

Heat Exchangers

Part 3 - DURABILITY & RELIABILITY





FAILURES IN HEAT EXCHANGERS

Today's vehicle manufacturers demand not only high thermal performance but also problem-free and durable heat exchangers. To them, heat exchangers should have high mechanical strength because the largest rejection and warranty claims these manufacturers receive in aluminium heat exchangers are due to leakage within just one year of usage.

WHAT TRUCK MANUFACTURERS SAY

One area of improvement that truck manufacturers are looking for is a greater resistance against corrosion.

These manufacturers are already experiencing problems in this area. Besides function and price, durability in a heat exchanger is an important consideration for them.

WHAT BUS MANUFACTURERS SAY

Bus manufacturers are facing problems such as the cracking of tubes at around 180°C for heat exchangers used in buses. For these manufacturers, the existing heat exchanger technology has certain limitations that result in reliability problems.

As a heat exchanger is subject to harsh conditions - high pressures, high temperatures, corrosive fluids and environmental influences - its quality directly affects the functionality of vehicles.



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REASONS FOR FAILURES

When a heat exchanger fails, it performs at a lower efficiency level and no longer provides cooling to the engine.

The failures may be due to various reasons. One common reason is that the heat exchanger is blocked, thereby obstructing the flow of coolant within the tubes. Also, the fins may have been damaged, resulting in insufficient cooling.

Some of the more common causes of heat exchanger failures are as follows:

TUBE-TO-HEADER LEAKS

There is a failure in the joint, resulting in coolant loss.

FIN DETERIORATION

There is electrochemical deterioration of the fins, which is often caused by road salt or marine atmosphere in combination with sulfuric pollutants.

FIN BOND FAILURE

There is a loss of solder bond between the fins and tubes. The fins are loose in the core and cause a loss of heat transfer, and also reducing the strength of the heat exchanger.

CORROSION

Aluminium heat exchangers are especially sensitive to coolant quality and face the problem of pinhole corrosion on the coolant side, often resulting in leakage failures. In addition, aluminium heat exchangers, especially those used in trucks, tend to experience external corrosion from road salt. Also, aluminium heat exchangers have low strength at elevated temperatures.



SOLUTION: CUPROBRAZE TECHNOLOGY

HIGHER DURABILITY & RELIABILITY

With the limitations confronting existing heat exchanger technologies, just how do we overcome them?

CuproBrazed heat exchangers offer greater reliability and thus longer life span due to their greater corrosion resistance and strength. Apart from the use of copper, CuproBrazed heat exchangers utilise specially-made alloys and coatings that provide added corrosion resistance.

GREATER CORROSION RESISTANCE

The corrosion resistance of CuproBrazed heat exchangers is better than that of soldered heat exchangers and very competitive to aluminium ones. In salt containing environment, CuproBrazed shows clear superiority over other types of heat exchangers

Using special alloys developed for CuproBrazed heat exchangers the galvanic differences in the core have been practically eliminated. New coating technologies have also been developed to withstand environmental factors after further downgauging of materials.

To verify the corrosion resistance, CuproBrazed heat exchangers have been subjected to the following rigorous tests:

- **REP (Road Environment Pollutant) Test**

Figure 1 shows the results of a 336-hour REP test. Unlike aluminium, CuproBrazed showed no corrosion at the joints.

Fig 1: REP Test Results 336 Hours

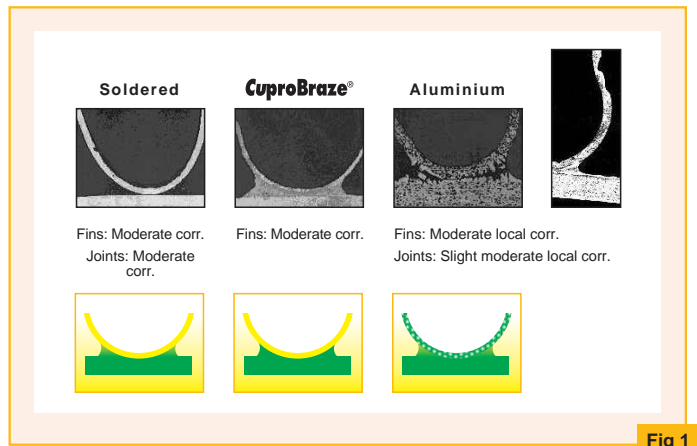


Fig 1

- **Salt Spray Test**

Figure 2 shows the results of a 744-hour salt spray test. In comparison to aluminium, CuproBrazed showed no corrosion on the tubes and relatively little corrosion on the fins.

Fig 2: Salt Spray Test Results 774 Hours

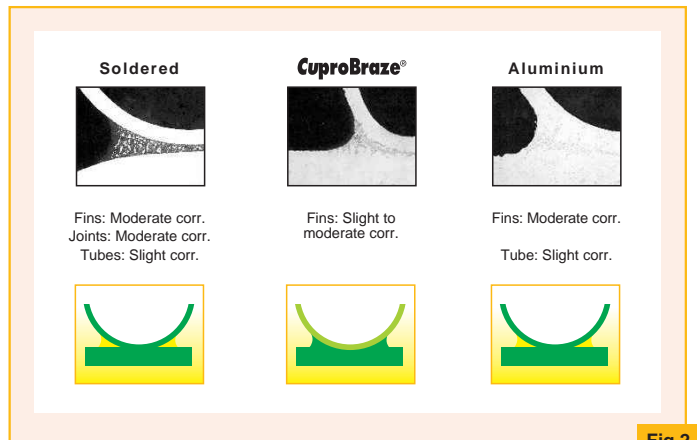


Fig 2



SOLUTION: CUPROBRAZE TECHNOLOGY - cont'd

• **SWAAT (Sea Water Acetic Acid Test)**

Figure 3 shows the results of a 336-hour SWAAT. The results show slight to moderate corrosion on the fins for *CuproBraz*e as compared to moderate corrosion on the joints for aluminium.

[... a special kind of dedicated slurry has been used

for tube/header joints, which provides these joints

the strength to withstand high stresses and

ensure leak-proof performance]

• **Marine Atmosphere Corrosion Test**

Figure 4 shows the results of a 15-month marine atmosphere corrosion test. Aluminium showed moderate corrosion in both the fins as well as the joints whereas *CuproBraz*e showed only slight corrosion on the fins.

Fig 3: SWAAT Test Results 336 Hours

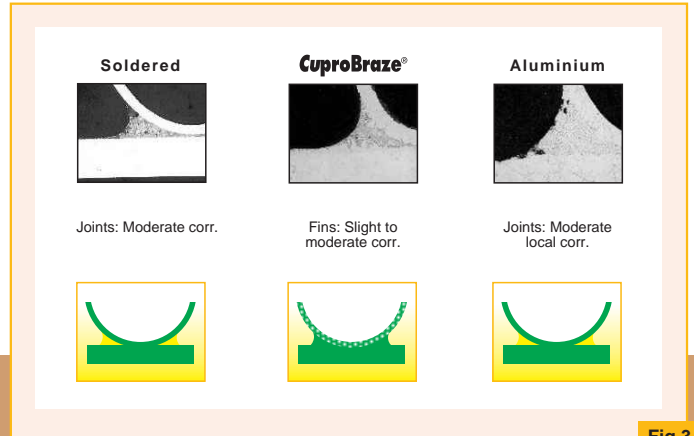


Fig 3

Fig 4: Marine Atmosphere Corrosion Test Results 15 Months

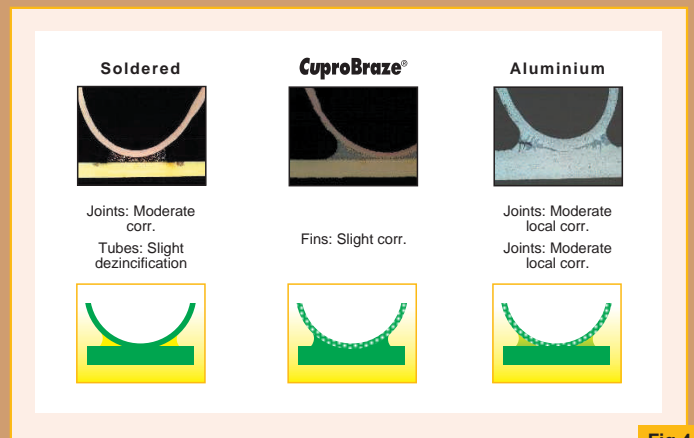


Fig 4

HIGHER STRENGTH

To ensure the overall strength and durability of *CuproBraz*e heat exchangers, three new alloys were developed.

The first one is an anneal-resistant fin material that maintains the strength of the fins after brazing. Strong fins are required because they support the tubes.

The second alloy is an anneal-resistant tube alloy that retains its fine grain structure after brazing and provides ductility and fatigue strength in the brazed heat exchanger core.

The third is the brazing alloy.

Overall, *CuproBraz*e heat exchangers offer higher strength or performance in the following areas:

• **Stronger tube-to-header joint**

The most critical braze joint of the heat exchanger is the tube/header joint as it has to be totally leak-free. Therefore, a special kind of dedicated slurry has been used for tube/header joints, which provides these joints the strength to withstand high stresses and ensure leak-proof performance.

• **Less sensitivity to bad coolant**

A copper/brass heat exchanger is less sensitive to a bad coolant than an aluminium heat exchanger is.



SOLUTION: CUPROBRAZE TECHNOLOGY - cont'd

• **Strength at elevated temperatures**

Copper and brass are much stronger and less temperature sensitive than aluminium.

Fig 5: Strength vs. Temperature for Typical Alloys for brazed heat exchangers in Aluminium and Copper

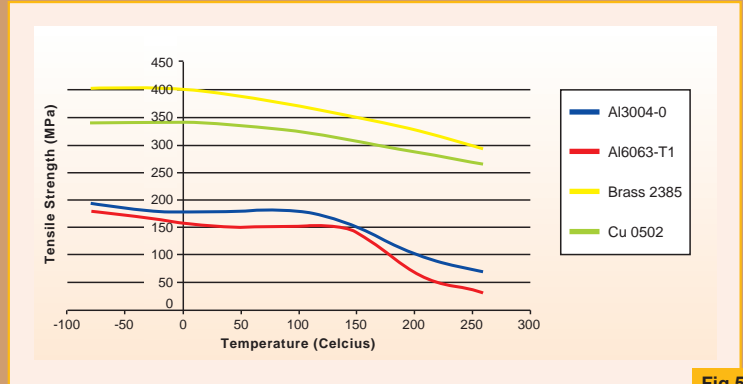


Fig 5

• **Lower thermal stresses**

Copper and brass have lower thermal expansion than aluminium. This creates less thermal stresses both in the manufacturing process and in the final application of the heat exchanger.

• **Withstands internal pressure**

The thin gauge high strength materials make the heat exchangers more flexible thus reducing stresses.

Fig 6: CAC cross section

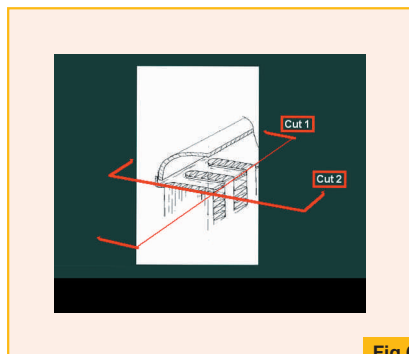


Fig 6

Fig 7: Al Case, Cut 1

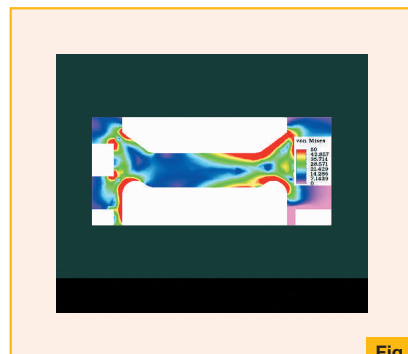


Fig 7

Fig 8: Cu Case, Cut 1

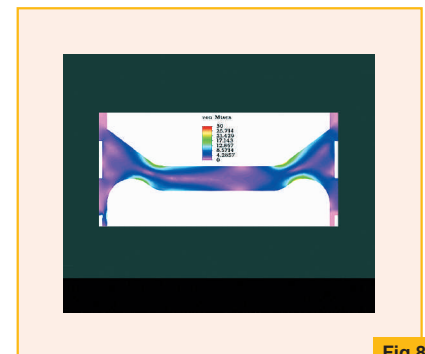


Fig 8

[A copper/brass heat exchanger is less sensitive to a bad coolant than an aluminium heat exchanger is.... Copper and brass are much stronger and less temperature sensitive than aluminium.]



CuproBraze[®] a new, better process
to make heat exchangers



CONCLUSION

It is clear that all vehicle manufacturers are no longer satisfied with the durability and reliability of existing aluminium heat exchangers.

This is because heat exchangers are subject to high temperatures, pressures and corrosive environments and thus need to have higher corrosion resistance and strength than current aluminium heat exchangers.

The solution is to use *CuproBraze* technology in the manufacture of heat exchangers. The combination of copper and brass in such heat exchangers offers higher corrosion resistance and greater strength.



Useful References:

www.dieselnet.com

An online information service on diesel emissions, emission control, diesel engines, fuels, and more...

www.sae.org

Website of The Engineering Society for Advanced Mobility in Land, Sea, Air and Space.

www.behrgroup.com

Website of Behr GmbH & Co, a specialist in environmentally compatible vehicle air-conditioning and engine cooling. Behr is one of the leading original equipment manufacturers for passenger cars, commercial vehicles.

www.narsa.com/acj/

Automotive Cooling Journal of the U.S. National Automotive Radiator Service Association

www.copper.org

A service of the U.S. Copper Development Association

Resources:

For more information about *CuproBraze*, free literature and technical tips, you can look up the website of the *CuproBraze* Alliance at:

www.CuproBraze.com

If you have any questions or requests for information, you can email to: Info.cuprobrazecuprobraze.com

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