TIB #05

Air/Oil Transmission Cooling

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Air to oil cooling is not new, it has been used on portable compressors, on stationary engines, and some vehicle applications, all with varied success; depending on the installation and the duty cycle.

Over the last few years, there has been an increasing trend for vehicle operators to use automatic transmissions, especially in stop / start city works. Typical applications include councils garbage vehicles and waste disposal units. With manual transmissions, clutch life was limited which is expensive; both through repair bills and down time. However, the Allison transmissions have been proven to be very successful.

The basic principle is similar to the passenger vehicle, where the power from the engine flywheel is transmitted to the gearbox through a torque converter. In the initial stages of operation, the torque converter permits a 'slip' action until lock up occurs through each up shift, and similarly prior to down shift. It is at these points, that through its basic function, part of the mechanical energy is transformed to heat energy; the transmission oil being the receiver of heat.

The amount of heat given to oil is variable, due to the varying vehicle load and input horsepower characteristics, however it is generally accepted that in the selection of oil coolers, the 70% efficiency point is the design criteria. To obtain this, the engine is 'matched' to the transmission, thus obtaining the correct selections of engine, torque converter, and transmission.

There is clearly then a situation where the heat rejected from the transmission could be as low as 1% (which may be most of the time) or up to 30%.

Since it may be possible under some circumstances to have the converter working hard (such as a concrete agitator or tipper in very soft ground) the oil cooler selection must be of sufficient capacity to dissipate this heat at the worst condition and on the hottest day.

To remove heat, there are two (2) methods employed:

1. Water / Oil
2. Air / Oil

The <u>water / oil</u> comes in two forms; either fitted to the bottom tank or between the radiator outlet and engine water pump.

Since the maximum heat transfer occurs with the greatest flow, the in tank oil cooler has the disadvantage of not being able to guarantee all the available cooling water flow over its surfaces.

The "remote" type guarantees all water flow through the cooler, thus maximum heat transfer. With continuing increases in engine BHP and higher water pump flows, care must be exercised to ensure that the cooler does not impede or restrict the water flow to the pump.

There are disadvantages in this system:-

1. The radiator has to be increased in capacity to accept the higher heat load from the transmission.

2. The <u>by-pass plumbing should be re-routed to enable by-pass water to flow over the cooler, when thermostat closed</u>.

3. A sudden converter heat load may increase the water temperature in the cooler line. The engine, already working hard, may find a combined increase in temperature of 15 - 20°F in the jacket.

4. The circuit recovery is slow.

5. Diagnosis of temperature problems may be difficult, due to two (2) sources of heat in the system.

6. If a failure occurs - water or oils will mix with expensive repair bills!

An Air / Oil system for transmission oil cooling on both medium and heavy vehicles is a better proposition than a tubular heat exchanger. It is easier to install, has less plumbing requirements, and perhaps most important of all, the aspects that it is isolated from the jacket water system, thus making diagnosis of any problem easier, and in most cases, the existing radiator will suffice.

With a manual transmission vehicle, the radiator is normally designed for a nominal ambient of between 100 - 120°F at the engine maximum torque, or with high speed diesel's at a minimum recommended speed range. Since the converter match point is generally 300 - 500 engine RPM higher than maximum torque, there is more air available for the fan to cater for the temperature rise over the oil cooler prior to air entry to the radiator. The average temperature rise at 70% efficiency could be in the order of 15 - 30°F, however as in most cases, the oil cooler covers around one third to one half the radiator core; the average rise in air temperature to the radiator may only be 10°F.

However, this does not mean every installation is satisfactory; each vehicle has its own characteristics and must be investigated prior to fitment.

It is interesting to note, however, that on a vehicle that had an enlarged radiator for the water / oil type and was marginal, when the water / oil was removed and an air / oil fitted, the temperature of both transmissions oil and jacket water fell dramatically.

In summary:-

1. Air / oil coolers must be designed to cater for the heat load required.

2. They should not be fitted without investigation.

3. Economics - though air / oil may cost more, as a unit comparison, the final installed cost is generally cheaper.

4. A cooler of a capacity less than that required may prove to be useless, which causes oil temperature rise and then breakdown.

5. A separate oil circuit eliminates problems in troubleshooting overheating of the jacket water.

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Issue : 1 Date : 31/05/01

ECN : Approval :