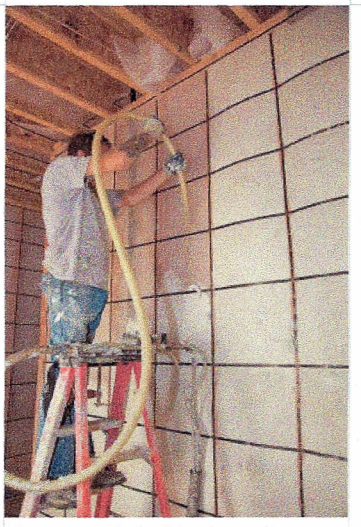
"What About Air Krete?" A Deeper Look at the Insulation Alternative

The foamed magnesium oxide cement is often seen as a blue-ribbon contender for least-toxic insulation. But the manufacturer falls short in providing key metrics.

By Tristan Roberts

When discussing the challenges of finding a healthy, high-performing, affordable product amongst today's insulation materials—and in particular, in confronting the environmental performance of spray polyurethane foam (SPF)—we are often asked, "What about Air Krete?"

Going back to 1997 (see "Air Krete: Foam Without Plastics"), *EBN* has generally endorsed the use of Air Krete, with some caveats. On the plus side, it insulates about as well as other common fibrous insulation materials (at about R-3.7 per inch); is spray applied and flows into small voids particularly well; and, most notably, is primarily inorganic cement, containing no flame retardant chemicals, and being inert to insects, fire, and moisture.



The company behind Air Krete, a foam insulation made of 98% cementitious materials, is claiming that it insulates to an impressive R-6/inch with a new formulation—up from R-3.7. Air Krete is installed in cavities such as behind webbing as shown here.

Recent changes in the product's distribution as well as dramatic changes in the company's performance metrics led us to reexamine Air Krete, however, and we're concerned about the accuracy of some of the company's new claims.

More bubbles, more R-value

The most striking claim currently being made by Air Krete is that it offers an insulation value of R-6 per inch. That's pretty high—much higher than the R-3 to R-4 values that we expect from most other building insulation materials.

The basic formula to make Air Krete uses compressed air, heated water, and magnesium oxide (MgO) cement combined in a special rig onsite and sprayed into wall or ceiling cavities. As Bill Szabo, vice president for Air Krete, based in Weedsport, New York, describes it, "Air Krete is billions of uniform-sized soap bubbles with a coating of magnesium oxide cement on the surface of those soap bubbles." It comes out of a spray rig feeling like "gritty shaving cream," and as it cures and dries out over a period of weeks, it has "the look, feel, and consistency of dried sponge

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cake," according to Szabo—if sponge cake had a greyish-blue hue.

To achieve the new, higher R-value, R. Keene Christopher, the CEO and co-inventor of Air Krete, told *EBN* that the installation procedure has changed substantially. He explained that the Air Krete material is pushed through successively finer mesh screens and glass beads, ultimately resulting in "more bubbles per cubic inch." In addition, those bubbles are being strengthened by an additional pozzolan. "We are not only making a finer cell but capturing it better than before," says Christopher.

Szabo said that Air Krete applied for new patents in the fall of 2013 and has been converting its installers over to new spray rigs. As always, Air Krete has very little structural integrity and is intended for cavity installation only—in masonry walls, wall cavity retrofits, or behind insulation mesh like that used for blown cellulose.

Will the real R-value please stand up?

A stronger, reformulated, higher-insulating Air Krete is an exciting development—or should be. The only trouble is that Air Krete has used an unorthodox testing method to demonstrate the R-6 result and may even be in violation of Federal Trade Commission rules for how insulation sold to consumers must be tested. Those rules require testing according to one of several ASTM standards, the most commonly used being ASTM C 518-04, "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus." Yet Air Krete, whose website trumpets "NEW High R Value of 6.0 per inch makes airkrete insulation the top competitor in insulations," (sic) has published two test results to back that (dated Oct. 2013, June 2013), with neither one citing any ASTM method.

Both tests, by Dynalene Laboratory Services in Pennsylvania, use the "transient line source heat methodology" to show an R-value of 18 for a 3-inch Air Krete sample. The tests were done with a temperature probe designed for testing thermal conductivity of soils and minerals, according to Christopher. Also known as the "heated needle" technique, the probe creates a burst of heat and then measures the rate of transmission of that heat with an adjacent probe. Christopher says that the method is compliant with ASTM standards for testing conductivity of soil and rock, and the company making the probe is working on ASTM approval for insulation, something "we expect momentarily," he said.

Asked why Air Krete isn't using the standard ASTM C518 test (as it has done in the past to establish its R-3.7 value—see those results), Christopher complained that C518 "has never worked well" for Air Krete. It is "so light and friable," he said, that "sealing around the edges" of the test apparatus has always been a problem. He noted that Air Krete is mostly mineral content, making it appropriate for use with the thermal probe.

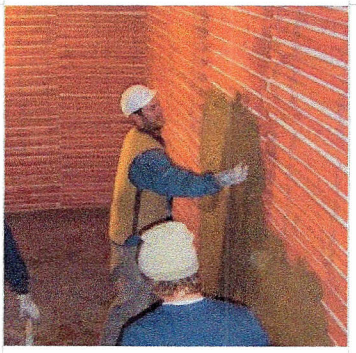
That doesn't make sense, David Ober, an independent building science consultant based in North Carolina, told *EBN*. C518 equipment has been the standard for measuring the thermal performance of all types of insulating materials for years; it simply measures heat flow through a monolithic material placed between two plates under steady-state conditions, and it is designed to be well insulated and guarded around the edges, according to Ober. (And it's not clear why Air Krete would have unique problems with C518, compared with any other fibrous insulation material like cellulose, fiberglass, or foam.)

"The insulation industry uses C518 equipment day in and day out in their plants to measure the thermal characteristics that are produced," with each testing taking at least one to several hours to perform, says Ober. "It would be ideal if the probe method would work and a reliable answer could be obtained in ten minutes. But so far that has not been the case."

EBN spoke with G. Todd Vanek, thermal market manager for Decagon Devices in Pullman, Washington, which makes the KD2 Pro device that Air Krete's R-6 results rely on. Vanek confirmed that "there is no ASTM standard for the heated needle technique in insulation." He

said that the company was embarking on a research project that would verify the performance of its sensors in insulation products. That research would use the company's sensors to measure insulation materials with known R-values. He said that the company was "comfortable with our results" currently but was prepared to make calibrations on its devices if the company or other researchers found inaccuracies. "If the results aren't perfect, we can make adjustments so they are," he said.

Ober isn't convinced. "The FTC rule works really well." He says, "If it really has R-6, put it through a C518 [test]. In two or three hours of testing, you'll know."



This installation at the Haliburton Highlands Museum in Haliburon, Ontario, was a great fit for the existing building, says Chris Magwood of Endeavour Centre. Air Krete, he says, "has lots of great advantages, including being non-toxic and having a great R-value, low embodied energy, and easy installation." Here clay plaster and wood lath are installed over Air Krete.

Is R-6 plausible?

Test methods aside, Ober argues that it's not clear on a physical basis how Air Krete can achieve R-6. Polyisocyanurate insulation, which can achieve R-6, is a foamed plastic in which the pores have been filled with a low-conductivity gas, reducing the heat transfer that would normally take place across air molecules in those pores. Another approach to achieving R-6 or better is with aerogels, which are small enough to isolate individual air molecules, preventing them from bumping into each other and conducting heat.

Christopher told *EBN* that he did not know the size of the pores in the reformulated Air Krete; he could only guess that they were very small based on the mesh screens. According to Ober, achieving nanosized insulation pores is a specialized process that Air Krete was not likely achieving with equipment in the field (nanogels are made in factory settings). "The [plastic] foam guys aren't any closer to doing it either," he said. Ober also doubts that such performance is achievable with only 2.5 pounds per cubic foot (pcf) of material, as is being used.

John Straube, Ph.D., P.Eng., of Building Science Consulting in Waterloo, Ontario, echoed those concerns. Reviewing Air Krete's older R-value test results showing R-3.7, he told *EBN*, "That is pretty good, but believable, as it is right on the curve of density-versus-R-value for a wide range of products." R-6 is hard to believe, says Straube.

Air barrier?

While they're at it, Szabo and Christohper could perform testing in accordance with Air Barrier Association of America (ABAA) standards to establish whether Air Krete is an air barrier. Because of its reputation for friability, lack of adhesiveness to framing, and lack of test data, *EBN* has assumed that it is not an air-barrier material.

Szabo, however, told *EBN* that Air Krete is an air barrier, and that "it's on our list to get that [testing] done." In the meantime, Szabo offered to provide before-and-after blower-door testing from a home with Air Krete installed in roof slopes, showing reduced air infiltration. However, filling cavities with insulation materials such as cellulose could be expected to reduce overall air infiltration, even though cellulose is not an air barrier.

Ingredients not clear

Air Krete has not been forthcoming about its product formula, even as the product transparency movement (see "The Product Transparency Movement: Peeking Behind the Corporate Veil") has raised expectations that environmentally progressive companies will be more forthcoming about the chemistry they use.

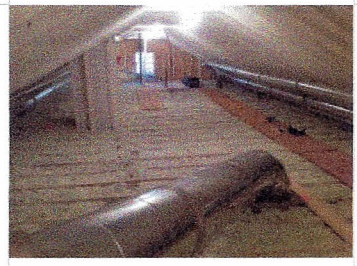
Air Krete's marketing emphasizes that its basic ingredients are "air, water, and MGO cement," but there seem to be other ingredients in the mix. Asked about Air Krete's formula, Christopher at first referred only to a State of Connecticut test showing that the product is 98% mineral content. Asked if there were other ingredients, he said they were "minimal," but, pressed by *EBN*, stated that it is "fair to say there's 2%" organic compounds—that is, most likely some kind of plastics or other non-mineral-based ingredients.

Emissions testing out of date

If Air Krete isn't yet on board with transparency programs like Declare or the Health Product Declaration format, providing solid emissions tests results might help reassure consumers that it is little more than just cement. Air Krete's main emissions test, conducted in 2009, is based on ASTM D5116 and concludes, "Neither formaldehyde nor volatile organic compounds are emitted." Unfortunately, that's not a useful test result, according to an indoor air quality testing expert from one of the nation's best-known laboratories, who spoke with *EBN* anonymously on the basis that he didn't want to disparage another laboratory's work.

The expert noted that D5116 is a guideline setting certain parameters for emissions testing: "It's not a test method." Moreover, he said, "I don't believe the specific measurement techniques that they used in the test report are in compliance with D5516, certainly not the state of the art." The current state of the art for emissions testing of green building products is CDPH Standard Method (sometimes referred to as California Section 01350), which is used by reputable third-party emissions certifications like Greenguard and SCS Indoor Advantage.

One key difference between the method used by Air Krete's test and a more standard method is how VOCs (volatile organic compounds) are collected and analyzed. In Air Krete's test, VOCs were collected and analyzed in two ways: a water dish was placed with Air Krete in a chamber, and the change in color of the water was used to detect the presence of VOCs. Secondly, VOCs were extracted from that water by a charcoal filter and then in turn by solvents, before analyzing them with gas chromatography–mass spectronomy. Neither method of detection is very sensitive, according to the expert *EBN* spoke with.



Occupants of the Robertson residence in Georgia are complaining about strong odors from this attic installation of Air Krete. In speaking with other installers and projects, *EBN* could not identify problems of a similar nature. Unfortunately it was hard to put such concerns to rest in part because the manufacturer is not forthcoming with Air Krete's emissions or ingredient information.

A more up-to-date method in compliance with CDPH is to use a cartridge to adsorb VOCs, then pull them off the cartridge with heat rather than solvents, and then analyze the results with spectronomy.

Basically, he said, "It's not clear what chemicals they looked for, and it's not a very sensitive analysis." He added, "This test doesn't indicate that it's a bad product; they just don't have any story related to emissions." A CDPH Standard Method test would cost Air Krete about $3,000, said the expert—not a huge sum for a company marketing a product nationally on the basis of being chemically inert.

As with the R-value claim, Air Krete may very well have low or no emissions, but the company isn't doing a very good job of proving it.

Is something being added to Air Krete?

Throughout *EBN*'s investigation of Air Krete, a question persisted that clashes with the product's image as an inert insulation material: what is that 2% organic material that Christopher refers to, and might it cause harmful emissions?

The question was first raised by an Air Krete customer—the Robertson residence in Georgia (the homeowner did not want to divulge personal details out of concern for privacy). The customer complained that Air Krete, installed in an attic in November 2012, smelled unpleasant—"like latex caulk"—and caused queasiness and other health effects in anyone who spent time in the attic or downwind of the attic hatch. *EBN* received a small sample of the product installed in Georgia, and while there was a very faint odor coming off the product (distinct from the earthy smell one could expect from drying concrete), we couldn't tell how significant it was (or would be in a closed attic).

EBN spoke with the contractor, Reid Hipp of Energy Logic in South Carolina, who confirmed installing Air Krete at the project but denied that there was any issue. Asked if it was possible that a licensed Air Krete contractor would doctor the formula and add content associated with emissions, Christopher told *EBN* that licensees have the right do that, but he didn't have any knowledge that it was happening.

Two other Air Krete contractors *EBN* spoke with—Greg McMillan of California (who installed Air Krete for 20 years but no longer does), and Douglas Palmer of Maryland, with 32 years of Air Krete experience—said that it was implausible that someone would successfully alter the formula onsite. "Combining the materials is a very meticulously laid-out system," says McMillan, who noted, "I have never experienced any kind of odor."

According to Palmer, "You can't mess with it. It works very well if you leave it be. If you start screwing with it, it does not work at all." He explained that if a hose is kinked, for example, the installer will quickly see that the air bubbles are not forming properly and can fix the problem.

Where there's smoke, what's burning?

As a cement product, Air Krete is not supposed to burn—a major selling point. Online videos show people putting a blow torch to Air Krete—and basically nothing happens, which is just what Christopher and Szabo said should be the case.

Air Krete is mostly cement: it's not supposed to burn. When we applied a blowtorch as shown here to these Air Krete samples provided by the manufacturer and by the Robertson residence in Georgia (on the top and the bottom, respectively), the insulation smoked mildly, browned in spots, and developed a coating of white ash. The samples did not appear remotely close to bursting into open flame, but the test clashes with the company's marketing of the product as completely inert.

Oddly, that wasn't exactly our experience. *EBN* received an Air Krete sample from the Robertson residence in Georgia and an additional sample directly from Air Krete in New York. When exposed to a handheld blowtorch, both samples gave off some smoke. At a close distance, it emitted an acrid odor, browned, and developed white ash on the surface (see photos). Asked why this would occur, Christopher wasn't sure; he said that he is constantly doing research and development, and perhaps he sent us the wrong sample. He offered to send a new one—which hadn't yet arrived at press time.

While neither sample seemed remotely in danger of bursting into flame—consistent with the company's claims—the samples' responses to flame seemed to indicate that they contained more than just cement.

For one more angle on what might be in Air Krete, we consulted the Pharos building product and chemical library as well as its senior researcher, Jim Vallette of the Healthy Building Network. Since Air Krete has not engaged with Pharos, the Air Krete information there is based on patent research and other public documents. Pharos lists several organic compounds as possible ingredients in Air Krete, but the main concerns that come

up in Pharos have to do with the cement content—the toxicity of residuals in the cement or emissions during cement production. Vallette told *EBN* that his greatest concern about the chemistry was that Air Krete might contain isocyanates, a toxic ingredient in spray foam, but Christopher told us that is not the case.

Confronting cost and distribution

The uncertainties we found with Air Krete aside, it has some wind in its sails with a new distribution agreement through the Dr. Energy Saver network of home improvement contractors. Mike Rubin, product manager for Dr. Energy Saver, based in Connecticut, said that of the 80 contractors the company works with, a handful have started offering Air Krete. "There's a ton of interest, and I really feel like it's about to get blown wide open," he said, noting, "Air Krete didn't have the marketing support that it needed" prior to the new agreement taking effect in 2013. He said that "Air Krete is top of the list" for customers looking for safe insulation materials. At Air Krete headquarters, Szabo said the company would also continue to work directly with its network of 25 to 30 dealers.

Among professionals *EBN* spoke with, demand for Air Krete appeared limited to specialty projects. Palmer said he had three types of customers: those with multiple chemical sensitivities, who might only do one "safe room" in a home to limit expense; those with financial means looking for the greenest product (former Vice President Al Gore falls in this category, with Palmer having insulated his Tennessee residence); and those needing a retrofit for which Air Krete is a good performance fit due to its ability to flow into small voids.

Installed costs for the product vary, with Rubin quoting about $4/ft^2$ for a first-floor 2x4 wall, or $1 per board foot. Palmer said he charged from 80 cents a board foot to $2, depending on project specifics. Other cost estimators have quoted us $2.45/ft^2$ for a 2x6 wall, or less than 50 cents a board foot. Those prices put Air Krete well above products like fiberglass and cellulose in cost but competitive with or cheaper than rigid foam or spray-applied foam.

What's ahead for Air Krete?

We can hope that better days are ahead for Air Krete: that the company can do a credible update of its thermal performance and emissions tests, participate in an ingredient disclosure program, and continue to grow its distribution network while maintaining quality assurance. If it can do these things, we remain enthusiastic about its place in the green building industry.

April 2, 2014

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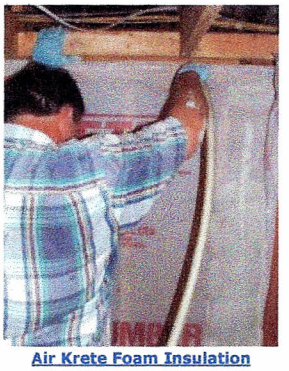

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