Materials

Brazed copper-brass reduces odors from mobile air conditioners
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Vintage Air makes a climate control system that is popular with OEMs as well as the aftermarket. Brazed copper-brass technology allows for a compact and durable heat-exchanger core.

As engineers look at the complete picture of technology, copper is becoming attractive once again as a material for mobile air conditioners (MACs). This change is driven by at least five factors:

• Bad odors from aluminum

• New environmental regulations driving a change to new refrigerants

• High-pressure systems based on CO_2 as a refrigerant are under development; copper is stronger than aluminum and has better thermal conductivity

• A new environmentally friendly brazing process for copper-brass components

• The development of innovative heat-exchanger designs

In MAC applications, aluminum components have been plagued by bad smells. The odor from aluminum evaporators has been a topic growing in interest since the late 1990s. Research originating in Japan, the U.S., and France suggests that MAC odors are a worldwide problem.

Component manufacturers have sought to overcome the problem with various coatings, but a satisfactory solution has been elusive. Yet, the solution might have been right “under their noses” for years. Vintage-style MACs with copper

components generally do not suffer from this odor problem.

Copper metal evidently possesses a property that resists the growth of such microorganisms. It has long been “common knowledge” that germs do not thrive on copper surfaces, but until very recently it has been very difficult to offer objective validation of this claim.

Over the past couple of years, the **International Copper Association** and the **Copper Development Association** funded an extensive series of tests to determine if there is any foundation to antimicrobial claims. The experiments were conducted by an **EPA**-certified, third-party laboratory, and the results did indeed confirm what many in the industry suspected all along: Copper has remarkable antimicrobial properties, although the exact mechanism for these properties remains undetermined.

In March 2008, the U.S. EPA approved an application to market a group of copper alloys, including brass and bronze, as having well-defined antimicrobial properties. The approval is the first time that the EPA has allowed health claims to be attached to a solid antimicrobial material rather than a liquid or aerosol disinfectant.

Regarding refrigerants, their ozone depleting potential (ODP) was significantly curtailed thanks to the banning of R12 refrigerants, which contain chlorofluorocarbon (CFC). Each molecule of CFC contains two chlorine atoms, and each chlorine atom has the potential for reducing 100,000 ozone molecules.

Today, R12 refrigerants have been widely replaced by R134a, a hydrofluorocarbon with the formula C2H2F4. The ODP of R134a is zero. Although R134a has a global warming potential (GWP) of only 1420 compared to the 10,700 GWP of R12, the European Union has passed legislation to limit the GWP of refrigerants to levels below 150, effectively phasing out the use of R134a between 2011 and 2017.

A likely substitute is R152a, a hydrofluorocarbon with the formula C2H4F2, which has a GWP of 120 to 140. A major difference between R134a and R152a is that the latter is flammable, so R152a can only be used in the engine space and not in the passenger space. Typical designs include a secondary loop with a water-glycol mixture. A successful MAC design based on R152a technology would be an acceptable solution for the foreseeable future.

In addition, **Honeywell** developed an alternative refrigerant, HFO-1234yf, for use as the main constituent of its Fluid H. HFO-1234yf is a low-GWP hydrofluorocarbon with the formula C3H2F4. **DuPont** and Honeywell have agreed to cooperate on this alternative refrigerant.

Another promising candidate refrigerant is carbon dioxide, also known as R744. Carbon dioxide is environmentally ideal; there would be no contribution to global warming since it would be extracted from industrial waste for use as a refrigerant.

New CO_2 MAC designs have been under intense development for the past 15 years or more. The technology is challenging. For example, these systems require a gas cooler instead of a condenser, an internal heat exchanger, and an evaporator. Nonetheless, working air conditioners have been developed, and the likelihood for success is high.

As new air conditioners are developed, new designs of copper-brass heat exchangers for condensers, gas coolers, and evaporator (vaporizer) units are being considered. A new multitube design made from copper strip could be used for the air cooler, which expels the heat from the compressed CO_2 gas prior to storing the CO_2 as a pressurized liquid in an accumulator. Copper-brass designs are also available for the evaporator components.

Perhaps the wild card in the game of materials selection is availability of

CuproBraze technology for brazing copper-to-copper, brass-to-copper, and brass-to-brass. This brazing process produces joints that are much stronger than soldered joints. Also, brass is much stronger than aluminum, so components can be produced that are durable enough to withstand the high pressures associated with R744 air-conditioner designs.

The strength and thermal conductivity for the copper-brass materials are superior to that of aluminum. The result is more compact designs of air conditioners, which could be an important factor for the new refrigerant.

Copper is proving to be a tough competitor for large heat exchangers, where its high cooling efficiency and durability trumps other factors. Presently, the CuproBraze production process is well understood and manufacturers are producing heat exchangers in volume. For the smaller heat exchangers used in MACs, the same advantages may favor copper over aluminum.

For MACs, comparing the antimicrobial properties of copper with the odor problem of aluminum provides one other compelling reason to select copper.

Nigel Cotton, Automotive Manager, International Copper Association, wrote this article for Automotive Engineering International.

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