

EXECUTIVE Report

Brazed Copper-Brass Simplifies Charge Air Cooling System for Clean Diesel

New Materials Technology Results in Fewer Parts, Superior Performance and Cost Savings

The control of emissions from diesel engines drives the development of higher pressures of charge air. Since pressure and temperature rise together in a compressor, charge-air temperatures after the compressor are higher too.

Current CAC designs are becoming obsolete because of the high pressures and high temperatures reached by modern compressors with variable inlet geometry and dual compressor systems. Current CAC designs use brazed aluminum cores, but aluminum loses its strength at elevated temperatures, so manufacturers are facing challenges in the design of CAC systems.

There are two ways to solve this problem of excess pressures and temperatures. The first uses current aluminum CAC technology with a pre-cooler. The other depends on copper and brass alloys that are brazed using the CuproBraze® technology. These alternatives will be referred to as the “Pre-cooler solution” and the “CuproBraze solution,” respectively (Fig. 1a and 1b).

This article can only outline a basic cost comparison. Nonetheless, it clearly shows the potential cost savings for the CuproBraze solution compared to the Pre-cooler solution, even when many of the performance advantages of CuproBraze technology are not included in the analysis.

Comparison of Cooling Systems

First it is necessary to compare the cost of an aluminum-CAC (for the Pre-cooler solution) versus a copper-brass CAC (for the CuproBraze solution). For a given cooling performance, a larger CAC heat transfer area is required for the CuproBraze solution compared to the Pre-cooler solution. By weight, about 25 percent more material must be added to the core. Historically, copper costs more than aluminum per unit weight, so differences in metal prices must be factored into the calculations.

Fig. 1 – In the near future, higher charge air temperatures will mandate the use of (a) a pre-cooler to cool the charge air before it reaches the temperature-challenged aluminum CAC; or (b) the conventional approach (no pre-cooler) with a copper-brass CAC.

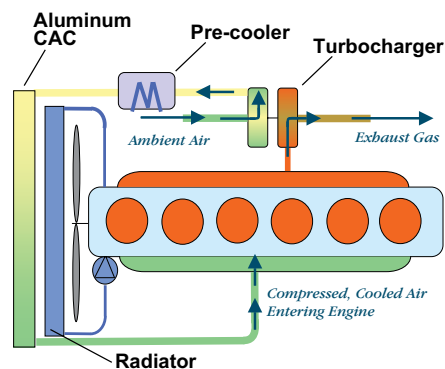


Fig. 1a – Aluminum CAC System Schematic

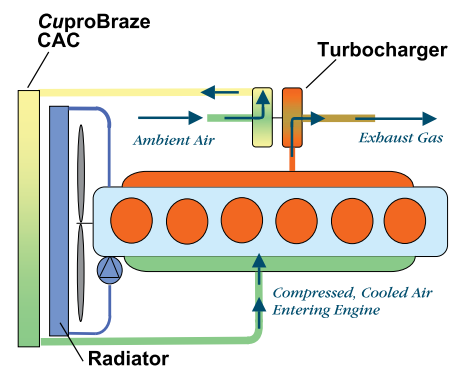


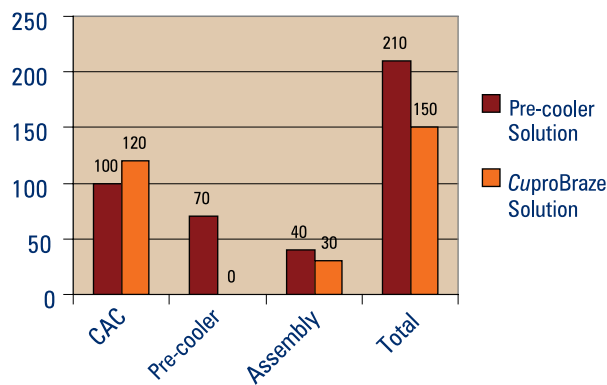
Fig. 1b – CuproBraze CAC System Schematic

The International Copper Association, Ltd. (ICA)

is the leading organization for the promotion of the use of copper worldwide. The Association's twenty-nine members represent about 80 percent of the world's refined copper output, and its six associate members are among the world's largest copper and copper alloy fabricators. ICA is responsible for guiding policy, strategy and funding of international initiatives and promotional activities. With headquarters in New York City, ICA operates in 28 worldwide locations through a network of regional offices and copper development associations.

For general mailing information about the CuproBrazed process or ICA's CuproBrazed consulting services, please contact International Copper Association at: mrosario@copper.org. For technical information contact: cuprobrazed@copper.org. For European inquiries contact: ndc@eurocopper.org.

Figure 2 The CuproBrazed solution (with no pre-cooler) is more cost-effective than the Pre-cooler solution (with aluminum CAC). These costs are in normalized units that are indexed relative to the cost of an aluminum CAC (which is assigned a normalized cost of 100 units).



100 for the CAC + 70 for the pre-cooler + 40 for assembly = 210 total. The last pair of bars in the bar chart approximates the total cost comparison.

Savings to Truck Makers

These cost estimates suggest that the CuproBrazed solution is good for the bottom line. It could significantly reduce overall costs

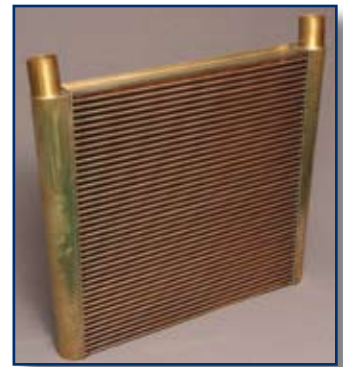
compared to the Pre-cooler solution. As a first approximation, the CuproBrazed solution can save the truck maker around

$$\frac{210 - 150}{210} = \frac{2}{7} \approx 28\%$$

In order to assign some hypothetical monetary values to these relative savings, consider what the savings would be if the Pre-cooler solution costs, say, 525€. Then the CuproBrazed solution might cost 375€. A truck manufacturer producing around 40,000 units per annum would save six million Euros per year, which is a substantial amount to add to the bottom line.

Counting on Superior Performance

The single CAC system offers many other advantages. It requires less under-the-hood space, installation is less complicated and it has fewer parts than the alternative. All of these factors and trade-offs must be considered in design decisions.



A brazed copper-brass CAC delivers the superior performance required for clean diesel engines.

The superior performance of copper and brass is the reason for the reduction in total system cost described above. Strictly speaking of performance, comparing a CuproBrazed CAC directly with an aluminum-CAC, the former is clearly superior with regard to durability, temperature tolerance and cooling efficiency. CuproBrazed CACs are more resistant to fatigue and vibration than aluminum CACs [1,2]. The value to the OEM in terms of customer loyalty and its reputation for quality cannot be estimated with such simple calculations as presented above.

Whatever the application, CuproBrazed technology is a leading candidate for meeting the demands for effective cooling solutions today and even more so in the future. OEMs around the world are realizing that it delivers superior quality and saves money. And that combination is tough to beat! ■

References

1. International Copper Association, CuproBrazed Executive Report Number 41, "New Designs of Charge Air Coolers Increase Performance and Durability, Part I: Laboratory Testing Verifies Claims of Durability and Efficiency," available online at www.cuprobrazed.com/lit_er.asp.
2. International Copper Association, CuproBrazed Executive Report Number 42, "New Designs of Charge Air Coolers Increase Performance and Durability, Part II: Laboratory Testing Aids in Design Improvements. Available online at www.cuprobrazed.com/lit_er.asp.

See www.cuprobrazed.com for additional materials suppliers, equipment makers and heat-exchanger manufacturers.