Relative humidities at which condensation will occur on the inner pane of double windows

Nowak, E. S.; Wilson, A. G.

Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/20358730
Technical Note (National Research Council of Canada. Division of Building Research); no. TN-258, 1958-07-01

NATIONAL RESEARCH COUNCIL OF CANADA

DIVISION OF BUILDING RESEARCH

No. 258

TECHNICAL NOTE

NOT FOR PUBLICATION — FOR INTERNAL USE

PREPARED BY EN and AGW — CHECKED BY — APPROVED BY RFL

PREPARED FOR Northern Section, DBR — DATE July 1958

SUBJECT Relative Humidities at which Condensation will Occur on the Inner Pane of Double Windows

---

The levels of relative humidity at which condensation will occur on the inside surfaces of the inner panes of double and triple windows are given in Table I. These are based on temperatures that were calculated assuming one-dimensional heat flow, that is, no variation in temperature in any vertical plane. The inside air temperature used in these calculations was 70°F.

The U values used were those given in the 1958 ASH&AE Guide (p.212) for double and triple windows having 1-inch air spaces. The method and data on which these U values are based are given in an ASHVE Research Paper (1). The following coefficients are used in arriving at these U values.

Outside film, fo = 6.6 Btu/hr sq ft °F

Inside film, fi = 1.5 Btu/hr sq ft °F

Air space conductance = 0.94 Btu/hr sq ft °F

The outside film coefficient is based on an outside air temperature of 0°F, clear skies and no solar radiation, and a convection coefficient of 4.0 Btu/hr sq ft °F. The value for the outside convection coefficient corresponds to the average value for a smooth surface 10 feet long when swept by a parallel air stream at 15 mph.

The values of relative humidity for double windows given in Table I do not correspond exactly with those obtained from Fig. 4 (p. 229) of the 1958 ASH&AE Guide since the latter are based on a U value of 0.55 and an inside film coefficient of 1.65. The U value of 0.55 corresponds to that given in the Guide for windows with a ½-inch air space.

It has been mentioned that one-dimensional heat flow was assumed in calculating the surface temperatures in Table I. Measurements on double windows installed in the Building Services cold room of the Division have shown that substantial vertical temperature gradients occur in the air space between the panes, with temperatures at the bottom being lower than at the top. The temperature variations in the air space result in similar variations of lesser magnitude in the temperature of the inside surface of the inner pane. These surface temperature variations depend not only on the air space temperatures but also on the temperature, velocity and direction of the room air moving over the window. The type and location of the heat distribution equipment is therefore a factor.

In measurements on a double window 2 feet high with a $\frac{3}{4}$-inch air space, it was observed that some condensation occurred over the lower part of the inner pane at relative humidities as low as 46, 30 and 20 per cent at cold room temperatures of 20°F, 0°F and -20°F. Temperature measurements indicated that condensation would occur over almost the entire inside surface of the inner pane at the relative humidities given in Table I. In this study the vertical air temperature gradient in the warm room was quite small although the heat was introduced on the wall opposite the window. Smaller vertical surface temperature gradients and higher mean surface temperatures would be expected with heating outlets located directly beneath the windows.

Reference

1. Parmelee, G.V. and W.W. Aubele. Heat flow through unshaded glass (design data for use in load calculations). Trans. A.S.H.V.E., Vol. 56, 1950. p. 371-398.

TABLE I

Relative Humidities at which Condensation
will Form on Inner Panes of Double and Triple Windows

Outside Temperature °F	Double Window ("U" Value of 0.53)		Triple Window ("U" Value of 0.34)	
	Temperature on inside surface of inner pane °F	Inside relative humidity at which condensation will occur on the inside surface % R.H.	Temperature on inside surface of inner pane °F	Inside relative humidity at which condensation will occur on inside surface % R.H.
40	59	68	63	78
20	52	53	59	68
0	45	41	54	57
-20	38	32	50	49
-40	31	23	45	41