DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON

THERMAL INSULATION

July 13, 1934.

This letter circular has been prepared to serve as a reply to numerous requests for information on thermal insulation and allied subjects. On account of the large number of such inquiries to be handled, it is necessary that our reply to most of them be in the form of a circular covering the subject in a general way and indicating how more detailed information may be obtained. It is not possible in general for the Bureau to quote data or make calculations for specific inquiries. A list of references is appended, and in the text these references will be referred to by number.

Insulating Materials

Many of the inquiries received are for the name of the "best" insulating material or for recommendations as to choice among competing brands. In so far as an answer to such questions is possible, it may be found in reference (1). It is not possible to supply numerical data on the conductivity of individual insulating materials, most of which are sold under trade names, and are somewhat variable in insulating and other properties.

General information concerning insulation and insulating materials, sufficient for most practical purposes of comparison, will be found in reference (1). This publication contains data on the insulating values of a number of fairly well defined classes or groups of materials used for house and cold storage insulation, the differences between various materials within each group being so small as to be of little practical importance.

Data on the thermal conductivities of individual materials of various sorts will be found in references (2), (3), (4), (5) and (11). Reference (5) contains data on various loose fibrous materials packed to various densities. Reference (11) contains a very useful table of insulating values of various building and insulating materials in thicknesses commonly used or sold.

Data on various combinations of aluminum foil as insulation will be found in references (6), (7), (8) and (9). The data in (6) on crumpled foil are quoted in reference (3).

Since the principles involved in the use of aluminum foil or other bright metal sheet as thermal insulation are not generally understood, a brief discussion will be given here. Aluminum foil is used to increase the insulating value of air spaces by reducing heat transfer by radiation. It is of value only in conjunction with air spaces, and has no value when placed in contact with solid material on both sides, except in so far as it may act as a building paper in preventing air leakage.

If one interior surface of an air space more than about 3/4 inch across is lined with aluminum foil, the insulating value of the air space will be increased by an amount roughly equivalent to that of 7/16 inch of fiber insulating board. Very little additional insulating value is gained by lining the opposite interior surface with foil. If a sheet of aluminum foil is placed in the middle of an air space more than 1-1/2 inches across, in such a way as to divide the original space into two parallel spaces, insulating value equivalent to that of about 1-1/8 inches of insulating board is added. Paper with aluminum foil glued to both sides or a sheet of bright tin plate would produce the same effect. Sheet material coated with aluminum paint can also be used in this way for insulation, but is considerably less effective than actual metal foil.

Heat Losses from Buildings

General information on this subject, together with estimates of probable fuel savings resulting from the use of insulation, weatherstripping, and storm windows will be found in reference (1). Methods of application of insulation and additional data on economies are given in references (10) and (11).

Data on heat transfer through building walls and roofs, insulated and uninsulated, through windows with single or multiple glazing, by air leakage, etc., are compiled in reference (2). Among the original sources of such data, references (12) and (13) may be consulted.

Domestic Heating Plants

The Bureau has no publications or special information on domestic heating plants, boiler ratings, radiator ratings, etc. Information on this subject will be found in reference (2).

Refrigerator Insulation

Materials of the same character as house insulation are used for refrigerator insulation. A brief discussion of the special precautions required in installing refrigerator insulation is given in reference (1). It should be pointed out that the insulating value of a refrigerator wall depends primarily on the thickness of the insulation, since the insulating values per unit thickness of the various materials used for this purpose do not differ by large amounts. The Bureau has no definite information regarding the kinds or thicknesses of insulation actually installed in the walls of the various commercial brands of refrigerators.

Condensation of Moisture

Prevention of moisture condensation (sweating or frosting) on windows, between the panes in double glazed sash, and between the panes in refrigerated display cases, is the subject of a large number of inquiries. When the temperature of a surface falls below the dew point of the surrounding air, condensation of moisture takes place on the surface, or if the temperature be below freezing, frosting results. Condensation on the inside of window panes can be decreased, and possibly eliminated, by reducing sources of water vapor within the building, and/or providing greater ventilation to the outside. In special cases, such as closed-off show windows, condensation may be reduced by heating such spaces, thereby increasing the temperature of the glass surfaces.

With multiple glazing, condensation on the interior glass surfaces can be eliminated by ventilating the air spaces to the air on the cold side. Under ordinary conditions, a small amount of ventilation is sufficient, which does not decrease the insulating value of the air spaces to any appreciable extent. It is important to seal the pane of glass in contact with the warm air of the room as tightly as possible. The attempt to seal all panes, while theoretically correct, is often unsuccessful in preventing condensation. In refrigerated display cases, no attempt need be made to seal any pane of glass, except

the one in contact with the air in the room. With exterior multiple glazed sash, it is of course necessary to seal the external pane so that rain cannot enter. Ventilation of the air spaces to the outside can be provided in this case by small holes so placed that rain cannot enter.

Steam Pipe and High Temperature Insulation

The Bureau has published no data on the thermal conductivity of insulators at steam or higher temperatures. References (5), (14) and (15) contain some data on this subject.

References

Government publications marked thus (*) are not for free distribution, but can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices indicated (stamps not accepted). Many of the publications listed below will be found in some of the larger libraries.

1.* National Bureau of Standards Circular No. 376, "Thermal Insulation of Buildings", five cents.

2. "Guide", published annually by the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York, N. Y., $5.00.

3. "Refrigerating Data Book", American Society of Refrigerating Engineers, 37 West 39th St., New York, N. Y., $3.50.

4. "Heat Transmission of Insulating Materials, 1922 Report (revised to 1924) of the Insulation Committee of the American Society of Refrigerating Engineers, $2.00.

5.* National Bureau of Standards Research Paper No. 243, "Mechanism of Heat Flow in Fibrous Materials" (out of print and not available for distribution; can be consulted in National Bureau of Standards Journal of Research, Vol. 5, page 973).

6. Gregg, "The Use of Metal Foil as an Insulating Material", Refrigerating Engineering, Vol. 23, p. 279; May, 1932.

7. Mason, "Thermal Insulation with Aluminum Foil", Industrial and Engineering Chemistry, Vol. 25, p. 245; March, 1933.

8. Breitung, "Aluminum Foil as a Basis for Insulation", Refrigerating Engineering, Vol. 22, p. 11; July, 1931.

9. Svenson, "Insulation Ideas overturned by Aluminum Foil", American Builder, September, 1932.

10.* "House Insulation, Its Economies and Application", 19th Report of the National Committee on Wood Utilization, Department of Commerce, 10 cents.

11.* "Insulation on the Farm", 25th Report of the National Committee on Wood Utilization, Department of Commerce, 10 cents.

12.* National Bureau of Standards Research Paper No. 291, "Heat Transfer Through Building Walls", 15 cents.

13. "Heat Transmission Through Building Materials", Bulletin No. 8, Engineering Experiment Station, University of Minnesota.

14. R. H. Heilman, "Insulation of Superheated Steam Surfaces", Transactions of the American Institute of Chemical Engineers, Vol. 16, Part 2, p. 79; 1924.

15. L. B. McMillan, "Heat Insulating Properties of Commercial Steam Pipe Coverings", Journal of the American Society of Mechanical Engineers, Vol. 38, p. 8; 1916.