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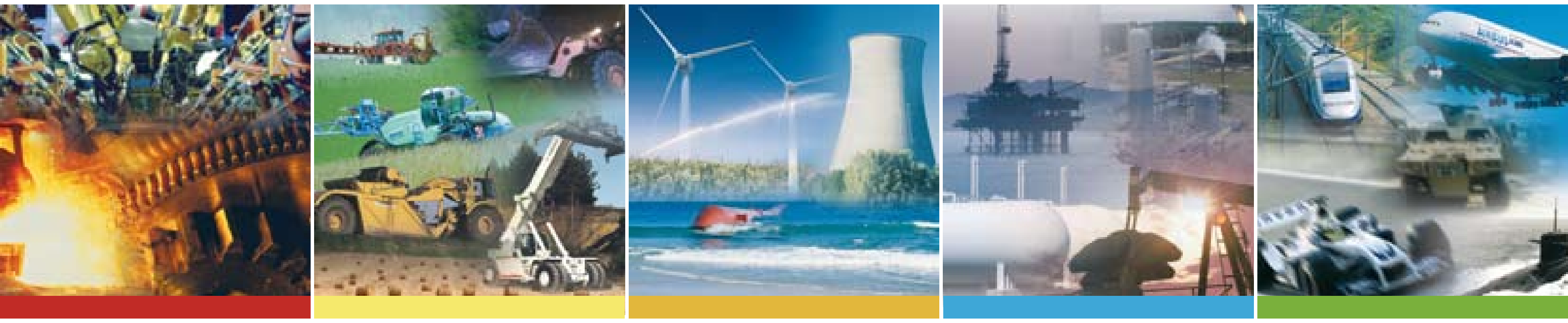


... in Fluid Management

Keeping it Cool

OLAER OILTECH OILAIR HYDRAULICS INC. FCH

Keeping it Cool

Working makes you hot, especially in a hot environment. We perspire. Relief though, is not far away: a cool drink or a jump into cool water brings our temperatures back to comfortable. But what happens to hydraulic equipment and electrical switching cabinets of machines and systems?

Many hydraulic systems and switching cabinets suffer, overload, stress and fulfil their function only partially. Some even give up the ghost entirely. To prevent this, the system must be cooled with air, water or coolant. Every situation has its own ideal solution.

Cooling liquids with air coolers

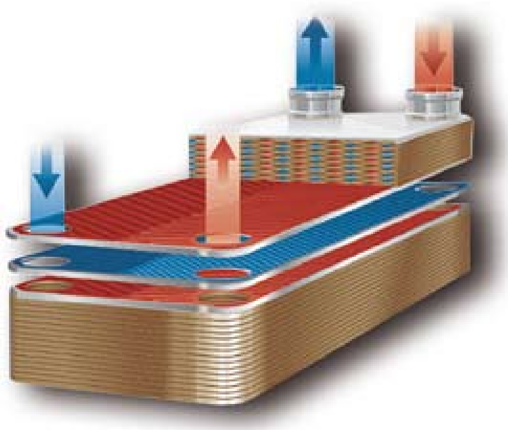
The optimum working temperature for oil in a machine tool in most cases lies between 50 and 60°C. If the temperature of the oil is too high, it undergoes faster physical changes and for many functions becomes too viscous. This also causes more leakage. There are different possibilities for cooling oil. One of these makes use of the ambient air. In most hydraulic systems, approx. 60 to 70% of the energy put in is converted to mechanical work, with the remaining 30 to 40% being converted to heat by friction and pressure changes. This relatively poor degree of efficiency results in a high oil temperature, which is undesirable for the oil and the components of the hydraulic system.

The type of cooler matches the application

As an example, during the return cycle of folding presses there is a broad range of oil volume flows and pressure peaks. This would be very bad for an air oil cooler mounted in the return cycle, since it would have to tolerate a high pressure and in addition be set up for a much higher volume flow. In this case, a bypass flow cooler with a quiet circulation pump should be used. The cooler works autonomously in a bypass circuit and is controlled by means of thermostats fitted in the oil tank, activated by changes in oil temperature. For other machine tools, such as grinding machines, the hydraulic and spindle oil can be economically cooled by means of air coolers. The electric motors are available in standard 50 and 60 Hz versions, which is very advantageous for export purposes. Construction machines and street cleaning vehicles today are being built more compact and lighter, so often there is not enough room for a large hydraulic tank. Air coolers can be employed to handle the heating of the oil. If the engine water needs to be cooled at the same time, it is advisable to install a combination cooler. Hydraulic motors may also be installed. The coolers are equipped with a standard thermostat connector, with the option of an external bypass. The integrated terminal box with relays is becoming more popular, as customers need only supply electrical power. Combination coolers are designed specifically for the requirements and available space of the vehicle. To ensure that the air plates – especially for mobile use – do not block too quickly, washboard plates with separations of 5 mm are used. The inclusion of the air cooler is recommended if a Toil-Tair greater than 20°C can be accepted. In comparison to water coolers, air coolers are more expensive, but more economical in operation.

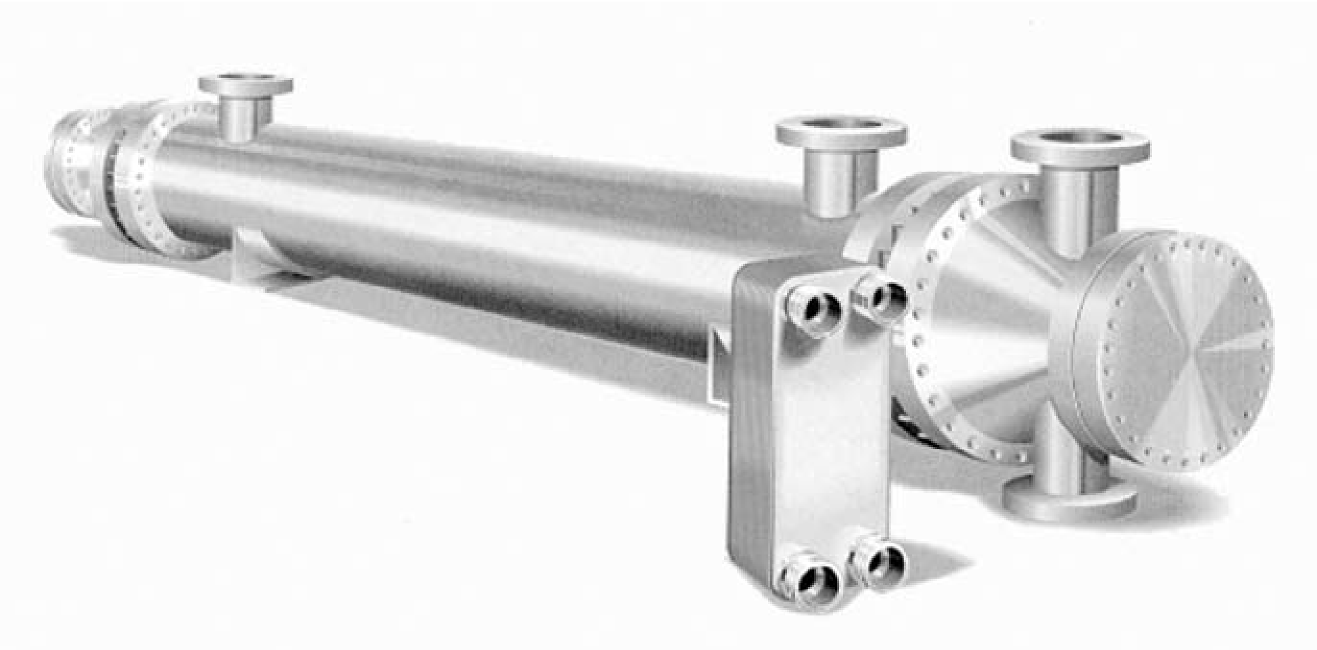
Heat Exchanger

The task of a heat exchanger is to transfer the heat from a liquid medium (usually hydraulic oil) to another medium (usually water), without these two media coming into contact or mixing.



There are two principal types of heat exchanger design available: tubular heat exchangers and plate coolers. Although soldered plate coolers have been in use for a number of decades already, they have been used in hydraulic only during the past ten to fiveteen years. Nevertheless, the many advantages they offer have led, in this short time period, to their nearly completely replacing the tubular heat exchangers in this field of application.

The soldered plate cooler...



… and in comparison to a tubular heat exchanger. In order to transfer 120 kW of heat, this heat exchanger must have a diameter of 200 mm, be 2250 mm long, and in operation weigh 130 kg, as opposed to 18 kg for a soldered heat exchanger.

The operating principle behind the soldered plate cooler

The packet of plates is built up from a number of plates to suit the thermodynamic requirements. The heat exchanger consists of up to 200 profiled plates of stainless steel, soldered in a vacuum process. Since every second plate is rotated 180° in the plane with respect to the previous plate, two separate flow spaces are created. Normally the two media used in the heat exchanger flow through the plate heat exchanger in the opposite directions. The geometry of the channels provide a turbulent flow, which in comparison to other systems leads to a two to five times greater heat exchange coefficient, even for low volume flows. Standard oil coolers normally provide an oil flow/cooling water flow ratio of 2:1; plate coolers to the contrary have an optimum ratio of 5:1 of even 10:1.
Water consumption, and thereby continuous operating costs, is greatly improved by the use of plate coolers in water-cooled hydraulic systems. The high performance characteristics of plate coolers open up new possibilities for oil cooling systems. It is therefore possible to operate with very small differences between the input temperatures of the two media, or a high differential between the input and output temperatures of the one media.

Compact design and low weight with high temperatures and pressures

Soldered plate coolers have very low space requirements, which is often only 30% that of the equivalent tubular heat exchanger. This is because they consist almost entirely of heat exchange surfaces, permitting a compact design. Weight savings up to 80% and the low content volumes are further advantages. The many points of contact of the profiled plates – which create a type of herringbone pattern – result with hard soldering in an extremely stable plate packet. Approved operating pressures up to 30 bar, and burst pressures of usually over 100 bar, are possible due to this special design. Soldered plate coolers have no seal and can be used in a very large range of temperatures.

Resistance to dust and corrosion

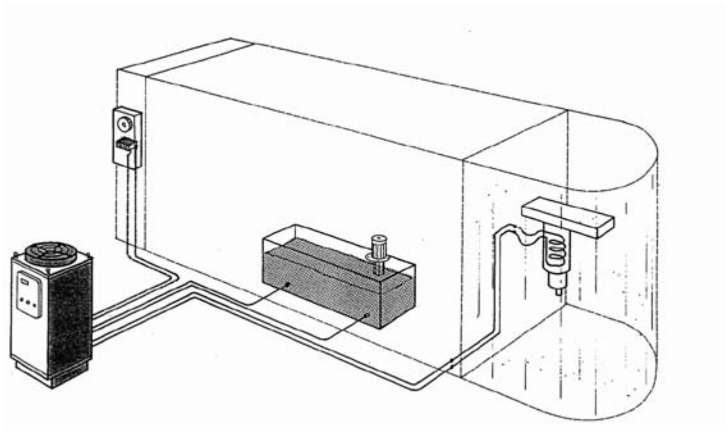
Turbulent flows in free channels with smooth surfaces do not experience the type of extreme velocity reductions which can present the danger of deposit formation. To the contrary, tubular heat exchangers, which frequently work with laminar flows, operate with very low velocities on the surfaces, which favours the formation of contaminant deposits. High-quality material such as acid-resistant stainless steel plate, material no. 1.4401, and copper and nickel as soldering material, provide excellent resistance to corrosion, even for relatively poor water quality.

Cost savings

The soldered plate cooler is in most cases considerably more economical than other types of heat exchangers. This is due not only to the lower purchase price, but also to the simple integration design. Along with the large range of plate coolers, there are also screwed plate coolers with NBR, EPDM or Viton seals available. Air coolers or heat exchangers make it possible to guarantee thermal stability of, for example, machine tools. If in summer and winter constant media temperatures of ± 0.5°C are required, a cooling system must be integrated. The most commonly used devices are the water and oil-cooling systems, also known as «chillers».

Water and oil-cooling systems

These are best suited for the cooling of, for example, high-frequency spindles of high-performances drills used in the production of circuit boards. In this field very small manufacturing tolerances of just ± 0.002 mm are required. The water temperature must be maintained constant so that the drills do not overheat. A constant water temperature provides the accuracy required for the drilled circuit board, even at high spindle RPMs.
So that the high working precision of machine tools and other machines can be guaranteed, constant spindle oil, lubrication oil and gear temperatures are mandatory. Obtaining an optimum cooling result depends on many factors. Only through an accurate analysis of the prevailing characteristics can the optimum solutions be found for each application. Modern cooling systems help to keep operating costs down, with the result that cooled machines and tools last longer and work more accurately. Well-regulated cooling leads to higher workpiece throughput and improved quality in the production. A cooling system also permits a range of different cooling cycles with various media and different medium temperatures. An example: for a machine tool the spindle and gear oil is cooled by means of a cooling system. At the same time the switching cabinet is cooled with water via an air/water heat exchanger.



Example: machine tool with spindle and gear oil cooling and additional switching cabinet cooling system with water via an air/water heat exchanger.

Control panel conditioning

In the time of electro- mechanical control systems, in most cases ventilation slits were sufficient to extract the heat in control panels. The ventilation slits permitted not only cooling air but also dust to enter the control panel. The insulating effect of dust on electronic parts led to overheating, which would lead sooner or later to a malfunction. Today's machine tools are controlled by modern electronics. The electronics of today's control technology are becoming smaller and more powerful, with a resulting increase in power dissipation in the control panel. The sensitivity of the electronic parts in the control panel to temperature and external effects, such as dust and humidity, is also increasing.

It is therefore necessary to maintain a constant, stable temperature distribution in the control panel. A correct control panel operating temperature is the precondition for a long serviceable life of electronic components. Downtimes are also thereby prevented. Downtime of a system means production loss, which is inevitably associated with high costs. The correct operating temperature in a control panel is between 30°C and 50°C depending on the components installed. As early as in the design and development phase, the designer or electrical engineer is concerned with the question of the temperature during later application.

Water and oil cooling system also known as a ‹‹chiller››.

1) Application of an air conditioner when $T_{Enclosure} < T_{outside}$

If for example the environment temperature «$T_{outside}$» lies clearly over the desired enclosure inside temperature, air conditioner come to application. They work after the principle of a compression chiller. A refrigerant is used as cooling medium. With this, the enclosure temperature can always be kept constantly, independently of the environment temperature.

2) Application of an air-water heat exchanger when $T_{Enclosure} < T_{outside}$

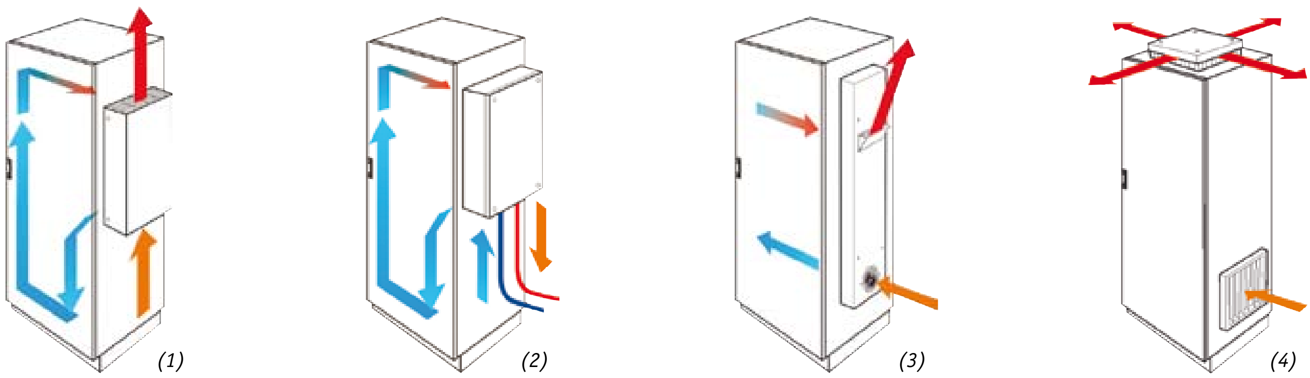
The enclosure inside air of these heat exchangers are cooled through a cooling medium. The conducted heat in the enclosure is not released to the environment, but transported away by a water return pipe. It can be reused, for example with a heat recovery installation.
This kind of enclosure is often used, if together with the electronics, other areas are cooled with water such as hydraulic oil, transmission oil or high frequency spindles. In most cases, the necessary cool water is generated through a water-cooling system in the „self contained circuit“.

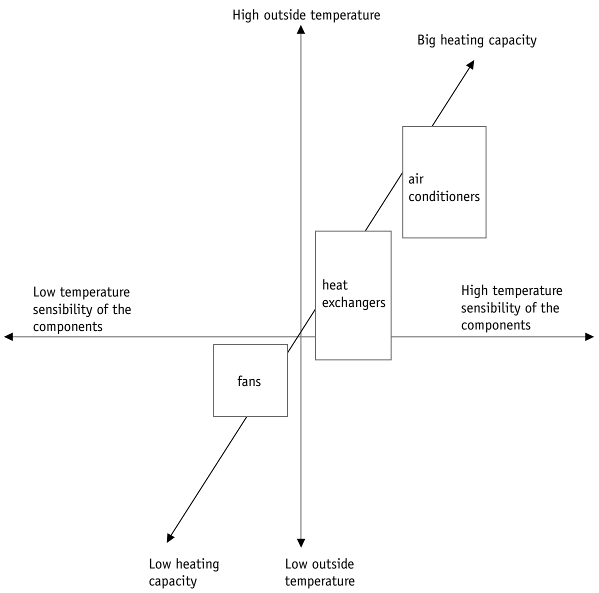
3) Application of an air-air heat exchanger when $T_{Enclosure} > T_{outside}$

Air-air heat exchanger have got two completely divided air circulations. The installed components are protected from outside attacks. At these indirect enclosure air conditioner, a heat exchanger package assigns the heat out of the switchboard cabinet to the cooler environment.

4) Application of fan- and filter units or roof mounted fan- and filter units $T_{Enclosure} > T_{outside}$

Fan- and filter units in combination with an identically constructed filter guarantee a consistent temperature allocation in a switchboard cabinet. They are used especially when little heat capacities must be deviated.
The limit of fan- and filter units are reached, when the environment of the enclosure is affected by humidity, chemical substances or high dust attack. In this case air-air heat exchanger come to application.





An initial idea of the type of control panel conditioning required can be obtained from the following diagram-on.

Diagram: control panel conditioning in dependence of temperature sensitivity, external temperature and heat levels.

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