APPLICATION DATA SHEET

COPPER • BRASS • BRONZE

Intrinsic Antimicrobial Properties of Copper in HVAC Applications

Copper and copper alloy metal surfaces have an intrinsic ability to inhibit the growth of algae, fungi/molds, viruses and bacteria. Studies confirm that these surfaces are effective antimicrobial agents that kill microbes within hours.

In today's modern buildings, concerns about exposure to toxic microorganisms have created a dire need to improve the hygienic conditions of heating, ventilation and air conditioning (HVAC) systems, which are believed to be factors in over 60% of all sick building situations (Collet and Associates). The combination of copper's superior resistance to mold growth and excellent thermal conductivity can improve the energy efficiency of the systems in which it is installed.

Using antimicrobial copper and copper alloy metals instead of biologically inert materials in heat exchanger tube, fins, filters and condensate drain pans is recommended as a viable and cost-effective means to help control the growth of fungi and bacteria that thrive in these dark and damp components of HVAC systems.

The antimicrobial properties of uncoated copper and copper alloy metals are continuously effective and do not diminish over time. In fact, they are enhanced with the natural formation of a self-protective corrosion film (tarnish) (Michels 2005). Improvements to indoor air quality are also anticipated.

Prominent pathogenic risks in HVAC systems include *Legionella*, sp, and molds, such as *Aspergillus niger.*

Aspergillus niger: Dr. C.W. Keevil, of the School of Biological Sciences at the University of Southampton, U.K., placed *A. niger* spores on aluminum and copper coupons and kept them at a temperature of 20°C. After six hours, all spores on the aluminum were viable, while on the copper all spores were rendered nonviable (**Figure 1**). In separate testing, *A. niger* spores in nutrient broth were placed onto aluminum and C11000 (99.9% copper) copper. After 10 days of incubation at 37°C, there was no observable spore germination on the copper surface, while hyphae formation was clearly visible on the aluminum surface (**Figure 2**).

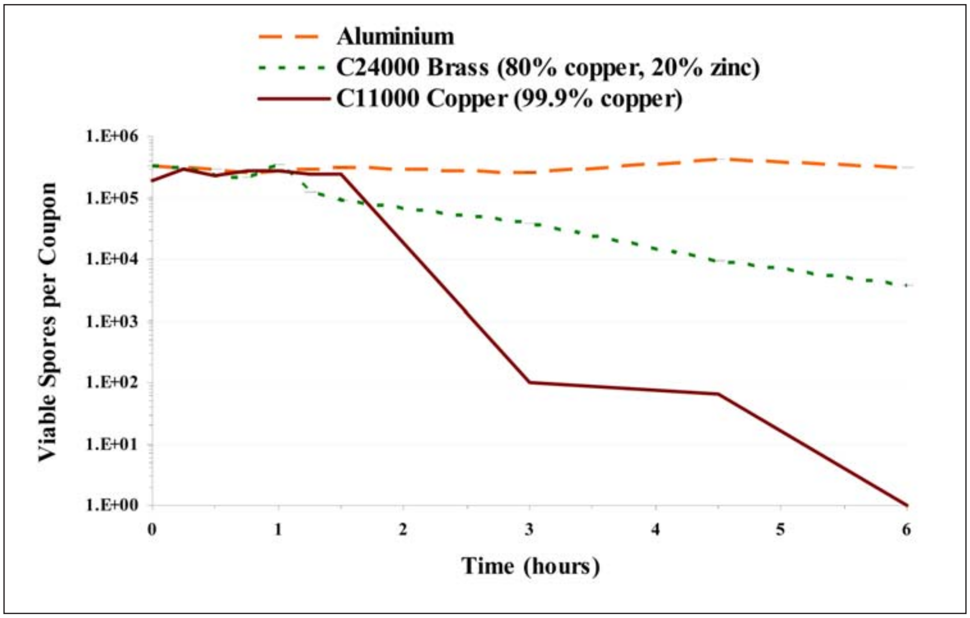

Figure 1. Viability of *Aspergillus niger* on aluminum, C24000 (brass) and C11000 (copper) at 20ºC

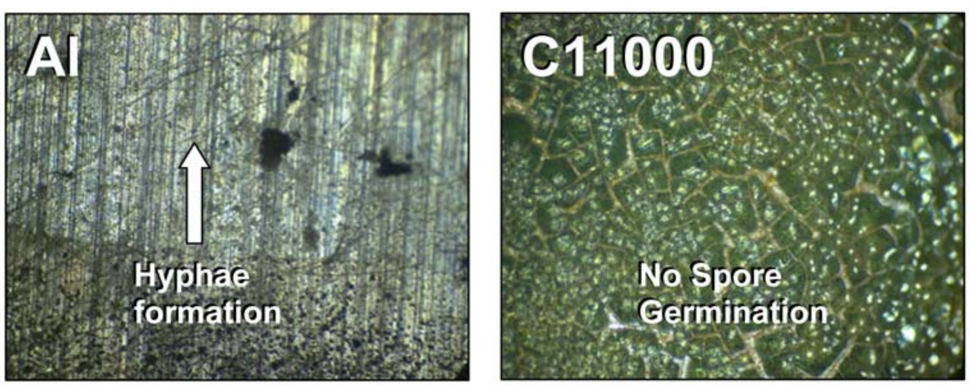

Figure 2. *Aspergillus niger* spore germination on aluminum and copper. A fungal broth of 10^6 spores were placed onto aluminum and C11000 copper, incubated at 37°C (image taken at 100X) after 10 days. No spore germination was observed on the copper, while hyphae formation was clearly visible on the aluminum.

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Keevil also tested the viability of Methicillin-resistant Staphylococcus aureus, an antibiotic-resistant "superbug" on several copper alloys (**Figure 3**). He found that pure copper (C19700, 99% copper), can eliminate a concentration of 10^7 of these organisms within 90 minutes, while brass (C24000, 80% copper, 20% zinc) does it in four and-a-half hours. Stainless steel, however, showed no reduction after six hours (the full duration of the test) (Michels 2005).

Other independent laboratory tests conducted for the U.S. Environmental Protection Agency, preparatory to submission of application for registration of health claims show that copper alloys, containing greater than 65% copper, eliminate 99.9% of the following pathogens: *Staphylococcus aureus, Enterobacter aerogenes, Escherichia coli* O157:H7, Methicillin-resistant *Staphylococcus aureus* (MRSA) and *Pseudomonas aeruginosa* within two hours. Studies conducted on Adenovirus, Influenza A and *Listeria* show similar results.

L. pneumophila: It was demonstrated that biofilms of high species diversity can be generated reproducibly for many months on a range of plastic and metal materials and that *L. pneumophila* can survive and grow in the biofilms, even at temperatures up to 50°C on plastic surfaces *but not on copper* (Keevil 2002). The authors were able to show the hierarchy of biofouling activity, with copper the best material and some of the metal and plastic surfaces demonstrably the worst (**Table 1**). These findings support the use of copper, rather than stainless steel or plastic, for evaporator drain pans.

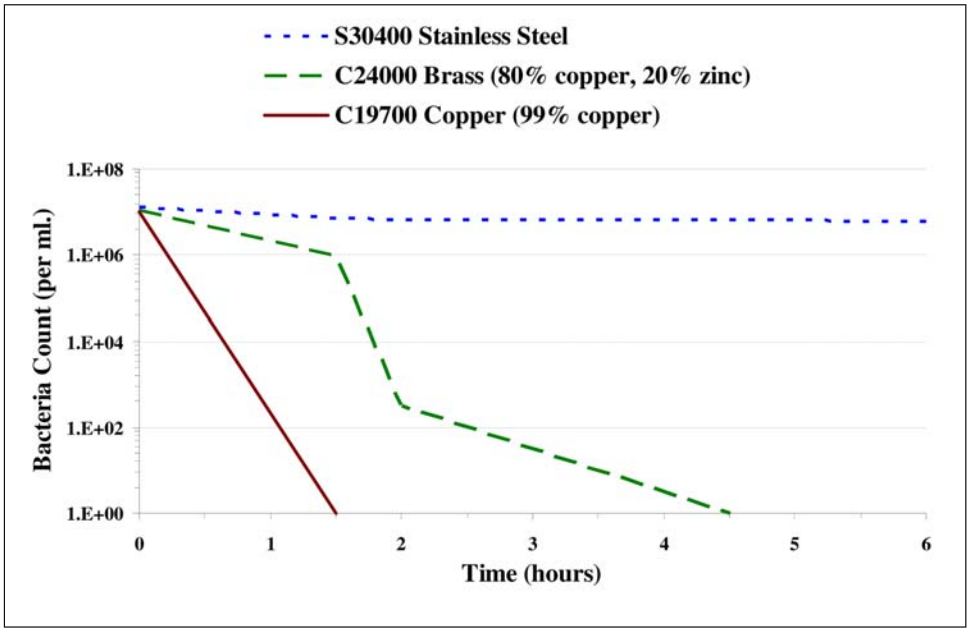

Figure 3. Viability of MRSA on C19700 (copper), C24000 (brass), C77000 (nickel-silver), and S30400 (stainless steel) at 20ºC

Table 1. Comparison of plumbing materials to biofoul and support colonization by *L. pneumophila* at 30ºC in a medium-hard drinking water

Material	Maximum Colonization		Colonization Ratio	
	non-*legionellae*	*L. pneumophila*	non-*legionellae*	*L. pneumophila*
Copper	70	0.7	1	1
Glass	150	1.5	2.1	2.1
Polybutylene	180	2.0	2.6	2.9
Stainless steel	210	10	3.0	14.3
Polyethylene	960	23	13.7	33
uPVC	1070	11	15.3	15.7
cPVC	1700	78.5	24.3	112.1
Steel	4900	450	70	642
Ethylene-propylene	27000	500	386	714
Latex	89000	550	1271	785

[a]Colonization units are 10^3 cm^{-2}. The colonization ratio is the CFU of the total microbial flora or *legionellae* recovered from each material compared with the copper data.

References:

Christopher Collett & Associates Ltd., indoor air quality specialists, Surrey, British Columbia, Canada, (604) 535–4215, *http://chris.collett.net/sick-buildings.htm*. accessed January 5, 2007.

Michels, H.T., *et al.,* "Copper Alloys for Human Infectious Disease Control," Copper for the 21st Century Symposium, held at Materials Science and Technology Conference, September 25-28, 2005, Pittsburgh, Penn.

Keevil, C.W. (2002). Pathogens in environmental biofilms. The Encyclopedia of Environmental Microbiology (ed. G. Bitton). New York: Wiley, 2339-2356.

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