TIB #06

Radiator Maintenance

AIR RADIATORS

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Radiators are designed to give maximum life with minimum maintenance, thus providing efficient reliable service to the end operators.

There are environmental conditions however, which reduce the efficiency of the radiator; both internally and externally, thus reducing the performance.

The following information gives a brief description of the various procedures and methods involved in internal and external cleaning.

Cleaning and Testing

(a) ***External Cleaning of Radiator***

It is essential that coolant air passages be kept reasonably free from obstruction. Excessively fouled radiator cores could cause a significant drop in cooling air quantity, with a resultant increase in water and lube oil temperatures. Regular inspection will determine the regularity of external cleaning necessary.

Cleaning Methods

(i) When dust accumulation is not severe, brushing down of the approach air side of the core faces is recommended. A soft type of brush is recommended so as not to damage or deform the copper fins. If necessary, this could be followed by blowing compressed air at no greater than 700 kPa through the air side of the radiator panels in the opposite direction to the normal air flow, until loose material is blown free.

(ii) If the fin and tube exterior surfaces are allowed to become caked with dirt, through neglect, stubborn areas may be cleaned by washing and hosing down with detergent and hot water. Shell Teepol or Turco Sokleen, or equivalent, diluted in water are suitable for this purpose. A low pressure (175 kPa) steam jet is also effective in removal of external stubborn dirt.

(b) ***Internal Cleaning of Water Radiators***

If satisfactory coolant water is used and the correct inhibitor applied in accordance with the engine specification, little or no internal cleaning should be necessary. However, if due to neglect, scale has formed on the inside of the radiator section, it generally follows that the whole closed water circuit will need de-scaling.

(c) ***Radiator Installed***

(i) Drain and flush the entire cooling system with fresh water.

(ii) Add a cooling system cleaner as nominated by the engine manufacturer, then top up system.

(iii) Operate engine for 100 to 150 km, or approximately two hours after the engine has warmed up (over 60°C).

(iv) Drain system whilst hot and flush out with clean warm water. This will clear the system of general sludge, oil or grease deposits.

Note Operations (ii), (iii) and (iv) should be repeated if large deposits of scale are known to exist in the system.

(v) Drain and flush thoroughly with clean water.

(vi) Refill with clean water and add the engine manufacturer's nominated inhibitor. Top up the system.

(vii) Operate engine and check for leaks.

(d) ***Cleaning and Testing of Water Radiator Panels***
(Removed from cooling module)

Radiators can be cleaned internally, as well as externally, if removed from the cooling module using two methods.

(i) The circulation method with the tanks in place.

(ii) Tank dip method with the tanks removed.

It is strongly recommended that unless suitable cleaning equipment is available, the radiators should be sent to a recognised radiator repair company who is suitably equipped to handle large industrial radiator equipment.

(e) ***Circulation Method with Tanks in place***

(i) Flush with warm water or steam if available.

(ii) Circulate internally a hot solution of diluted cooling system cleaner in excess of 50°C, if possible in the reverse direction to the normal water flow for half an hour. Rapid circulation of compressed air would assist the cleaning action.

(iii) Drain and flush with hot water.

(f) ***Bath Wash Method - Tanks Removed***

(i) Remove the tanks and separate the core section by removing the flange bolts.

(ii) Place in a large tank operated at a rolling boil (100°C) containing Turco Rabrite, or equivalent, diluted in water for thirty minutes. This operation will remove all grease, oil and sludge, along with some scale from the interior, and all grease, oil and paint, etc., from the exterior.

(iii) Thoroughly rinse in a second tank of boiling water.

(iv) Remove from tank, drain and rinse with fresh water and/or steam if available.

(g) ***Leak Repairs - Matrix Failures***

The most likely cause of failure would be 'corrosion' or physical damage.

(h) ***Method of Repair***

Repairs are best performed by an experienced repairer, preferably in a well equipped radiator repair shop. (See Air Radiators list of approved repair depots)

(i) ***Types of Repairs*** - *(water and oil matrix)*

(i) Tube Plate Failures

Because of the heavy soft solder build-up on the tube to tube plate joints internally, the removal of the end tanks (and centre tank where fitted) is essential for effective repair on this type of failure.

At the point of leakage, a simple soft solder repair is necessary, and a person experienced in soft soldering of non-ferrous metals is desirable because of the high conductivity of the copper and brass used in matrix construction.

Experience and skill is necessary to prevent excessive heat spreading to, and upsetting, other tubes and tube joints.

(ii) Tube Failure

If a tube fails, it is generally necessary to seal off the faulty tube, using soft solder at each end, thus blocking the tube out of the cooling circuit. Usually about five percent of the tubes can be blocked off in this way without noticeably affecting the radiator performance.

If the cause of tube failure on the water matrix is corrosion/erosion, then repairs should be considered as temporary and replacement cores and gaskets ordered immediately, as other tubes in the core are probably also under corrosion/erosion attack.

(j) ***General Repair Comments***

It is recommended that all repairs be made using a 40/60 grade solder. Leak areas should be thoroughly cleaned prior to flux and solder application, and repair areas should be thoroughly washed to remove any flux or other residue.

Leak testing of the repaired matrix is also desirable prior to refitting.

(k) ***Failures***

Our bolt on radiators are designed and subjected to rigorous testing procedures which include :-

* Pulsometer - testing from 0 to 30 PSIG for a minimum of 50,000 cycles (Most get to 150,000 + cycles).

* Shaking - subjected to shaking at various frequencies in all three planes (vertical, side, and rear) at forces up to 12 G.

*Thermal testing to confirm:
- heat rejection
- ambient capability
- draw down specifications
- deaeration specification

Failures - therefore are investigated with interest to identify the cause.

* Most failures can be traced to:
- mechanical - poor or incorrect mounting
- corrosive - etching of solder by coolant

If a radiator is to fail through poor manufacturing, it will occur within one month, or around 20,000 km.

Failures after then can generally be traced to etching of solder, thus weakening the joint, causing porosity or fracture.

Mechanical

Other areas of mechanical failure may be influenced by mounting or operating conditions, such as:-
- road conditions
- type of load - full / empty runs
- tyre pressures - too high
- spring type - hard ride
- duro of rubbers - work hardening
- ground speed - G forces
- driver

Corrosion

Solder Bloom

Solder bloom is the term used in the USA for the growth of solder from lead (PB) to lead oxide (PBO_2).

It is the result of oxidisation of the lead by corrosive elements in contact with the solder.

Solder bloom can be recognised as the build up of lead, which may show as a mount or powder crustacean, depending on the stage and type of/or condition of inhibitor.

Porosity

Porosity is the effect of corrosion of the lead in the solder.

Corrosive elements attack the lead and form small pin holes and gradually work through the solder.

Inspection of a joint failed from this cause will generally show as a build up of powder crustacean. The colour may be white, red, blue, or another colour, depending on the die used in the inhibitor.

Impingement

Impingement is caused by entrapped air forming around the projection of the tube through the header plate.

These bubbles of air are subject to a level of high frequency vibration caused by variations in water flow and pressure.

The effect of this mechanical vibration plus the oxygen in the air is to develop pin holes which work through the lead, causing porosity, and finally, leakage at the joint.

PH Level

The neutral PH level is 6.9.

To provide a cleansing operation, it is desirable to maintain the PH on a slightly alkaline level - in the region of 7.0 - 8.0.

PH levels higher than 8.0 can result in dezincification of brass, which destroys the original solder brass alloy joint - with resultant porosity or failure.

Low levels become highly corrosive and have a similar effect.

Water Quality

Quality of water used in a cooling system is important.

Water with high salt, or chlorides, calcium or magnesium, should be avoided.

Distilled water must not be used.

Rain water is probably the best water for use in a cooling system.

(I) ***Treatment***

It is important to recognise that with the various metals in the cooling system together with the influence of change of temperature - inhibitors must be used, and used with consistency.

The values of most inhibitors work within an optimum band of efficiency, both as a percentage of total coolant capacity and life expectancy.

Variation to operating cycle; temperature changes, type of base water used and so on, influence the inhibitor's ability to provide protection from corrosion. Therefore, part of the preventative maintenance plan must be regular checks on coolant inhibitor levels.

External - corrosion - copper fins will oxidise in certain atmospheric conditions.

Salt air, super phosphate, or sulphur pits are examples of conditions highly conducive to copper oxidisation.

To avoid early replacement, cores can be produced in solder coated fin (SC). The fins are pre-coated in solder, hence extending their life.

External abrasion - this is experienced in earth-moving and other applications where sand or other abrasive materials are present in the cooling air stream.

In areas where such design is practical, face velocities should be lowered to reduce the effective impact.

SC cores also provide some extended life. PH levels should be monitored and recorded.

Inhibitors

There are a variety of inhibitors on the market, most contain a complex variety of "buffers" and chemicals to provide protection for each of the metals within the system.

Air Radiators prefers not to comment on any particular brand of inhibitor. It must be appreciated, however, that sodium nitrate is highly corrosive to solder.

The main USA inhibitors are sodium nitrate based. We are advised sodium nitrate is the best available material known to man to prevent cylinder liner corrosion.

The inhibitors also include a buffer to protect the solder against sodium nitrate and that under correct dosage rates, corrosion of the solder will not occur.

(m) ***Field Results***

Results of failures in the field can be identified into three groups :-
(i) Impact - mechanical stress, caused by incorrect mounting or high stress.
(ii) Corrosion - caused by lack of attention to maintenance of inhibition.
(iii) Operating Environment

(n) ***Mechanical Design***

Radiators are a complex designed machine, and require attention to detail. Further details are covered in our technical information bulletins which are available on request.

Summary

Radiators are installed to help protect your engine – they therefore require and deserve correct maintenance.

Radiators correctly mounted and maintained will offer long life without major cost to the operator.

Radiators by themselves will not fail - most failures are the result of lack of maintenance of inhibitors, causing erosion and corrosion of the solder joints.

Therefore, regular coolant checks are essential to minimise both the cost of repair and down time.

For further information, contact Air Radiators.
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