RECO-COOL

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INTERPRETATION OF USED COOLANT ANALYSIS

Testing of coolants in use (whilst still within service) can give a vital indication on the health of the cooling system of a piece of equipment, and the health of the coolant itself. More and more sites are using Coolant Analysis to provide an indicator to advise maintenance practices. Many independent laboratories can run coordinated coolant testing programs. Recochem is very pleased to provide technical support services to ensure that the appropriate tests are conducted and properly interpreted.

This bulletin provides an interpretation on some of the likely scenarios as a result of non-conformances through the coolant testing programs.

COLOUR

The colour of the coolant is an important indicator. Simply, it will give a good indication if contamination has occurred. The colour of the coolant should not change through the life of the coolant (although some "colour life" coolants are being developed which do change when they near the end of their useful life). Most coolants, however, are designed to maintain their same colour throughout their life.
If the colour of the coolant has changed, it is generally an indication of some contamination. Some examples:-

a) If the coolant appears colourless – it is likely that the cooling system has been refilled with plain water. Check RA and pH (and also other inhibitor additives) which will indicate – through their absence – if the fluid is simply water. If this is the case, special attention should be paid to the corrosion metal content. Suggest to drain and refill.
b) If the coolant is a totally different colour – blue or red instead of green (or vice versa), then it is likely that the cooling system has been refilled with a different coolant product. Proper interpretation will require understanding of which product has been filled into the system.
c) If the coolant is the same colour but deep/darker – it may be that it has been topped up by "concentrate"
d) If the coolant is the same colour but lighter – it may be the that it has been topped up by water.
e) If the coolant is dark, almost black: this is one sign of elastomer degradation. It may be that the coolant is contaminated by particles of the rubbers and elastomers in the system which have oxidized. Suggest to drain and refill.
f) If the coolant is red or brown – this is an indication either of rust (check content of corrosion metals such as Fe, Cu, Al). Or alternatively, the coolant could be contaminated by dirt/dust (check Si levels). In either case, suggest drain and refill. Further maintenance may be required on the cooling system depending on the source of the contaminant.

ODOUR

The odour of used coolant gives an excellent indication of any sort of contamination present, or any chemical reaction going on inside the cooling system that might be affecting the performance of the coolant. Used coolant should be odourless.

a) Solvent or Acetone odour is a sign that the MEG in the coolant is being oxidized. The coolant has either been left in the system too long (past its standard life), or alternatively the cooling system is running far too hot (which suggests that either the thermostat or the waterpump are not operating effectively).
b) Ammoniacal odour may be a result of improper cleaning after a cooling system cleanse. Stray current in a cooling system may cause to reduce nitrites or nitrates in a coolant – this could also be a cause.
c) Burnt odour – suggests that the system is running too hot
d) Fuel odour suggests some fuel contamination in the coolant

In each of these scenarios, any case of unusual odour is normally an indicator of a more significant problem in the cooling system. Drain and refill the coolant, and check the cooling system for integrity, leaks and performance testing.

GENERAL APPEARANCE

Coolants should be clear and bright, and uniformly coloured. Any flocculation, sedimentation or solids or particulate matter is a general cause of concern.

a) Presence of flocculate sediment is an indication that the inhibitor in the coolant is breaking down. This could be caused through a number of reasons, including contamination with another coolant of different chemistry type, or commencement of inhibitor breakdown. Check levels of other inhibitors.
b) Presence of metallic or rust particles indicates some corrosion activity. Iron (very common cooling system metal) is magnetic, and these iron particles will respond to a magnet
c) Sediments can be a result of ingress of dirt and dust. Check system for leaks and integrity.
d) Gel-like substance is an indicator that the fluid has been overdosed with SCAs. Drain and refill with appropriate coolant.
e) There should be no visible sign of an oily film. Such a film is a likely indication of either fuel or lubricant residue. The cooling system should be checked for integrity.

Any unusual appearance must be checked, through an evaluation of the system itself. Suggest in most cases where the fluid is not a usual appearance of clear and bright, that the coolant should be drained and refilled.

pH

pH is a test which determines the acidity or alkalinity of the coolant. Coolant fluids are generally alkaline. The pH scale is a uniformly adopted unit of measurement, where a pH of 7 indicates neutrality (ie neutral water). pH measurements higher than 7.0 are usually indications that the fluid is alkaline, and pHs lower than 7.0 are usually acidic. It is important to avoid acidic conditions in a cooling system, which are typically corrosive.

a) There is usually a typical pH specification for a used coolant that it should meet. The actual pH result should be compared to the specific range that is applicable for the coolant in use.

b) Where the pH is unusually high, this tends to indicate that the coolant has been contaminated with another type of coolant.
c) Where the pH is approximately 7, check the fluid to ensure that it is not simply straight water
d) Where the pH is lower than 7, this is a corrosive condition and the fluid should be drained, flushed and replaced immediately.

Typically, inorganic coolants (Conventional, or Traditional inhibitor types) exhibit a higher pH than OAT or Hybrid type coolants.

RESERVE ALKALINITY

The Reserve Alkalinity (or RA) is a measure of the reserve inhibitor content of the fluid. It is a direct measure of the remaining inhibitor level. RAs can differ considerably depending on coolant type. The RA result should always be compared to the RA for that particular coolant.

a) Low RA indicates that the coolant inhibitor level is low (suggesting that it is nearing the end of its life). Or that the coolant has been overdiluted with water.
b) High RA indicates that the coolant has likely been underdiluted with water ("concentrate" coolant has been added)
c) An RA of zero is typical for water.

INHIBITOR LEVEL

The Inhibitor level is usually measured by calculation from the RA

% GLYCOL

The level of glycol in a coolant is a measure of one of the main constituents of the blended coolant. This is a ready measurement which gives a good idea of the level of dilution of the coolant, and whether it is still within the original specification. In colder climates, glycol level is important to provide adequate protection for the fluid against freezing.

The Glycol % should be compared with the original fluid.

a) Low % Glycol indicates overdilution with water. This also overdilutes the corrosion inhibitor package. Suggest to drain and refill with fresh coolant
b) High % Glycol indicates that the product has been incorrectly topped up with concentrate. High % Glycol does affect the efficiency of heat transfer, and is also susceptible to higher levels of oxidation. A fluid of >90% Glycol has poor freezing point. The remedial action in this case depends on the likely scenario.

FREEZING POINT

The Freezing Point of the coolant is usually measured by calculation from the % Glycol, and the diagnostics are the same.

WEAR METAL ANALYSIS

A good coolant analytical report will also indicate levels of wear metals in the fluid (usually measured in levels of ppm). The presence of wear metals indicates varying levels of corrosion activity. Different metals are common in different parts of the engine, and therefore when unusual metals are indicated in the wear metal analysis, it is useful to consult with the OEM to determine exactly where the wear may be originating from.

In analyzing wear, it is most important to look at trend analysis. Wear is alarming if it is sudden, and significantly higher than previous analytical test results. In cases where the levels of any wear metals have doubled since the previous analytical report, this suggests that onset of wear and corrosion could be taking place. In these cases, not only should the fluid be changed, but the equipment should be monitored to determine where the wear is occurring and what preventative maintenance scheduling should be performed.

Wear levels can increase gradually and consistently. This is less alarming than sudden onset, however again wear metals should be monitored closely when any element shows an increase beyond approximately 10ppm.

The typical wear metals tested include Iron (Fe), Tin (Sn), Aluminium (Al), Copper (Cu), Lead (Pb), and Zinc (Zn).

Other metals

The analysis of some other metals is also sometimes included in the wear metals analysis (as the typical test – ICP – is the common test method for all metal types).

WATER SPECIES

These metals are not normally associated with cooling system wear or corrosion, as they are not normally used in system design. Typical metals in this category are Mg (Magnesium) and Ca (Calcium). They may be present in areas where the tapwater is poor, and are naturally occurring elements in the water itself.
High levels of either of these two metal species indicates typically that the cooling system has been diluted with (poor quality) tapwater. Calcium and Magnesium can prevent the inhibitors from properly doing their job. Therefore, when a coolant contains high levels of either of these two species, the general recommendation is to drain and refill.

DIRT SPECIES

Sand and dirt often contains traces of Silicon (Si) which is also often reported in the wear metals analysis. Silicon is not used in the cooling system design.
Analyses which show very high levels of silicon (especially where the level has jumped) is an indication that the fluid has been contaminated by dust or dirt, or sand. Usually this is also apparent through the appearance of the fluid (where such sedimentation is visible).
It should be carefully noted that Silicon levels can also be present in the coolant inhibitor additive, so presence of this species should be regarded carefully.

COOLANT ADDITIVE SPECIES

There are some metal species which are deliberately intended to be in the coolant – and depending on the coolant type – will be apparent (even in virgin coolant of this type). These species are actually part of the coolant inhibitor additive pack. Sometimes, the analysis of these metals is used as a direct indicator (like RA) of the ongoing level of inhibitor.
Examples here are Molybdenum (Mo), Boron (B) and Silicon (Si). It should be carefully noted that Silicon levels can also be an indicator of dirt/sand ingress, so presence of this species should be regarded carefully.

OTHER DIRECT COOLANT ADDITIVE ANALYSIS

Apart from the analysis of Mo, B and Si (which may be tested and results reported as part of the wear metals testing analysis), there are other tests which may be reported which are direct indicators of the presence and level of the additive inhibitors in the coolant itself.

These tests should be regarded carefully, as not all coolants contain these addtives. These tests can be performed and reported discretely.
Phosphate
Nitrate
Nitrite

Where levels of the corrosion inhibitor packages are very low, this indicates that the coolant is nearing the end of its useful life, and drain and refill is recommended.

Where levels of the corrosion inhibitor packages are very high, this indicates that the coolant has been topped up with concentrate. Diagnostic advice depends on the level of inhibitor and the quantity of topup.

Where new corrosion inhibitors are detected in coolants which should not contain them, this indicates that the coolant has been contaminated with a different type and brand of coolant. The appearance should be checked to ensure that there is no flocculant or sediment (which would indicate that the coolants are not compatible). Diagnostic advice depends on the level and type of contamination observed.

COOLANT CHANGEOVER PRACTICE
In normal circumstances, when a coolant is near the end of its life, a simple drain and refill technique is suitable to replace the coolant. Used coolant should always be disposed of appropriately and in consideration of local legislative requirements. Used coolant should never be tipped into untreated waterways.

In some circumstances, where sedimentation, contamination, excessive wear metal buildup, or excessive dirt or dust is present, it may be necessary to add another step in the changeover procedure. In these cases, the fluid should be drained, then the system should be flushed with either demineralized water, or a fresh charge of coolant – then that flush should also be drained. This helps to remove all of the unwanted contamination species. Then the system can be refilled with fresh coolant.

SUMMARY
Using these simple diagnostic tools, a great deal of information can be learned about the performance of the coolant, and the health of the cooling system. Maintaining a good healthy coolant is the first step in ensuring that the cooling system is clean and clear of corrosion.

As soon as indicators of system corrosion is apparent, it is good practice to properly service the cooling system, to replace leaks, service areas where pressure loss is occurring, and replace system parts that are corroded or worn.