



## Evans UK – A detailed response to No-Rosion

### **Introduction and the need to respond...**

Evans Waterless Engine Coolants represent a major evolution in engine cooling technology and from NR's point of view a direct challenge to their business and 100 years of 'water-based' thinking. Inevitably there will always be contrary responses when a revolutionary product or idea comes to the fore. Marconi, Edison and the Wright brothers all had their inventions scorned before they were accepted and whilst including Evans alongside such illustrious names could be considered indulgent, the point we wish to make is clear. Evans would always urge potential adopters of any new technology to verify the facts with a suitably qualified source and be wary of commercially incentivised bias or hearsay.

Fortunately a significant number of individuals, race teams, fleet operators and manufacturers have taken the time to thoroughly and diligently evaluate Evans WEC. These include many well known and highly respected engine designers, builders, tuners and restorers from the aeronautical, automotive, bike and heavy duty diesel sectors. Evans recent appointment as a technical partner to Honda and the use of Evans WEC in their engines provides another excellent point of reference and 'one in the eye' for unqualified cynics and those with an axe to grind. To find out more about Evans technical partners, distributors and advocates please visit [www.evanscoolants.co.uk](http://www.evanscoolants.co.uk)

Evans usual strategy is not to engage with subjective forum hearsay or respond to documents that contain errors. Instead we prefer to focus our efforts on presenting detailed technical information, corroborated by hard-data and highly credible points of reference, to those who are intent on making informed decisions. Unfortunately the NR document is doing the rounds and contains many inaccuracies mixed in with a few facts that have potential to cause confusion. So on this occasion we feel it is prudent to flex this policy and quash their claims in a constructive manner.

### **Competence and Credibility aligned with Due Diligence...**

In 2011 Hydra Technologies Ltd. was appointed the UK licensee to manufacture and distribute Evans WEC throughout the UK, Europe and Middle East. HTL's core business is the formulation and manufacture of specialist heat transfer fluids, supplied to OEMs, distributors and end users in the Refrigeration & HVAC, Solar Thermal & Geothermal sectors. HTL also designed, built, installed and operated large fluid processing equipment for Pepsi-Walkers and Co-Op dairies. Via its Marine & Offshore Supplies division HTL has extensive experience in designing and packaging mechanical and marine equipment, including: engine driven generators and fire-pump sets, process cooling, filtration and fresh water systems.

Prior to establishing Evans UK HTL spent 14 months in due diligence reviewing all the data and test reports, collated by Evans USA over an 18 year period. Similar due diligence procedures were subsequently performed by Allianz (product liability insurers) and UK Steel Enterprise division of TATA (share holding investors). It would be reasonable to say, that none of the above mentioned companies would have proceeded if the product was flawed in the way NR purports.

### **Formulated from experience...**

Jack Evans and Tom Light, the men who perfected Evans WEC, are innovative mechanical engineers and their specialty had been the design of high performance engine cooling systems. For many years Jack and Tom improved pump and cooling system design for a wide range of racing and production engines, working with Nascar, Ferrari, General Motors etc. During this investigative era they confirmed that water-based coolants were often restricting engine performance and operating outside waters physical and chemical limits, even with additional pressure and inhibitors added. By replacing water with 100% glycol they eliminated the boiling and vapour issues, but were unable to remove sufficient heat energy to prevent a gradual increase in engine temperature. Over several years, experimenting with various glycols, synthetic and organic diols plus non-aqueous



corrosion inhibitors, Jack and Tom formulated a patented WEC that; is non-toxic, has low viscosity, boils above 180°C, protects below -40°C, has low vapour pressure, doesn't retain dissolved oxygen and has very low electrical conductivity. All of these properties combine to ensure Evans WEC eliminate the boiling, corrosion and erosion issues associated to water-based coolants, whilst effectively cooling the engine.

**Empirical versus theoretical...**

Engineers often request Specific Heat, Thermal Conductivity and Viscosity data from us which is logical, but for Evans coolants can be misleading. Water has the best heat transfer characteristics (provided it is water not vapour) and theoretical calculations often indicate that using Evans will require a larger cooling system. This is the undoubted reason why OEM design engineers have persevered with water for all these years. In reality the 20 years of empirical data gathered by Evans proves there is much more going on inside an engine cooling system than  $Q = M \times Cp \times \Delta T$  might suggest. Therefore we would always recommend testing Evans in a working engine to fully realise its extensive benefits.

*Steve Hickson*

Managing Director



## 1. Corrosion prevention and ASTM D1384 Tests

The corrosion tests carried out by NR are not relevant because they were performed using 66% water 33% Evans – as laid down in ASTM D1384.

Evans Global have commissioned several independent labs to perform bespoke corrosion tests, using ASTM D1384 procedures but without water present. The results (please refer to the attached documents) confirmed extremely low corrosion rates. Formalising a non-aqueous coolant testing procedure is included in the remit of ASTM sub-committee D15.22 for use by manufacturers of waterless engine coolants. John Light, Evans USA CEO, has been appointed by other members of D15 to head-up the D15.22 sub-committee, which also includes members from several other coolant manufacturers and Evans UK.

Whilst we have no reason to refute NRs results for their own inhibitor formulation, the fact remains that all inhibitors mixed in to water-based coolants fail over time. This is mainly due to the cyclical re-oxygenation of the coolant every time it heats and cools, which is exacerbated by galvanic activity. Hence the need to replenish inhibitors and/or coolant every 1 to 4 years.

## 2. Effective removal of water-based coolants prior to filling with Evans

NR are correct in stating Evans coolants operate most effectively when at 97% to 100% concentration....otherwise they would not be waterless. However they are wrong to state that it is difficult to reach this desired concentration. As with the recent conversion of Stagecoach buses in Cwmbran, Porth and Merthyr Tydfil and all other conversions carried out to date, it has been very easy to achieve >97% and for most engines a >99% concentration.

To achieve >97% concentration it is necessary to flush through a 'wet' engine with Evans Prep Fluid, as this will hygroscopically scavenge any remaining water from the cooling system simply, quickly and effectively. The flushing process is well within the capability of a DIY car enthusiast and easy for any apprentice mechanic.

**Worse-Case Conversion Example:** *To convert a 70L bus cooling/heating system from 50:50 coolant.*

After draining of the 50:50 coolant 14L is left behind, which equates to 20% volume of which 10% is water = 7L.

Add 56L of Evans Prep Fluid and run engine until thermostat opens. Stop engine, allow to cool and drain Prep fluid. Again assume 14L is left behind, which now equates to 1.4L water remaining.

Add 56L of Evans Heavy Duty waterless coolant and run engine until thermostat opens.

The remaining 1.4L of water equates to 2% of the total cooling system volume.

**Poor Conversion Example:** *To convert a 70L bus cooling/heating system from 50:50 coolant.*

After draining of the 50:50 coolant 7L is left behind, which equates to 10% volume of which 5% is water = 3.5L.

Add 63L of Evans Prep Fluid and run engine until thermostat opens. Stop engine, allow to cool and drain Prep fluid. Again assume 7L is left behind, which now equates to 0.35L remaining.

Add 63L of Evans Heavy Duty waterless coolant and run engine until thermostat opens.

The remaining 0.35L of water equates to 0.5% of the total cooling system volume.

**Standard Conversion Example:** *To convert a 70L bus cooling/heating system from 50:50 coolant.*

After draining of the 50:50 coolant 2L is left behind, which equates to 2.86% volume of which 5% is water = 1L.

Add 68L of Evans Prep Fluid and run engine until thermostat opens. Stop engine, allow to cool and drain Prep fluid. Again assume 2L is left behind, which now equates to 0.029L remaining.

Add 68L of Evans Heavy Duty waterless coolant and run engine until thermostat opens.

The remaining 0.029L of water equates to 0.014% of the total cooling system volume.

### 3. Payback and the Avoidance of False Economy

Evans WEC have been long-term proven to eliminate many of the problems and on-costs associated to water-based coolants. Specifically the prevention of;

- a) Downtime and recovery costs associated with overheating, boil-over and after-boil.
- b) Replacement and maintenance of components damaged by corrosion, erosion and cyclical pressurisation.
- c) Premature devaluation and/or scrapping of vehicles, which have suffered accelerated wear and tear by water.
- d) Year on year change-out of water-based coolant....and probably constant top-ups throughout the year.

Once converted to Evans there is no need to change the coolant again, ever! Recently Joe Umstead, who has driven a DDA powered truck for 20 years and more than a million miles on a single fill of Evans Heavy Duty Coolant, was asked how the cost compared with standard coolant. His reply was "he had no idea because it had been so long since he bought any!" Joe's original reason for switching to Evans was radiator failure caused by inhibitor drop-out.

(Note: In the event of maintenance Evans WEC can be drained and reused.)

Currently, as documented by the BTC Testing Advisory Council, 60% of all engine failures are caused by cooling system failure and during 2012 the AA responded to >56,000 breakdowns caused by overheating and cooling system failure.

#### Cause and Effect

Based on these facts all engine and coolant manufacturers must appreciate the benefit (see the logic) of completely eliminating the causes of corrosion etc. rather than employing temporary measures that only delay those effects.

In conclusion the difference in cost between Evans WEC and water-based coolants is rapidly offset by the life-long operational savings and improved reliability gained.

### 4. Running Temperatures with Evans

No-Rosion's findings on engine temperatures are, to put it constructively, very confused and bear no relation to the extensively proven and documented reality. By necessity Evans must refute NR's statements based on >0.5M successful conversions carried out over a 20 year period and we are happy to provide our customers with lists of highly credible end users and distributors.

In our sales literature we explain that water is the best heat transfer fluid.....provided it is water and not vapour. As confirmed in tens of thousands of cases, engines are regularly suffering from vapour pocket formation around the combustion zone. This often leads to erosion, cavitation, over-heating, detonation and other combustion issues.

When an engine cooled with a water-based coolant is at low load and there is no detectable vapour production, then it will run 2 - 10 Deg.C cooler than with Evans. As the engine load increases and vapour pockets develop (in water-based coolants) it is common to see the temperature gauge register an increase - whereas with Evans the gauge will remain steady at all loads. This is because with Evans there is always liquid coolant in contact with metal. With the 2 - 10 Deg.C increase in the coolant temperature there is a similar increase in the lube oil temperature, but it remains well within acceptable operating parameters.

Other than NR's report there have been no reported cases of erosion to valve seats or guides etc. when using Evans.....to the contrary Evans has overcome these problems in many engines previously suffering from vapour formation. Our assumption is that NR did not properly convert their one-off test engine and left air pockets and/or water in the head - subsequently their findings are incorrect. Possibly if NR did not have a commercial motive they might have proven more diligent and thorough in their testing.

It is also worth mentioning that engines filled with Evans reach operating temperature more quickly than water cooled engines. This is known to reduce emissions from diesel engines.

## 5. Evans and the need for ECU Reprogramming

As mentioned above engines filled with water-based coolants often vary in operating temperature range more than those filled with Evans, especially around the combustion zone. Specifically, due to vapour formation a water-cooled combustion zone is often operating outside of the predicted or intended parameters and subsequently the ECU program can be expected to over or under-fuel the engine based on incorrect temperature feedback.

Substantial research and corroboration based on thousands of Evans conversions confirms there is no necessity to adjust ECU settings following a 'fluid-only' conversion and many customers confirm an improvement in performance and/or MPG. As Evans is adopted by more OEMs there may be some additional adjustments that can be made to take additional advantage of the improved cooling around the combustion zone.

As detailed in Evans UK Economax brochure and [www.economax.co.uk](http://www.economax.co.uk), installing Evans waterless coolant facilitates the opportunity to increase in engine running temperature. Increasing heavy duty engine coolant temperature from approx 85 -90 Deg.C to 110 – 115 Deg.C has been proven to:

- Improve fuel combustion and reduce exhaust emissions.
- Reduce fan-on time by up to 50%, achieved through widening the Delta-T.

Attached to this communication are two independent reports corroborating these statements and providing evidence of the incentive for Veolia and others to convert their fleets from water to Economax.

## 6. Evans Coolants and Nucleate Boiling

Nucleate boiling is the phase change state where micro-bubbles of vapour are formed on the hot metal surface and then move off in to the main coolant flow, where they are condensed (collapse). Nucleate boiling is the most efficient means of heat transfer from a metal to a liquid and is used in nuclear power plants where the loading conditions (heat generation) can be precisely predicted and controlled. Unfortunately these perfectly balanced conditions are rarely found in IC engines, as the load, speed and ambient conditions are constantly varying.

Nucleate boiling will exist from time to time in an engine, but often the ideal heat transfer balance moves towards Critical Heat Flux which leads to Film Boiling. When film boiling occurs a thin layer of vapour separates the liquid coolant from the metal to be cooled. As described in the attached technical bulletin by Tom Light, the vapour bubble formed in water-based coolants is part water, part ethylene glycol and the latter will readily recondense leaving behind a pure water-vapour bubble. This water vapour bubble will not recondense until the engine metal temperature drops below 95 – 115 Deg.C.

Evans has a much lower vapour pressure compared with water-based coolants and this is manifested in a boiling point above 180 Deg.C. As with water-based coolants nucleate boiling conditions will not occur on a predictable basis with Evans, but what is certain is that Evans will not reach CHF except in the most extreme conditions. Subsequently film boiling does not develop and there is always liquid in contact with the hot metal, maintaining effective heat transfer.

NR provide data relating to the reduction in surface tension of water using their additive, a common surfactant. Surfactants are already present in most 'off the shelf' antifreeze solutions and can increase heat transfer.....up to a point. When water phase changes from Nucleate Boiling to Film Boiling the energies and forces present cannot be controlled by surfactants. This is corroborated by the number of engines that continue to overheat and boil-over.

If, as NR imply, Evans did not perform more effectively than water-based coolants then surely Honda, Veolia, LA Metro, Kamaz-Master etc. etc. would have identified its limitations and not made the change.



#### 7. **Evans and Viscosity**

Evans is more viscous than water at all temperatures....up to the point where water boils and vapourises - here viscosity is irrelevant. Evans viscosity has proven to be no issue for all but a few pre-1920's engines, that use a siphon system instead of a pump and occasionally engines where the cooling impeller is already eroded or the radiator blocked with corrosion debris. In the latter scenarios cooling system failure is usually imminent, e.g. pump, radiator, head or hose failure, and to avoid a reoccurrence of such failure(s) Evans should be considered during and/or after repairs have been completed.

For the remaining 99.99% of engines cooled with water pumps Evans works without issue....again the proof of 0.5M conversions corroborate this.

#### 8. **Evans Reduces Cavitation, Cylinder Head and Liner Erosion**

Apart from eliminating corrosion (See 1.) Evans WEC are proven to reduce the formation of the small vapour bubbles that constantly form and collapse on the surface of liners. This is a major problem for heavy duty engines fitted with wet liners and the subject of many SAE papers. Many measures have been tried to counteract the internal (combustion side) and external (wet side) pitting, but liner porosity and cracking continue to cause catastrophic engine failure. In the new ASTM D7583 Liner Cavitation Test, as developed by John Deere, Evans WEC excelled in comparison with all other water-based coolants and achieved the lowest result (21 pits) ever recorded. This test was performed by the Southwest Research Institute, an independent, non-profit applied R&D organisation in San Antonio, Texas. As with all test findings Evans have disassembled many engines to verify the same results in working vehicles and plant. I.E. Evans does not just rely on one or several lab tests, but has always proven the product in the field and over several years.

The issue of vapour bubble formation on liner surfaces is a manifestation of entrapped vapour coming out of solution where pressure drops occur. A similar thing happens in tortuous path cooling channels and impeller pump volutes. Specifically where the water-based coolant rapidly changes direction there will always be a pressure drop and this provides the entrapped vapour with an opportunity to escape, or phase change. Another word for this process is Cavitation, which is often responsible for poor/reduced circulation rates and erosion to metal and plastic (gaskets) parts, leading to eventual failure. In comparison to water and water-based coolants Evans has a much reduced vapour pressure and subsequently is much less prone to vapour bubble formation or phase changing inside the cooling system.

It is this low vapour pressure of Evans that reduces internal operating pressures from approx 1.2 Bar down to approx 0.25 Bar. Evans users, distributors and advocates often like to prove this unique function by removing the coolant cap whilst the engine is hot or still running! We would always advise 'safety first' when dealing with hot liquids but it really does surprise most people. On a practical note the lower operating pressure also reduces internal cyclical stresses on hoses, clips, radiator seams and head gaskets.



## 9. Health & Safety

NR's comments and bias are very much race-track orientated where, as they point out, glycol based coolants are sometimes banned. This is because Evans and 50-50 water-glycol coolants are synthetic based and slippery if spilt. Although Evans market is 99.9% non-track orientated and 90% of non-track engines are filled with a mixture of water and toxic ethylene glycol there is more to the track story.....

As detailed above and in Evans product literature many engines and especially racing engines are operating at or beyond the physical limit of water. This often requires engine tuners to de-rate performance. In racing, performance is everything and for this reason Evans has been finding its way in to all categories of racing machines for more than a decade. Admittedly sometimes it's been done on the QT but we expect the need for secrecy to change over the coming years. Because Evans generates substantially less pressure than water-based coolants, there is little potential for it to spray anywhere in the event of a hose or radiator failure. In this respect we have received several accounts from 'Evans racers' about crashes and impacts that have holed their radiator but not prevented the driver from completing the race....because the coolant did not spurt from the leak and instead gently dribbled out. I.E. they lost little coolant and could carry on.

During the 2012 season several Evans sponsored racing teams attended dozens of events at Brands, Oulton Park, Donnington, Snetterton etc. and not once did we witness a coolant spill from any of those cars or bikes. Rather, most race suspensions were due to lube-oil, brake-fluid or fuel leaks.

Because Evans offers racing teams such a measurable advantage (see Honda, Kawasaki, Mosler etc.) we will be working with these teams and the appropriate authorities to review current racing restrictions. If, as with lube-oil connections, racing cooling systems employed threaded-union connections and for belt-and-braces a braided metal over-hose the risk would be even further reduced and provide far less concern or risk compared with fuel, lube-oil and brake-fluid. When risk is properly reviewed and the benefits (of Evans) carefully considered, then evolution tells us there is always a way to control and reduce that risk to move performance forward.

Towards the end of their report NR refer to the issues of flammability. Neither 50-50 water-antifreeze mixtures nor Evans WEC are classified as flammable and both have a very high auto-ignition temperature. However, under abnormal conditions not expected or predicted to occur by engine designers, both coolants pose an extremely small risk of fire. There are a number of reported incidents of engines catching fire with 50-50 coolant sited as the fuel source. Specifically, coolant under pressure has sprayed out from a burst hose etc. on to a red-hot (glowing) exhaust manifold, where the water element is instantaneously evaporated leaving behind neat ethylene glycol. As detailed in the attached report the odds of such an event occurring are considered too remote to be identified as a real risk for insurance companies to quantify or load any premiums.

Evans coolants pose an even smaller risk of fire in comparison to 50-50 coolant, as they will not spray under pressure and are far less likely to cause a burst hose.