Sizing Aluminum Air-Cooled Heat Exchangers: High Flows, High Heat Rejection, No Problem

Air-cooled heat exchangers are essential to equipment maintenance and performance because they remove unwanted heat from mechanical systems. Oil begins to break down and degrade if heat is not removed which quickly leads to damaged seals, pumps, and other pieces of expensive equipment. Air-cooled heat exchangers use forced convection as the primary mode of heat transfer. An AC, DC or hydraulic motor powered fan movies ambient air over fits to transfer heat from hot oil, glycol or compressed air to ambient air.

Aluminum bar and plate style heat exchangers allow the customer to save space and reject large heat loads because they use turbulators to lessen the boundary layer and turbulate the internal fluid as it flows from the entering tank to the exiting tank. In other words, turbulators are internal fins used to force turbulent flow of the internal fluid. There are different turbulators for different mediums. The same principal applies for the ambient air. The fan moves ambient air across air fins which also turbulated to increase the heat transfer per given area.

The demand for larger air-cooled bar and plate style heat exchangers is growing because it allows the industry to move away from using expensive city water to cool the system. The heat exchanger size increases when the heat load increases, which is directly proportional to oil flow and temperature. The solution to the industry's demand is AKG's HD Series aluminum bar and plate style heat exchanger. The "HD" stands for heavy duty. These exchangers are designed to handle very viscous oils at very high flow rates – rejecting up to 500 horsepower with a 50 degree entering temperature difference. AKG used proprietary research and development to go to market with a turbulator that will meet the large heat transfer needs with very little pressure drop at the expected temperatures and pressures of an oil cooler. Most importantly, the HD Series oil coolers are designed to last in the field and can withstand extreme applications. Every HD Series oil cooler is leak tested before shipping to the customer and is available in horizontal and vertical configurations. In addition to highly engineered turbulators, the HD Series comes standard with WEG's W22 severe duty motor.

Sizing and selecting an HD Series oil cooler is simple. Table 1 summarizes the information required. The HD Series can handle applications at maximum temperatures and pressures of 250 °F and 250 psi, respectively.

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Information Required To Size Oil Cooler	
Flow rate (gpm):	
Viscosity (SUS):	
Temperature desired (inlet our outlet °F):	
Heat load (horsepower):	
Maximum pressure drop (psi):	
Operating pressure (psi):	
Ambient temperature (°F):	
Elevation (ft.):	

Table 1. Information required to size an oil cooler

Once the information required is gathered from the application there are governing equations that can be used to quickly calculate what size heat exchanger is needed for the application. Lastly, Figure 1 displays the nine HD Series models with their corresponding flow rates, and temperatures for ISO VG150 oil. If another grade of oil is used it will change the selection. AKG does offer a web-based online selection software program that will aid the selection of the correct product.

(1) $Btu/hr = \Delta T \times Oil\ gpm \times 210$

(2) $Btu/hr = \Delta P \times GPM \times 1.5$

(3) $Btu/hr = horsepower \times 3545$

(4) $\Delta T = T_{oil\ entering} - T_{oil\ exiting}$

(5) $Q = M \times Cp \times \Delta T$

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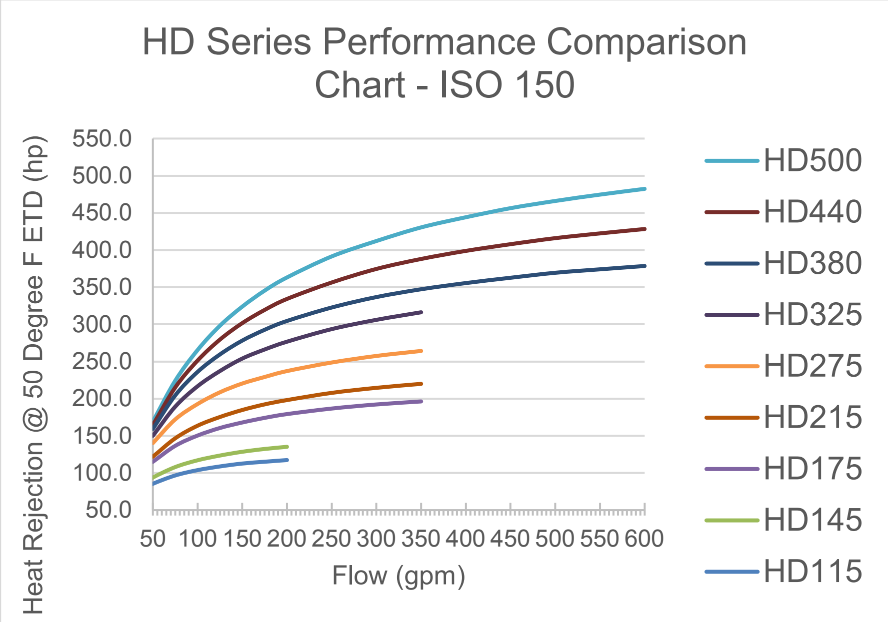

Figure 1. Performance for AKG's HD Series oil coolers

Oil systems tend to operate at much higher pressures than jacket water or charged air-cooling systems. As a result, the oil cooler is designed with material and features sufficient for the application to allow the cooler to operate as intended while also maintaining the life expectation set by the customer. The following failure modes are associated with oil coolers: coolers pressure cycling, over pressurization, and thermal cycling. If the system exposes the oil cooler to frequent, high amplitude shocks it is likely that the cooler will fail prematurely. The pressure pulsing of the oil places the internal fins, or turbulators, in a state of cyclical tensile strain. Eventually, the fatigued aluminum fins fail allowing the fluid channel to slightly balloon. The result is a split in the braze sheet that runs parallel to the long profile. As the heat exchanger is loaded and unloaded, there are temperature differences. These differences cause the heat exchanger to grow in the X direction when loaded and decrease in the X direction when unloaded. The constant movement overtime will stress the oil cooler. Constant entering oil temperatures are recommended to extend the cooler's life. Lastly, over pressurization will also permanently deform the aluminum material because the extremely large system pressure will immediately stress the fins.

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