PRODUCT APPLICATION

Determining The Level Of Heat Load In Oil Circuits.

Heat is generated through energy being wasted in the form of inefficiency. Heating in a oil circuit is usually a by-product of motive power which may be some form of engine or motor or a device such as a brake or clutch which converts rotating energy into heat energy in the oil.

Another source may be by conduction, convection or radiation from either direct solar energy or any other external parasite source.

In a hydraulic system, the main energy source is usually the input power entering the hydraulic pump from the engine or motor. Some portion of the input power will be wasted through inefficiency (friction and pressure losses) and will be evident as heat in the oil.

The degree of inefficiency in the circuit may be established by combined analysis of the known efficiency of the circuit components. More frequently it is established by making an estimate based on previous experience with the type of circuit being considered.

Typical hydraulic system circuits range in efficiency from between 80% down to 40% efficient. High efficiency pumps and motors combined with ample plumbing may deliver up to 80% efficiency. Gear pumps with gear motors or gear pumps with gerotor motors may be less than 50% efficient.

The heat load required to be removed from the system will be equal to the total inefficiency in the system, less the existing thermal heat transfer capacity of the system.

So with a circuit estimated to have a power input of 50 kW and an efficiency loss of 30%, there can be expected to be a requirement to cool 15 kW of heat. The components in the circuit may be able to dissipate some heat so the heat load required to be cooled with a heat exchanger will be something less than 15 kW.

Power, Heat and Oil Flow Relationships.

In the above example we determined that we need to remove 15 kW from a circuit. Now what does 15 kW really mean in terms of heat. The following are formulae which can be used with hydraulic mineral oils to provide relationships between power, heat and oil flow.

1 $$\Delta T\ °C = \frac{kW \times 34.5}{L/min}$$

2 $$kW = \frac{L/min \times \Delta T\ °C}{34.5}$$

3 $$L/min = \frac{kW \times 34.5}{\Delta T\ °C}$$

L/min = Oil flow in Litres per minute.
ΔT °C = Entering temp of oil minus exit temp of oil.

Applying formula **1** to the above example with oil flow at 100 L/min we get the following result.

$$\frac{15 \times 34.5}{100} = 5.2$$

So we require a constant reduction in temperature of 5.2°C in our oil to dissipate 15 kW for 100 L/min.

Oil and Air Temperature Relationships.

For the cooling of oil with a air cooled heat exchanger it is obviously necessary to have the air temperature cooler than the entering oil temperature. The temperature difference between the entering oil and the entering cooling air is called the ETD (entering temperature difference).

The larger the ETD the easier it is to cool the oil and by definition the smaller the air cooled heat exchanger will be. For purposes of sizing a suitable heat exchanger, it is usual to set the inlet temperature of the oil at the maximum temperature the system is required to operate at.

Oil temperatures in modern hydraulic systems are preferred to be maintained in the 60°C to 70°C range. The temperature of the cooling air will be the ambient temperature of the air in the locality where the system is to be used.

Selection of The Exchanger By Performance

In this catalogue, performance shown on graphs is usually expressed in kilowatts per degree °C of entering temperature difference between the oil and the cooling air (kW/°C).
So if the ambient temp is 30°C and the oil temp is required to be 60°C, a 15 kW heat dissipation would require a oil cooler capable of 0.5 kW/°C at the required oil flow.

Computer Model Selection Program

We provide complete performance graphs for most models of our air cooled heat exchangers. However, for accurate sizing we recommend the use of our computer model selection program which covers almost all of our standard models of air cooled and water cooled exchangers. The program operates on most PC computers under Windows.

Electronic Drawings Of Heat Exchangers

Our computer model selection program now also includes electronic drawings of most models. These drawing are available in DXF format for customer use.

Heat Load Based on Temperature Rise Over Time

Example:

Initial oil temp	20°C
Final oil temp	85°C
Time for temp rise	35 minutes
System oil volume	240 litres
Oil heat capacity	1.72 kJ/L°C

$$\text{Heat Load} = \frac{240 \times 1.72 \times (85-20)}{35 \times 60} = 12.8\ kW$$