Properly designed buildings with thick walls and wide overhangs provide a comfortable inside temperature in hot or cold weather. A 16-inch thick adobe wall has a U factor (BTU/hour/sq. ft./degree F.) of .163 compared to .280 for solid brick and .490 for concrete blocks. (See Twining Laboratory Report, Appendix A.)

New Mexico Bureau of Mines & Mineral Resources

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NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY

Thermal properties

In New Mexico, thermal specifications for building materials are covered in the 1977 New Mexico Energy Conservation Code as adopted from the Uniform Building Code and the New Mexico State Building Code. Portions of the New Mexico State Building Code relating to adobe appear in appendix 2.

Traditionally, materials are evaluated for thermal performance based on measurements known as *R-* and *U-values*. The *R-value* is an indicator of the ability of a wall to insulate effectively. Insulation is nothing more than the resistance of a material to the transfer of heat, and naturally the higher that resistance, or R-value, the better insulator a material is. The R-value is calculated by dividing the thickness of the wall by the wall's thermal conductivity, a value established by the amount of heat per ft^2 per hr flowing from the hotter to the cooler side of the wall.

The *U-value*, sometimes referred to as the *value of conductance*, is represented by the reciprocal of the R-value and reflects the rate at which heat is conducted through a material. Total R- and U-values may be calculated for a given wall by adding up the sum of the values of each of the individual components of the wall structure; for example, all insulation, interior sheathing, framing, or masonry must be taken into consideration.

R- and U-values do not, however, tell the full story in determining what constitutes a high-quality, thermally efficient wall (Fine, 1976). Both of these values reflect the rate at which heat passes through a wall only after it has achieved the *steady-state condition*, or the state when heat energy is passing uninterrupted from one side of the wall to the other at a constant rate. What is not taken into consideration, and what is of critical importance in the case of masonry-mass walls such as adobe, is the *heat capacity* of the wall, which determines the length of time that passes before a steady state of heat flow is achieved. The higher the heat capacity of the wall, the longer period of time it will take for heat flow to reach a steady state. In real situations, external and internal temperatures are changing constantly so that a true steady-state condition is rarely achieved. What does occur, in the case of a high-capacity wall such as adobe, is outlined below.

In the morning, when the sun rises, heat from the warmer, exterior side of the wall begins to move through the adobe mass. Depending not only on the resistance (R-value) of adobe, but also on the heat capacity of the wall (a factor both of the specific heat capacity of adobe and the wall thickness), the heat takes a certain length of time to reach the cooler, interior side of the wall and to be released in the surrounding air. In adobe walls of sufficient thickness and of sufficient R-values (perhaps supplemented by other insulation), the normal daily fluctuations of temperature never allow much heat to pass through the wall at a steady state. At night, when the warmer side of the wall drops in temperature, heat already absorbed into the masonry-mass wall continues to flow, not just in one direction, but to both sides of the wall until a temperature equilibrium has been reached. This cycle is repeated in what is known as the *flywheel effect* and is responsible for the comfort well known to those who inhabit properly designed adobe homes.

Taking into account these principles, clearly the thermal properties of masonry materials in general, and adobe in particular, have often been unjustly maligned because only R- and U-values have been considered when evaluating these properties. For mass materials such as adobe, a more accurate representation of thermal performance than R- and U-values is given by what is known as the *effective U-value*. This value is determined as a factor both of the resistance of the wall to the transfer of heat and of its capacity to hold heat. Therefore, in actual home use, optimum comfort may be achieved by a mass wall with a moderate R-value and high heat capacity (adobe with a small amount of insulation), as well as by a highly resistant wall with little or no heat capacity (traditional highly insulated frame wall). The New Mexico Energy Institute has recently developed effective U-values for many different wall types (including adobe), and recently such performance-based criteria has been incorporated into the New Mexico Energy Conservation Code for building materials. The effective U-values may be used in lieu of traditional R- and U-values for cases where a design relying primarily on passive-solar gain and masonry-mass materials would not normally pass code standards.

(NOTE): Unlike the "R" factor the "U" factor of the lesser number is the more desirable.
See "THERMAL PROPERTIES"

COMPARISONS OF HEAT TRANSMISSION COEFFICIENTS

	"U" Factor (B.T.U. per hour, per square foot, per degree F)
ADOBE*	
7½" Wall	0.304
12" Wall	0.208
16" Wall	0.163
POURED CONCRETE	
8" Wall	0.70
12" Wall	0.57
SOLID BRICK	
8" Wall	0.50
12" Wall	0.36
16" Wall	0.28
CONCRETE BLOCK (Lightweight Aggregate)	
8" Wall	0.36
12" Wall	0.34
(Gravel Aggregate)	
8" Wall	0.56
12" Wall	0.49
WOOD FRAME WALLS	
Stucco Exterior ½" Plasterboard Interior	0.31
Brick Veneer over 1" Sheathing ½" Plasterboard Interior	0.23
Adobe Veneer over 1" Sheathing ½" Plasterboard Interior	0.20
Stud Partitions ⅜" Plasterboard each side	0.33

*Results from test data of The Twining Laboratories' Report of Examination 300279.