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INDUSTRY NEWS

"Whole-Duct-System" R-Values

Just as the whole-wall R-value of a wall assembly is lower than the R-value of the insulation stuffed between the wall's studs, the "whole-duct-system" R-value of a serpentine length of flex duct is lower than the R-value of the insulation around the ductwork. Moreover, not all R-8 flex ducts perform equally. Recent tests at Oak Ridge National Laboratory (ORNL) show that a duct system using R-8 fiberglass-insulated flex duct does not perform as well as a duct system using R-8 cotton-insulated flex duct (see Table 1, page 5).

According to the ORNL tests, the "whole-duct-system" R-value of R-8 flex duct ranges from R-4.63 (the performance of a fiberglass-insulated "R-8" flex duct system in winter) to R-5.99 (the performance of a cotton-insulated "R-8" flex duct system in summer).

The R-ratings printed on flex duct jackets are calculated according to a standard test procedure (ASTM C518, "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus"). That procedure does not take into account reductions in the thermal performance of a duct system due to crimping of insulation at bends, at hangers, or at clamped connections to fittings. Because of these and other factors, "whole-duct-system" R-values are lower than the R-values shown on flex-duct jackets.

ORNL Testing

The recent ORNL tests compared the performance of three types of flex duct: R-4 fiberglass insulated flex duct, R-8 fiberglass-insulated flex duct, and R-8 cotton-

Table 1 — "Whole Duct System" R-values

	"Whole-duct-system" R-value, summer	"Whole-duct-system" R-value, winter
R-8 cotton-insulated duct	5.99	5.33
R-8 fiberglass-insulated duct	4.91	4.63
R-4 fiberglass-insulated duct	3.91	3.19

Table 1. Testing at Oak Ridge National Laboratory showed that the "whole-duct-system" R-values for flex duct are lower than the R-values printed on their jackets.

insulated flex duct. The cotton-insulated flex duct used in the tests was manufactured by Payless Insulation, which commissioned the tests.

Research engineer Tom Petrie conducted the testing in ORNL's large-scale climate simulator. The test compared the performance of three 10-inch-diameter duct systems, each about 34 feet long, installed in a test box simulating an unventilated attic with an insulated floor. The flex duct was hung from truss-like framing and arranged in a serpentine configuration (see Figure 2).

The performance of the three duct systems was evaluated at both winter and summer conditions. To simulate winter conditions, the attic temperature was held at 0ºF, and the duct air inlet temperature was held at 92ºF. To simulate summer conditions, the attic temperature was held at 140ºF, and the duct air inlet temperature was held at 47.5ºF.

When R-8 Is Less Than R-8

It is logical to assume that R-8 flex duct has half the heat loss of R-4 flex duct. In fact, the ORNL testing showed that the performance of R-8 flex duct was significantly worse than might be imagined from reading the duct labels. As Tom Petrie noted in his report, "If both systems were true R-8 systems compared to an R-4 system at installed conditions and there was no difference between summer and winter performance, the R8CF [R-8 cotton-insulated flex duct] and R8FG [R-8 fiberglass-insulated flex duct] systems would show 100% improvements [compared to the R-4 duct] both summer and winter." This was not the case. Rather than showing a 100% improvement in performance, the R-8 systems performed between 26% and 67% better than the R-4 system.

Figure 2. ORNL's testing lab includes a "simulated attic" installed in a large-scale climate simulator (see the "News Briefs" section of ***EDU***, July 2004). The apparatus was recently used to test the performance of three types of flex duct.

The R-8 cotton-insulated flex duct performed better than the R-8 fiberglass-insulated flex duct in both "summer" and "winter." The reasons for the performance difference between the two products is unknown, and ORNL researchers are reluctant to speculate on the matter. For the record, Jeff Christian, the director of ORNL Buildings Technology Center, merely commented, "As far as the side-by-comparison is concerned, Tom's numbers are Tom's numbers."

One possible explanation for the measured difference in performance: because cotton insulation is denser than fiberglass insulation, it compresses less when the duct is bent. Moreover, tight bends in fiberglass-insulated ducts create more turbulent airflow patterns than the gentler bends typical of the stiffer cotton-insulated ducts.

These phenomena — if indeed they account for the measured difference in performance — may have been aggravated by the twisty duct layout used in the ORNL test. Notes Petrie, "The real question is, how well did the serpentine layout in the test section approximate the features of duct systems in real attics?"

Figure 3. Superior Air Duct is a "semi-flex" duct insulated with 100% cotton insulation.

Cotton-Insulated Flex Duct

Marketing materials from Payless Insulation describes R-8 Superior Air Ducts as "semi-flex" ducts. The ducts incorporate insulation made from 100% cotton wrapped with a reflective Mylar jacket (see Figure 3). Superior Air Ducts are available in diameters ranging from 2 inches to 20 inches, in three different lengths (10, 15, or 25 feet). The list price is $2.82 per linear foot for the 6-inch-diameter duct and $4.04 per linear foot for 10-inch-diameter duct — about two or three times the price of fiberglass-insulated flex duct.

"The reason why we invented the Superior Air Ducts is our experience in attics," says Nana Wyngarden, the marketing director for Payless Insulation. "We do not see many fiberglass ducts in good condition; the holes, leakage and U-shapes can contribute to a huge energy loss. No one else in the industry seemed to target this problem, so we did. We chose cotton because it is an excellent insulator."

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