THE WISCONSIN ARCHITECT

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THE STATE ASSOCIATION OF WISCONSIN ARCHITECTS
WISCONSIN CHAPTER OF THE AMERICAN INSTITUTE
OF ARCHITECTS

Picnic Program

Smoke Prevention Convention

Condensation Problems

A. I. A. Report

Picnic Issue

Vol. 7 June, 1939 No. 6

Smoke Prevention Convention

At the last regular meeting of the Mayors Advisory Council your secretary was instructed to notify each association of the dates of the annual convention of the Smoke Prevention Association.

The 33rd Annual National Convention of the Smoke Prevention Association will be held in Milwaukee from June 13th to June 16th, inclusive, at the Schroeder Hotel. In view of the fact that tickets will be issued for this convention, kindly notify your secretary at your earliest convenience as to the number of tickets you will need. Admission is free.

Condensation Problems in Modern Buildings[1]

By

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(Continued from May Issue)

The use of relative humidity as a measure of the amount of water vapor present in a given atmosphere is not always satisfactory because this relationship varies with the temperature. Hence it is often more practical to use the vapor pressure of the water vapor for this purpose, since it is a direct measure of the amount of vapor present in the air. This property is commonly expressed in terms of inches of mercury or pounds per square inch.

Condensation will take place on a solid surface below the dewpoint temperature as, for example, the glass surface of a window. Condensation can also take place on materials permeable to vapor if the surface be below the dewpoint temperature.

If the adjacent surfaces in a comparatively confined space are at different temperatures, all below the dewpoint of the atmosphere in the space, the surface at the lowest temperature may, through condensation, reduce the dewpoint to its own temperature. The temperatures of the other adjacent surfaces will then be above the new dewpoint and therefore incapable of condensing moisture. Eventually, under these conditions, all of the condensation would be on the coldest surface.

Vapor may pass through a material composed of a single thickness of homogenous but permeable substance having one surface either above or below the dewpoint temperature of the atmosphere on the warm side and the other at a lower vapor pressure.

The movement of water vapor is largely independent of air movement and no general circulation of air is necessary to carry the vapor from its source to the condensing surface. Vapor actually moves by diffusion from points of high vapor pressure to zones of lower pressures.

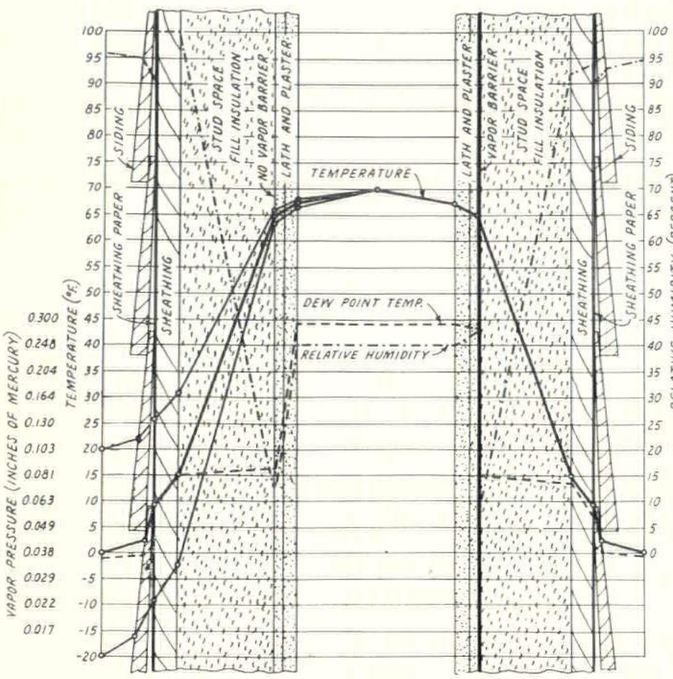
[1] Presented before Conference on Air Conditioning, University of Illinois, Urbana, Ill., March 8-9, 1939.

[2] Maintained at Madison, Wisconsin, in cooperation with the University of Wisconsin.

Most building materials, including plaster, wood, concrete, most kinds of brick, and various building papers, are permeable to vapor. The rate of vapor movement from one point to another is more or less proportional to the difference in vapor pressure between the points and inversely proportional to the resistance of the interposed materials. Walls of conventional house construction are composed of a variety of materials varying in permeability. Also the temperature gradients through a wall drop step by step according to the thermal properties of the material and the difference in temperature between the warm interior and the cold exterior. Should the temperature at any point within the wall, as for example, at the inner face of the sheathing, fall below the dewpoint temperature of the room side of the wall condensation would take place at that point.

A house wall typical of many insulated forms of construction is illustrated in figure 2A. This wall has lath and plaster on the inside and sheathing, paper, and bevel siding on the outside. Fill insulation occupies the entire stud space. Indoor conditions are assumed to be: Temperature 70° F. and relative humidity 40 percent; the dewpoint for these conditions is 44° F. and the water vapor pressure 0.295 inch of mercury. Temperature gradients through the wall are shown in solid black for three outdoor temperatures, namely 20° F., 0° F., and -20° F. Actual gradients in any individual wall of this type may be expected to be very similar to these. Much work has been done on this subject by many agencies and the facts are well established. Much less work has been done on vapor movement through walls and associated phenomena and we are much less sure of our ground. However, currently collected data indicate that, under the assumed conditions (outside temperature 0° F.), the temperature of the inner face of the sheathing very largely controls the dewpoint within the entire stud space. It appears that condensation upon this face, which is well below the dewpoint of the atmosphere in the room, serves to lower the dewpoint within the stud space. Just how much lowering takes place we do not know for sure. It seems apparent, however, that at the boundary conditions the dewpoint temperature throughout the stud space would be the temperature of the inner face of the sheathing. The relative humidity gradient corresponding to the illustrated dewpoint gradient is shown as a dot and dash line in the figure.

The amount of condensation that can develop within a wall depends upon the resistance of intervening materials to vapor transfusion, differences in vapor pressure, and time. Ordinary plaster and lath have comparatively low resistance. If the plaster is finished with paint the resistance is increased somewhat. High indoor vapor pressures are associated with high relative humidities and high temperatures. Low outdoor vapor pressures always exist at low temperatures, since even the saturate vapor pressures are low at low temperatures. Weather conditions are not static and the duration of critical conditions varies widely with the time of year and the severity of the weather. During long continued cold spells, such as the six weeks low temperature period in January and February, 1936, the condensation problem becomes acute, a large number of homes being affected. In the winter of 1937-38 there



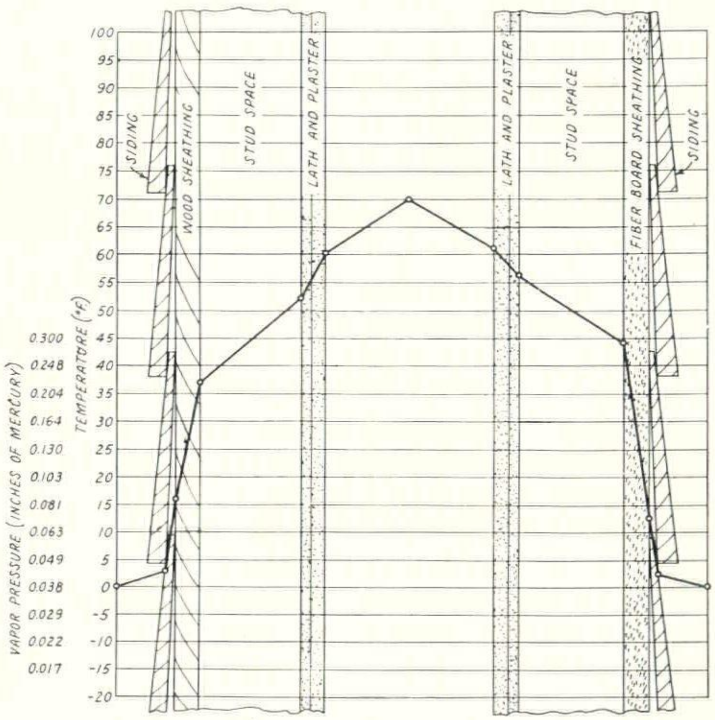
A FIG. 2 B

Section of conventional frame wall with fill insulation showing temperature, dewpoint, and relative humidity gradients without vapor barrier (figure 2A) and with vapor barrier (figure 2B).

was only one day at Madison, Wis., when the temperature was below zero though there were about 90 days in which it averaged below 20° F. Though the number of homes affected by condensation would be less during the mild winter conditions, many cases were reported. Where information was available it appears that the minimum humidities in the affected houses exceeded 35 percent and generally were higher.

In figure 2A we assumed a boundary condition in which the dewpoint temperature in the stud space was absolutely controlled by the temperature of the inner face of the sheathing, and there was a sharp drop in dewpoint temperature through the lath and plaster. The rate of vapor movement and the rate of condensation on the sheathing would be comparatively high on account of the low vapor resistance of lath and plaster. In figure 2B we have placed a vapor barrier between the studs and the lath. This barrier greatly reduces the rate of vapor movement through the wall, and thus very materially reduces the possibility of trouble from condensation. What actually happens to the vapor which finds its way through the barrier depends largely upon the vapor resistance of that part of the wall outside of the studs. If, for instance, the sheathing paper be an excellent vapor barrier one may expect most of the vapor to condense on the sheathing or sheathing paper, just as it did under the conditions we selected for figure 2A. If, on the other hand, the vapor resistance of sheathing paper and siding be very low, most of the vapor may escape to the outside atmosphere without condensation. We have chosen to illustrate this condition in figure 2B by showing the dewpoint temperature (the dotted line) as always below the atmospheric temperature. It must be obvious that as close an approach as possible to this ideal condition is desirable from the moisture standpoint, and our present tentative recommendations call for high vapor-resistance on the warm side of the wall, and low vapor-resistance on the cold side. These recommendations will doubtless be modified in detail as we learn more about the whole subject and especially about the extent to which rain driven under the siding by the wind is a factor.

Figure 3A shows the calculated temperature gradients through an uninsulated wall and 3B through a wall having ¾-inch fiber board sheathing in place of wood sheathing. As the heat loss through walls of those types is greater than through walls containing fill insulation, the sheathing temperatures are higher than those shown on figure 2A and consequently the vapor pressure differences are reduced accordingly. This in turn means that less condensation would occur at the same outside temperature in walls of these types than where fill insulation is used other factors being alike.



A FIG. 3 B

Section of conventional frame wall, showing temperature gradient with wood sheathing (figure 3A) and with ¾" fibre board sheathing (figure 3B).

Tests have been made to determine the comparative vapor resistance of various papers and wall materials used in building construction. Samples were sealed in copper pans containing water and exposed in a room controlled at 80° F. and 30 percent relative humidity and weighed regularly for 90 days or more. The values obtained after the rate of loss became constant were calculated on a basis of grains of moisture lost per square foot per hour.

(Continued on page 6)

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Activities of the Wisconsin Chapter American Institute of Architects

Several monthly meetings of the Chapter were postponed to enable members to complete assignments of P. W. A. and other urgent work before the first of the year.

The Executive Committee during the interim, however, convened weekly to discuss and dispose of many problems pertaining to or concerning the welfare of the architects in our community.

The February meeting resulted in a combined group meeting of the Wisconsin Chapter, the State Architectural Association and the Producers' Council Club of Milwaukee. This first meeting, under the auspices of the Chapter, was the result of previous conferences which planned six group meetings, two to be sponsored by each of the member groups.

Chapter President Philipp opened the meeting by giving a general synopsis of the program and Chairman Sutherland of the Activities Committee introduced John L. Hamilton, F. A. I. A., of Chicago, who presented the architect's viewpoint in a pleasing and constructive manner. Mr. Kachel took advantage of this occasion to present numerous criticisms of the architect as seen through the eyes of the general contractor. Mr. Cleary made the statement that close co-operation between lending institutions and the architect would probably result in mutual advantage.

Several Extcutive Board meetings have been held during March concerning the feasibility of consolidating the Wisconsin and Madison Chapters. A delegation from the Madison group, upon the invitation of the Wisconsin Chapter visited Milwaukee, and in a round table discussion, concluded that a unity of action would result in a better solution of the architect's problem in the State of Wisconsin. This contemplated procedure is permissible according to the By-Laws of the Wisconsin Chapter, Article 8, Section 14, Paragraph (c):

> "The Executive Committee, with the approval of the Institute Board, may organize one or more branch Chapters within its territory when it deems the interests of the Institute will be better served thereby."

It was the opinion at the meeting that the Madison Chapter would be represented by a recording secretary and by an additional Vice-President, and also the Madison group would have direct representation on the various committee assignments. This entire plan will be submitted to the Chapters for their approval and finally to the National Board for theirs.

The Secretary will be pleased to hear from those Architects who are not at present members, but have a desire to associate themselves with the American Institute of Architects.

ALEXANDER H. BAUER
Secretary A. I. A.
Wisconsin Chapter

The Invitation and Program for the Picnic on June 17, 1939

In behalf of the Kohler Co. I am pleased to invite the members of

THE STATE ASSOCIATION OF WISCONSIN ARCHITECTS, THE WISCONSIN CHAPTER AND THE MADISON CHAPTER OF THE AMERICAN INSTITUTE OF ARCHITECTS

and

THE PRODUCERS COUNCIL CLUB OF WISCONSIN,

to be our guests at a picnic
to be held in Kohler Village,

SATURDAY, JUNE 17, 1939.

— PROGRAM —

Arrival of guests before 2 P.M. at the General Offices of the Kohler Co.

A visit through Kohler Village, including
Display of Products
American Club
Waelderhaus
Demonstration House.

Games and entertainment at the grove south of Riverbend. Refreshments.

Dinner at Riverbend.

WALTER J. KOHLER
(Signed)

ROUTE FROM MILWAUKEE:

Take 141 from Milwaukee to the junction with 42 north of Pt. Washington. Take 42 through Sheboygan Falls and East to Kohler.

(Continued from page 3)

Table 1.—Comparative resistance of various materials to vapor transmission

Material	*Loss in grains per sq. ft. per hour*
Foil surfaced reflective insulation (double faced)	0.061 - 0.093
Roll roofing—smooth surface 40 to 65 lbs. per roll 108 sq. ft.	.093 - .123
Asphalt impregnated and surface coated sheathing paper glossy surfaced—	
50 lbs. 500 sq. foot roll	.153 - .555
35 lbs. 500 sq. foot roll	.123 - 1.480
Duplex or laminated papers 30-30-30	.990 - 1.850
Duplex or laminated papers 30-60-30	.370 - .617
Duplex papers reinforced	.493 - 1.480
Duplex paper coated with metal oxides	.370 - .930
Insulation backup paper, treated	.617 - 2.462
Gypsum lath with aluminum foil backing	.061 - .277
Plaster — wood lath	7.90
Plaster — Fiber board or gypsum lath	14.20 - 14.80
Plaster — 3 coats lead and oil	2.650 - 2.770
Plaster — 3 coats flat wall paint	3.080
Plaster — 2 coats aluminum paint	.831
Slaters felt	3.700 - 18.50
Plywood—1/4" Douglas fir, soy bean glue plain	3.080 - 4.620
2 coats asphalt paint	.308
2 coats aluminum paint	.930
1/2" 5-ply Douglas fir	1.920 - 1.975
1/4" 3-ply Douglas fir, art. resin glue	3.080 - 4.620
1/2" 5-ply Douglas fir, art. resin glue	1.975 - 2.420
Insulating lath and sheathing—board type	18.50 - 24.65
Insulating sheathing, surface coated— 3/16 compressed fiber board	3.640
1" Insulating cork blocks	4.440
1/2" and 1" blanket insulation between coated papers	1.380 - 1.440
4" mineral wool—unprotected	20.950

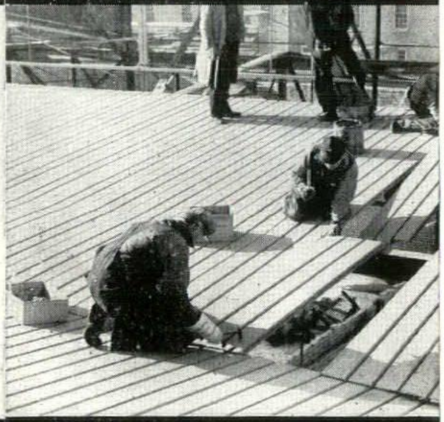
This is only a partial list of the materials tested up to the present time, and as the tests are incomplete, it will be subject to change as required with further work. Many of the materials have been tested under actual exposure conditions in laboratory test-house wall panels.

Figure 4 shows the moisture content of the sheathing in 3 test wall panels, differing only in type of vapor barrier used. These walls were of conventional frame construction, lath and plaster, stud space filled with rock wool, wood sheathing, asphalt impregnated and surface coated sheathing paper and siding. Panel No. 1 had a vapor barrier made of aluminum foil mounted on paper; No. 2, asphalt impregnated and surface coated sheathing paper weighing 50 pounds per roll of 500 square feet; and No. 3 had no special barrier. Starting about November 1 the sheathing shows a gradual increase in moisture content for each type, fastest where no barrier is used. Even with a barrier there is a definite pickup until in the case of No. 2 a moisture content of about 17 percent is reached, indicating that the inflow of water vapor exceeds the outflow until a certain balance is obtained. After that time conditions were nearly static until the outside weather conditions moderated and then the outflow exceeded the inflow.

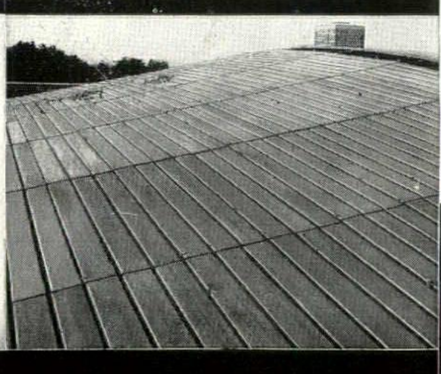
(Continued in July Issue)

Attaching Purlin Clip

Fast application cuts costs



Quickly ready for roll roofing



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