of installed power.

3.3 Pressure drop over filters

When filters are chosen, the maximum pressure drop over the filter is $\frac{1}{3}$ of the opening pressure of the bypass check valve. If this is not installed, assume that it is installed.