industry intend to continue to study this issue, and we will announce major developments as they occur.

Sincerely,

J.M. Barnhart, Executive Director
Thermal Insulation Manufacturers Association

Editor's Reply

The section in our article on particle size carries the sub-head "Similar Particle Size to Asbestos." That certain fiberglass products have fiber size distributions similar to asbestos is fact. That carcinogenicity of a material depends on fiber size is only a theory, but one that is supported by at least some research evidence. Admittedly, other evidence disputes the theory and both sides of the story were presented on page 5 of our article.

Regarding Richard Munson, the EDU article not only states that he is "closely connected to the cellulose insulation industry, and would probably benefit from any bad press given to fiberglass," but also that he is a "rabid hater of the fiberglass industry." Neither fact should prevent us, however, from taking a close and objective look at the information he presents. NN

RESEARCH & IDEAS

TAPING FOR TIGHTNESS -- SOME ASTONISHING RESULTS

Tests performed at the NAHB National Research Center have produced some remarkable information on the effectiveness of taping window flanges and wall joints for creating airtight walls. As part of a study of housewrap products performed for Dupont Corporation, Research Center staff found that taping alone could reduce wall leakage by 75%. Figure 1 compares those data with similar test data for walls treated with two brands of housewrap.

Before discarding your Tyvek in favor of tape, it is important to take a discriminating look at the validity of this type of testing. A full explanation of the test -- ASTM E-283 -- and its interpretation can be found in this month's feature article on housewrap products.

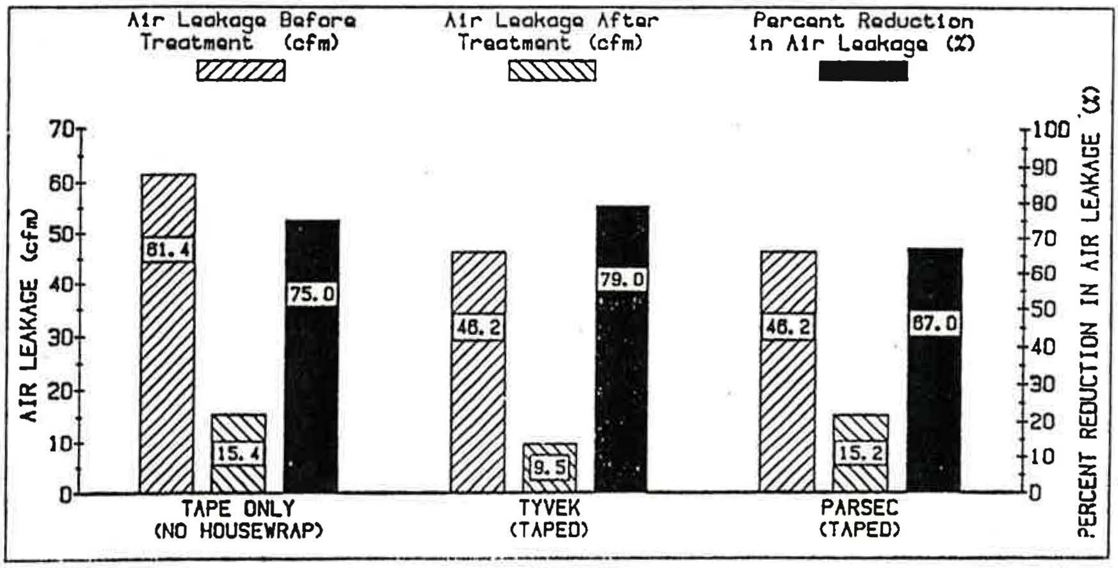

Figure 1 - Air leakage reduction through application of taped housewrap and tape without housewrap.
Source: NAHB Research Foundation.

CELLULOSE AND AIRTIGHTNESS -- MORE SURPRISES

The following case study should be quite interesting to anyone looking for evidence that cellulose fiber insulation contributes significantly to building airtightness.

A recently completed house in the Edmonton area was built with 2x6 walls insulated with cellulose-fiber insulation. The walls had a 10-mil polyethylene vapor barrier that was sealed at all seams and penetrations. Horizontal strapping was installed on the inner surface of the studs and the cellulose was blown in from the outside through holes in the plywood sheathing before the drywall was installed.

The house was pressure tested for air leakage and was found to be very tight -- 1.1 air changes per hour at 50 pascals pressure.

As an experiment, the building designers, Howell-Mayhew Engineers, slit the polyethylene air/vapor barrier in about 20 places and then retested the building for airtightness. There was absolutely no change in measured air leakage after the air/vapor barrier was slit. Furthermore, smoke pencil testing at the slits showed "not a breath" of air leakage. The cellulose, installed at a high density, was maintaining the building's airtightness. (No attempt was made to tighten the exterior sheathing and the siding had not yet been installed when the test was performed.)

For more information, contact Will Mayhew, Howell-Mayhew Engineering, 15006 103 Ave., Edmonton, AB T5P 0N8, Canada; (403)484-7506.

THIS MONTH'S CURIOSITY -- HEALTH HAZARDS OF HIGH-EFFICIENCY FURNACES

Last week, we received a call from a staff writer at Practical Homeowner magazine. He was preparing an article on the negative health impacts of high-efficiency heating equipment and wanted to know if we had any information. We told him "no" and advised him that to our knowledge, there were no health hazards associated with high-efficiency furnaces.

But the curious thing is we have heard several reports of health complaints immediately after the installation of high-efficiency furnaces in houses. Last month, for example, we were told of several such cases in Wisconsin. Homeowners complained of eye irritation and headaches just after the new furnaces were installed. In some cases, the problem was solved by installing a new furnace, but in at least one case, no solution was found.

What is the source of this problem? Can high-efficiency furnaces cause indoor air problems? With one possible exception, we think not. The exception is the Amana Energy Command which, according to an unconfirmed report from a utility representative in Wisconsin, caused a problem due to glycol leakage from the heat transfer module. The most plausible explanation for the complaints is that the problem houses already had indoor air pollution before the high-efficiency furnaces were installed, but no health problems developed because the old furnace exhausted the pollutants from the houses. When the new high-efficiency furnaces were put in, large quantities of air were no longer being ventilated from the houses, so health effects began to arise from exposure to the buildup of pollutants.

High-efficiency furnaces have been taking some hard knocks recently. Yes, there are bugs that still need to be worked out in these newly developed systems. And there are new lessons to be learned. One of them may be that to prevent indoor air quality problems, installation of high-efficiency furnaces should be accompanied by installation of house ventilation systems.

Any information or other curious reports from EDU subscribers would be welcomed.

Feature: THE HOUSEWRAP WARS

In the beginning there was Tyvek. Then came Parsec Airtight White, which was really Tyvek under a different name, followed by Parsec Airtight Wrap, then Rufco-Wrap, then VersaWrap and Air Seal. Finally Barricade. And the story isn't over. Next month promises to bring yet another housewrap, still unnamed, made from a product originally sold by Dupont.

One thing is certain. There is definitely a strong demand for housewrap. In fact, Dupont can't keep up with current orders for Tyvek and won't be able to meet demand until its new manufacturing facility in Luxembourg comes on line in 1988. No surprise then that competition has moved in. So what are these new housewrap products and how do they compare to Tyvek?

THREE BASIC TYPES

All the housewrap products currently available fall into three basic categories -- spun-bonded polyethylene, perforated polyethylene, and spun-bonded polypropylene.

1. Spun-bonded polyethylene

This is Tyvek, the original housewrap. Thin filaments of polyethylene are "spun-bonded" into a mat through a patented Dupont process. The resultant mat is extremely strong, relatively impervious to airflow, yet highly permeable to water vapor. Tyvek, introduced in 1980, is the only product of this type.

2. Perforated polyethylene

As the name implies, perforated polyethylene is polyethylene film with holes. At last count four companies were selling perforated polyethylene housewrap: Parsec Inc., Dallas, Texas (Parsec Airtight Wrap); Raven Industries, Sioux Falls, South Dakota (Rufco-wrap); Sto-Cote Products, Richmond, Illinois (Tu-Tuf Air Seal); and Diversifoam Products, New Brighton, Minnesota (VersaWrap).

All the perforated polys are actually the same product - Valeron, an extremely tough laminated polyethylene film manufactured by Van Leer Plastics, Houston, Texas. (See November 1983 EDU for a complete description of how Valeron is manufactured.) Regular Valeron, without perforations, is sold as a vapor barrier material under the names Tu-Tuf (Sto-Cote Products) and Rufco (Raven Industries). Perforated Valeron has been used in applications such as fruit sacks, where high strength and breathability are required.

3. Spun-bonded polypropylene

The latest material to hit the housewrap market is spun-bonded polypropylene. The only product of this type currently available is "Barricade," introduced last January by Simplex Industries, Adrian, Michigan. Like Tyvek, Barricade is formed by spin-binding plastic fibers into a mat. The main difference between Barricade and Tyvek is that the fibers in Barricade are polypropylene rather than polyethylene.

The bonded polypropylene mat used in making Barricade is relatively weak for stapling and probably not dense enough to effectively stop air infiltration. To overcome those problems, Simplex has done two things. First, they have incorporated reinforced edge and center strips for stapling. Second, they have applied a treatment to the polypropylene mat to decrease its air porosity. We were told by one source that the treatment consists of spraying with a polypropylene solution, but a spokesperson at Simplex would not confirm that, claiming that the treatment process is proprietary and as yet unprotected. Finished Barricade is translucent when in contact with a surface.

Another spun-bonded polypropylene housewrap is about to be introduced into the marketplace by the InterTech Group, Charleston, South Carolina. The base material for this new product is Typar, originally developed and sold by Dupont. According to a spokesperson at

InterTech, the product is now sold as a housewrap in Sweden under the tradename "Typar-Tat." Expect to see it marketed in the U.S. in May or June of this year.

WHICH HOUSEWRAP IS BEST?

Comparing Apples with Apples

Confronted with a growing variety of housewrap materials, the discriminating buyer will certainly want to carefully compare each product's physical properties and performance characteristics. Permeability, air porosity, tear resistance, cost, and ease of installation -- all are important. The problem is that for each important characteristic, there are several test methods and for some test methods, there are several ways for reporting the results. The situation makes it very difficult to compare "apples with apples."

Water Vapor Transmission (WVT)

Housewrap material should have a high water vapor transmission rate (WVT) (high perm rating) to avoid creating an exterior vapor barrier (at least in cold climates).

The standard method for measuring WVT is ASTM E-96. A sample of the material to be tested is sealed over a large shallow dish containing either a desiccant (Procedure A) or water (Procedure B). The dish is placed in a chamber with controlled temperature and humidity. The amount of water vapor passing through the test material into the dish (Procedure A) or out of the dish (Procedure B) is measured through repeated weighings.

Here's the problem. Measured water vapor transmission will not be the same with Procedures A and B. Therefore, any comparison between two products will only be valid if the same procedure is used to test both of them. Unfortunately, not all manufacturers use the same test procedure. Even worse, some manufacturers don't indicate which procedure was used for the tests of their products. The problem is exacerbated by the fact that, in addition to Procedures A and B, ASTM E-96 includes four other procedures (Procedures BW, C, D, and E)! Each differs as to test temperature and cup configuration and each will produce different results for the same material. Raven Industries, for example, publishes results for Procedure C, which measures WVT at 90°F (procedures A and B call for 73.4°F).

Table 1

Listed Water Vapor Transmission Rate in Perms for Various Housewrap Products

Product	WVT (perms)	Test Procedure (ASTM E-96)	Source
Tyvek	48	A	Dupont wallet factsheet
	85-95	Unknown	Dupont Technical Update
Parsec Air-tight Wrap	12	Unknown	Dupont wallet factsheet
	15	A	Parsec brochure
	17	B	Parsec brochure
	26	C	Parsec brochure
Rufco-Wrap	26	C	Raven factsheet
	12	Unknown	Dupont wallet factsheet
Barricade	33	Unknown	Dupont wallet factsheet
	37	A	Simplex (personal communication)
	70	B	"

Finally, not everybody expresses the results of the ASTM tests in the same units. The standard unit is the perm (grains per hour per square foot per inch mercury vapor pressure differential). But Dupont, for example, expresses the permeability of Tyvek in units of grams per 100 square inches per 24 hours. Unless you know the proper conversion factor, a comparison between Tyvek and a product rated in perms is extremely difficult.

Table 1 compares published WVT values for several housewrap products.

Air Porosity

To effectively reduce air leakage, a housewrap product should have low

Table 2

Air Leakage Reduction Test Results

(ASTM E-283)

Product	Measured Air Leakage (cfm) Without Housewrap	Measured Air Leakage (cfm) With Housewrap	Percent Reduction	Source
Parsec Airtight Wrap	243.5	18.5	92.4% (sealed at seams)	Parsec brochure
	243.5	77.5	68.2% (not sealed at seams)	Parsec brochure
Rufco-Wrap	56.8	21.4	62.3%	Rufco-Wrap brochure
Tyvek	NA	NA	88.2 to 98.9%	BOCA Report #79-34
	NA	NA	61%	Raven Industries factsheet

air porosity. Unfortunately, comparing the air porosity of these products is even more difficult than comparing water vapor transmission. An examination of manufacturers' literature will show two basic test reports -- ASTM E-283 and the "Gurley-Hill Porosity" test.

ASTM E-283 Test Results Are Often Meaningless

ASTM E-283 is the "Standard Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors." A wall assembly to be tested is fitted into one side of a test chamber. The chamber is pressurized to simulate some predetermined amount of wind force against the test wall. Air leakage through the test wall assembly is calculated by measuring the amount of air required to maintain pressure in the test chamber. To evaluate housewrap, a wall assembly is tested with and without the housewrap installed. The reduction in air leakage after applying the housewrap is typically expressed as a percent. Table 2 shows some results published by housewrap companies for ASTM E-283 tests of their products.

Here's why comparative results from this test are often meaningless. If the test wall is initially very leaky, then the housewrap will cause an enormous reduction in air leakage. But if the test wall is initially tight, then the housewrap will have little effect. (Compare the difference in Table 2 between the leakage of the walls without housewrap in the Parsec and Rufco-Wrap tests.) Since there is no "standard" base case wall in the ASTM procedure, the test can be configured to produce almost any result. Furthermore, the test is measuring the seal at joints, seams and penetrations as well as tightness of the housewrap material itself.

The NAHB tests

Recently, the NAHB National Research Center was commissioned by Dupont to perform comparative tests on Tyvek and Parsec using the ASTM method. Under the supervision of Christopher Mathis, research engineer at the Center, an extensive bank of carefully controlled tests were performed. (The testing was actually performed by a third-party independent certified laboratory.)

Forty separate tests were run on three identical wall sections. Some of the most illuminating results are shown in Table 3. Notice that when the window flange and ends were not taped, Tyvek stopped about 54% of the air leakage compared to the base case wall. With taping, the reduction jumped to 79%. Parsec was slightly more effective than Tyvek when untaped, but less effective when taped. But look at the result of the test wall with no housewrap. Taping alone reduced the total air leakage by 75%!

Table 3

NAHB National Research Center Air Leakage Test Results.

(All measurements are at 50 pascal pressure)

Test Configuration	Init (cfm)	Final (cfm)	Reduction (%)
Tyvek, untaped	46.2	21.2	54%
Parsec, untaped	46.2	19.2	58%
Tyvek, taped	46.2	9.5	79%
Parsec, taped	46.2	15.2	67%
Tape without housewrap	61.4	15.4	75%

What do these test data mean? If taken at face value, they might indicate that taping alone is almost as good as housewrap, so why bother with the housewrap? But notice that the actual leakage through the wall with tape alone is about 63% higher than the wall with taped Tyvek. (Two different test panels were used for these tests, but they were of identical size and construction.) Do any of the percent reduction figures have meaning? If so, which ones? Does Tyvek perform better than Parsec? Does tape alone perform better than Parsec?

Table 4

Air Porosity Measured With Gurley-Hill Porosimeter

Product	Porosity(sec/ 100cc-sq.in.)	Source
Tyvek	17.6	Tyvek brochure
	7.6	BOCA Report #79-34
Barricade	10.5	Barricade brochure
	5.0	Dupont wallet factsheet
Parsec Airtight White	7.0	Dupont Technical Update
	8.7	Dupont wallet factsheet

The Gurley-Hill Porosity Test

The Gurley-Hill Porosity test is a laboratory test that evaluates the air porosity of a material by measuring the time required to pass a given volume of air through a sample of the material under a specified pressure. Used mostly by the paper industry, it is prescribed as Method T-460 of the Technical Association of the Pulp and Paper Industry (TAPPI). The results are expressed in seconds per 100 cc of air or just seconds. The higher the measured time in seconds, the better the material as an air barrier. A brief examination of manufacturers' published values for measured Gurley-Hill tests shows several contradictions:

The most noticeable discrepancies are those values listed by Dupont and Simplex comparing each other's product. Simplex's promotional literature emphasizes the very poor 7.6 porosity listed for Tyvek in BOCA Research Report #7934. But Dupont claims that the 7.6 figure is a typographical error, that the "1" was left off before the 7.6 and that the actual value is 17.6 seconds as listed above. One must wonder, however, why Dupont hasn't had a new report generated since the date of the BOCA listing is 1979! According to Mark Vergnano, marketing specialist at Dupont's Fibers Marketing Center, they are in the process of having new tests performed.

On the other side, Dupont lists a poor 5.0 seconds for Barricade compared to Simplex's claim of 10.5. No explanation was available for that discrepancy.

[NITPICKER'S DELIGHT -- For those technical folks who delighted in renaming vapor barriers to vapor retarders, since no material is a complete vapor barrier, there is now a new opportunity. As shown by the Gurley-Hill tests, none of these housewrap materials are complete air barriers. That's right — air retarders.]

Strength

Gathering comparable laboratory measurements for the strength and tear resistance of these products is even more difficult than getting WVT and air porosity data. We finally gave up. Roughly speaking, Tyvek and the perforated polys are about equally tear resistant, although the polys might be slightly stronger. Barricade is definitely weaker, except at the reinforced stapling strips.

Ease of Installation

Tyvek and Barricade come in 3-foot, 4.5-foot, and 9-foot rolls. The perforated polys come in 4.5-foot rolls and J-folded 9-foot rolls. Which is easiest is pretty much a matter of personal preference.

For More Information

Barricade
Simplex Products Division
Anthony Industries
P.O. Box 10
Adrian, MI 49221-0010
(517)263-8881

Tyvek
Dupont Company
Textile Fibers Department
Wilmington, DE 19898

VersaWrap
DiversiFoam Products
1901 13th Street N.E.
New Brighton, MN 55112
(800)752-4306

Parsec Airtight Wrap
Parsec, Inc.
P.O. Box 38527
Dallas, TX 75238
(800)441-0324

Rufco-Wrap
Raven Industries, Inc.
P.O. Box 1007
Sioux Falls, SC 57117-1007
(800)227-2836

Feature: HIGH-EFFICIENCY GAS FURNACES — A SURVEY OF PROBLEMS

"I believe that the complexity of the equipment [high-efficiency gas furnaces] precludes the possibility of long-term, trouble-free operation. If any one of a dozen or more functions fails to take place, a 'lockout' will result. In some cases a safety control fails, and what we have come to refer to as a meltdown occurs. In this case, the interior of the furnace burns up, requiring wholesale replacement of parts and wiring, or the installation of a completely new furnace."

The above statement, written by a Pennsylvania heating contractor, appeared in New England Builder and, in similar form, in Air Conditioning, Heating and Refrigeration News. Although reports of "meltdowns" are relatively rare, complaints about the complexity and unreliability of the new medium- and high-efficiency induced draft furnaces are not. Even though many contractors report absolutely no problems with these new units, some people in the industry feel that more field testing should have been done before these units were let out into the marketplace.

A SURVEY OF 600 REPORTED COMPLAINTS

Exactly what are the probl
being experienced with mediu
high-efficiency gas furnaces.

what are the causes of those problems? A partial answer to those questions is provided by an extensive survey just performed for Alberta Energy by Howell-Mayhew Engineering, Edmonton. A total of 592 complaint reports were solicited from equipment distributors, heating contractors, gas inspectors, municipal inspectors, utility supervisors, builders, educators, government officials, and homeowners. Here's what they found.

COMPLAINTS, CAUSES, AND SOLUTIONS

System Shutdown -- The Number One Complaint

No surprises here. Almost 60% of the reported complaints concerned furnace shutdown caused by either component failure or false activation of safety switches. Another 16% of the complaints were about system shutdown due to improper installation.

Component Failure

High-efficiency furnaces contain a variety of new components not previously found in residential heating systems: induction fans, secondary heat exchangers, pressure
tial switches, temperature
vibration mufflers, pumps
s, and condensate disposal
According to the Howell-