Sealing HVAC Ducts:
Use Anything But Duct Tape

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BERKELEY -- You can keep your trouser cuff out of your bicycle chain with duct tape; if you need a money belt, you can use it to strap your money to your tummy. Some people claim they can cure warts with it. Unfortunately, one of the things you can't do with duct tape is seal ducts.

At least not for long, according to Max Sherman and Iain Walker of the Department of Energy's Lawrence Berkeley National Laboratory. For three months they tested a variety of sealing materials -- many kinds of duct tape, clear plastic tape, foil-backed tape, mastic, and injected aerosol sealant -- under conditions similar to those encountered in real heating, ventilating, and air-conditioning (HVAC) systems.

"We tried as many different kinds of duct sealants as we could get our hands on. Of all the things we tested, only duct tape failed. It failed reliably and often quite catastrophically," says Sherman, who heads the Energy Performance of Buildings Group in Berkeley Lab's Environmental Energy Technologies Division (EETD). "On the other hand, while duct tape may not last long as a sealant, in the short run it is strong, sticky, and fairly easy to use."

Accelerated testing shows that fabric-backed tape with rubber adhesive tends to fall off.
Photo credit: Iain Walker

Also see Max and Iain's duct tape website

During World War II, before it was called duct tape, the U.S. military bought quantities of the cloth-backed, rubber-adhesive tape for making emergency repairs on the battlefield. In the movie business it's called "gaffer's tape," used for everything from bundling cables to holding sets together. Contractors, however, are not supposed to use it for structural purposes, such as suspending ducts -- although this legal stricture may often be honored in the breach.

Walker notes that "tape manufacturers sell all kinds of colors and grades -- 'contractor' grade, 'professional' grade, even 'nuclear' grade, whatever that means. But performance doesn't seem related to grade." Although the Underwriters Laboratory (UL) has developed ratings for duct tape, these refer not to longevity but to such characteristics as strength and fire resistance. Houses are supposedly designed to last 30 years, and flex duct systems are often rated for 15 years, yet there is no UL rating that addresses the longevity of duct sealants.

To test longevity, Sherman and Walker devised an aging test, an accelerated way of mimicking the cycling of a home or office-building HVAC system from night to day and winter to summer (although at less extreme temperatures). Eight identical "finger joints" -- a standard method of fitting a smaller duct into a larger plenum by means of metal flanges, leaving gaps -- are tested simultaneously, each sealed with a different product.

The ducts are independently supported, and all other possible leaks are carefully closed, tighter than most real-world systems. Hot air at 75 degrees Celsius (167 degrees Fahrenheit) is forced through four of the ducts, cold air at 12 C (53.6 F) through the other four; the hot and cold air flows are alternated every five minutes. Although the industry recommends that some tape products be assisted by collars or clamps, these are rarely used in the field and were not used in the accelerated testing of the sealants.

Sherman and Walker also performed a bake test in which the sample joints were baked at temperatures of 140 to 187 F (60 to 75 C). In many parts of the U.S., Walker notes, air conditioning units and duct systems are often placed in the attic, "just about the worst place to put them. Attic temperatures can easily get up to 150 degrees F."

The researchers tested 19 different sealant samples in the aging rig and 13 in the baking rig -- what Walker calls "our rogues' gallery." When a joint leaked 10 percent of the air that it had leaked before being sealed, it was declared failed; most joints were tested until they were leaking 50 percent or more. Only one duct-tape product survived three months of the aging test. Eleven failed within days; some fell right off the joint. Clear tapes, foil-backed tapes, mastics, and aerosol sealant, although they lack strength, formed good seals for the duration. "We can't prove it yet, but we think that heat degrades the glue, and that's what's killing the duct tape," Walker says. While five duct tape products survived the baking test, in some cases this was because the backing separated from the glue, then fortuitously slid over the holes, plugged them, and baked shut again. In both kinds of test, duct tapes -- the majority of the products tested -- were the only sealants that failed.

The aerosol sealant system developed at Berkeley Lab's EETD was tested many times longer than the others. The sticky vinyl polymer is designed to be pumped through ducts to automatically seek out leaks, span them, and dry; in a program undertaken for the Environmental Protection Agency, Sherman and Walker sealed leaks with aerosol, then cycled the ducts from ambient air pressure and temperature to hot air at twice typical duct-system pressures, every 20 minutes for two years. There was no significant change in duct tightness. The aerosol's success motivated the researchers to try out other sealants, because, says Sherman, "we realized we were putting the aerosol through tests that more traditional sealants aren't put through."

Sherman and Walker are working to have longevity standards adopted by such agencies as the California Energy Commission and the American Society for Testing Materials. Meanwhile the researchers are proposing more rigorous tests and new and improved sealants.

As for the almost complete failure of the current crop of duct tapes, Walker says, "There is no reason to believe that duct tape adhesives and construction methods cannot be reformulated to work better at higher temperatures." In the meantime there are products in the market that pass both industry standards and also have good sealant longevity. Given its other advantages, Sherman and Walker would like to see better quality duct tape, as well as an improved rating system.

Sherman and Walker report their findings in the July/August issue of ***Home Energy*** magazine. The online edition can be reached at http://www.homeenergy.org/898ductape.title.html.

The Berkeley Lab is a U.S. Department of Energy national laboratory located in Berkeley, California. It conducts unclassified scientific research and is managed by the University of California.