Example 8: Find the coefficient of transmission U of a frame wall consisting of stucco, $\frac{25}{32}$-in. insulation board sheathing, 2 x 4-in. studs, gypsum lath and plaster, and with 2-in. blanket insulation between studs, for 25 mph wind velocity.

Solution: From Table 5, this wall, with no insulation between studs has a value of $U = 0.22$. From Table 16 Part A, Col. 4, this wall with 2-in. insulation added has a value of $U = 0.084$. Entering Table 20 in the 15 mph column, interpolate between 0.080 and 0.090 in 15 mph column and proceed horizontally to the 25 mph column where the U value is found by interpolation to be 0.085.

CALCULATING SURFACE TEMPERATURES

In many heating and cooling load calculations it is necessary to determine the inside surface temperature or the temperature of the surfaces within the structure. As the resistance of any path of heat flow is expressed in Fahrenheit degrees per (Btu) (hour) (square foot), the resistances through any two paths of heat flow would be proportional to the temperature drop through these paths, and can be expressed as follows:

$$\frac{R_1}{R_2} = \frac{(t_i - t_x)}{(t_i - t_o)} \qquad (6)$$

where

R_1 = the resistance from the inside air to any point in the structure at which the temperature is to be determined.
R_2 = the overall resistance of the wall from inside air to outside air.
t_i = inside air temperature.
t_x = temperature to be determined.
t_o = outside air temperature.

Example 9: Determine the inside surface temperature for a wall having an overall coefficient of heat transmission $U = 0.25$, inside air temperature 70 F, and outside air temperature −20 F.

Solution:

$$R_1 = 1/f_i = 1/1.46 = 0.684$$
$$R_2 = 1/U = 1/0.25 = 4.00$$

Then, by Equation 6

$$\frac{0.684}{4.00} = \frac{70 - t_x}{70 - (-20)}$$

$$t_x = 54.6 \text{ F}$$

The same procedure can be used for determining the temperature at any point within the structure.

A chart for determining inside wall surface temperature is given in Fig. 12 of Chapter 23, Panel Heating.

REFERENCES

[1] Standard Method of Test for Thermal Conductivity by Means of the Guarded Hot Plate, sponsored by A.S.H.V.E., *A.S.T.M.*, *A.S.R.E.*, and *N.R.C.*, and approved as a Tentative Code by A.S.H.V.E. and *A.S.T.M.* in 1942 (*A.S.T.M.* designation C-177-45, Approved 1945).

[2] Heat Transmission Through Building Materials, by F. B. Rowley and A. B. Algren (*University of Minnesota, Engineering Experiment Station Bulletin*, No. 38, p. 11).

[3] Thermal Properties of Soils, by Miles S. Kersten (*University of Minnesota, Engineering Experiment Station Bulletin* No. 28, June 1949).

[4] Radiation and Convection from Surfaces in Various Positions, by G. B. Wilkes and C. M. F. Peterson (A.S.H.V.E. TRANSACTIONS, Vol. 44, 1938, p. 513).

[5] Radiation Corrections for Basic Constants Used in the Design of All Types of Heating Systems, by B. F. Raber and F. W. Hutchinson (A.S.H.V.E. TRANSACTIONS, Vol. 51, 1945, p. 213).

[6] A.S.H.V.E. RESEARCH REPORT No. 869—Surface Conductances as Affected by Air Velocity, Temperature and Character of Surface, by F. B. Rowley, A. B. Algren and J. L. Blackshaw (A.S.H.V.E. TRANSACTIONS, Vol. 36, 1930, p. 444).

[7] Forced Convection Heat Transfer from Flat Surfaces, by G. V. Parmelee and R. G. Huebscher (A.S.H.V.E. RESEARCH BULLETIN No. 3, p. 40; also published in A.S.H.V.E. TRANSACTIONS, Vol. 53, 1947, p. 245).

[8] A.S.H.V.E. RESEARCH REPORT No. 1399—Heat Flow through Unshaded Glass: Design Data for Load Calculations, by G. V. Parmelee and W. W. Aubele (A.S.H.V.E. TRANSACTIONS, Vol. 56, 1950, p. 371).

[9] The Thermal Insulating Value of Airspaces, by H. E. Robinson, F. J. Powlitch and R. S. Dill (*Housing and Home Finance Agency, Housing Research Paper No. 32*, 1954, U. S. Government Printing Office).

[10] Thermal Test Coefficients of Aluminum Insulation for Buildings, by G. B. Wilkes, F. G. Hechler and E. R. Queer (A.S.H.V.E. TRANSACTIONS, Vol. 46, 1940, p. 109).

[11] A.S.H.V.E. RESEARCH REPORT No. 1213—Heat Loss Through Basement Walls and Floors, by F. C. Houghten, S. I. Taimuty, Carl Gutberlet and C. J. Brown (A.S.H.V.E. TRANSACTIONS, Vol. 48, 1942, p. 369).

[12] Measurements of Heat Losses from Slab Floors, by R. S. Dill, Wm. C. Robinson and H. E. Robinson (*National Bureau of Standards, Building Materials and Structures Report* BMS 103).

[13] Heat Transmission through Glass, by G. V. Parmelee (A.S.H.V.E. RESEARCH BULLETIN No. 1, July 1947).

BIBLIOGRAPHY

A.S.H.V.E. RESEARCH REPORTS:

No. 852—Effects of Air Velocities on Surface Coefficients, by F. B. Rowley, A. B. Algren and J. L Blackshaw (A.S.H.V.E. TRANSACTIONS, Vol. 36, 1930, p. 123).

No. 895—Wind Velocity Gradients Near a Surface and Their Effect on Film Conductance, by F. C. Houghten and Paul McDermott (A.S.H.V.E. TRANSACTIONS, Vol. 37, 1931, p. 301).

No. 914—Surface Coefficients as Affected by Direction of Wind, by F. B. Rowley and W. A. Eckley (A.S.H.V.E. TRANSACTIONS, Vol. 38, 1932, p. 33).

No. 915—Conductivity of Concrete, by F. C. Houghten and Carl Gutberlet (A.S.H.V.E. TRANSACTIONS, Vol. 38, 1932, p. 47).

No. 964—The Heat Conductivity of Wood at Climatic Temperature Differences, by F. B. Rowley (A.S.H.V.E. TRANSACTIONS, Vol. 39, 1933, p. 329).

No. 996—Insulating Value of Bright Metallic Surfaces, by F. B. Rowley (A.S.H.V.E. TRANSACTIONS Vol. 40, 1934, p. 413).

No. 1026—Thermal Properties of Concrete Construction, by F. B. Rowley, A. B. Algren and Clifford Carlson (A.S.H.V.E. TRANSACTIONS, Vol. 42, 1936, p. 33).

No. 1048—Thermal Properties of Concrete Construction, by F. B. Rowley, A. B. Algren and Robert Lander (A.S.H.V.E. TRANSACTIONS, Vol. 43, 1937, p. 33).

No. 1351—Overall Coefficients for Flat Glass Determined under Natural Weather Conditions, by G. V Parmelee and W. W. Aubele (A.S.H.V.E. TRANSACTIONS, Vol. 55, 1949, p. 39).

Radiation and Convection Across Air Spaces in Frame Construction, by G. B. Wilkes and C. M. F. Peterson (A.S.H.V.E. TRANSACTIONS, Vol. 43, 1937, p. 351).

Insulating Effect of Successive Air Space Bounded by Bright Metallic Surfaces, by L. W. Schad (A.S.H.V.E. TRANSACTIONS, Vol. 37, 1931, p. 285).

Thermal Conductivity of Wood, by J. D. MacLean (A.S.H.V.E. TRANSACTIONS, Vol. 47, 1941, p. 323).

The Specific Heat of Thermal Insulating Materials, by G. B. Wilkes and C. O. Wood (A.S.H.V.E. TRANSACTIONS, Vol. 48, 1942, p. 493).