



Designation: C 1129 – 89 (Reapproved 2001)

Standard Practice for Estimation of Heat Savings by Adding Thermal Insulation to Bare Valves and Flanges¹

This standard is issued under the fixed designation C 1129; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The mathematical methods included in this practice provide a calculational procedure for estimating heat loss or heat savings when thermal insulation is added to bare valves and flanges.

1.2 Questions of applicability to real systems should be resolved by qualified personnel familiar with insulation systems design and analysis.

1.3 Estimated accuracy is limited by the following:

1.3.1 The range and quality of the physical property data for the insulation materials and system,

1.3.2 The accuracy of the methodology used in calculation of the bare valve and insulation surface areas, and

1.3.3 The quality of workmanship, fabrication, and installation.

1.4 This procedure is considered applicable both for conventional-type insulation systems and for removable/reusable covers. In both cases, for purposes of heat transfer calculations, the insulation system is assumed to be homogeneous.

1.5 This practice does not intend to establish the criteria required in the design of the equipment over which thermal insulation is used, nor does this practice establish or recommend the applicability of thermal insulation over all surfaces.

1.6 The values stated in inch-pound units are to be regarded as the standard. The SI units in parentheses are provided for information only.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

C 168 Terminology Relating to Thermal Insulation²

C 450 Practice for Prefabrication and Field Fabrication of

Thermal Insulation Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments²

C 680 Practice for Determination of Heat Gain or Loss and the Surface Temperatures of Insulated Pipe and Equipment Systems by the Use of a Computer Program²

C 1094 Guide for Removable Insulation Covers²

2.2 *American National Standards Institute Standard:*
ANSI B16.5 Fittings, Flanges, and Valves³

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology C 168.

3.2 *Symbols*—The following symbols are used in the development of the equations for this practice. Other symbols will be introduced and defined in the detailed description of the development. See Figs. 1 and 2.

A_B = outer surface area of the bare valve or flange (does not include the wheel and stem of the valve), ft² (m²).

A_I = surface area of the insulation cover over the valve or flange, ft² (m²).

C = distance from the center-line axis of the pipe (to which the valve is attached) to the uppermost position of the valve that is to be insulated (recommended to be below the gland seal), ft (m).

D_F = the valve flange and the bonnet flange outer diameter (assumed equal), ft (m).

D_P = the actual diameter of the pipe, ft (m).

L_V = overall length of the valve, flange to flange, ft (m).

T = thickness of the valve flange and of the bonnet flange, ft (m).

q_B = time rate of heat loss per unit area from the bare valve or flange surface, Btu/h·ft² (W/m²).

q_I = time rate of heat loss per unit area from the insulation surface, Btu/h·ft² (W/m²).

Q_B = time rate of heat loss from the bare valve or flange surface, Btu/h (W).

Q_I = time rate of heat loss from the insulated surface, Btu/h (W).

¹ This practice is under the jurisdiction of Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.30 on Thermal Measurement. Current edition approved June 30, 1989. Published August 1989.

² *Annual Book of ASTM Standards*, Vol 04.06.

³ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

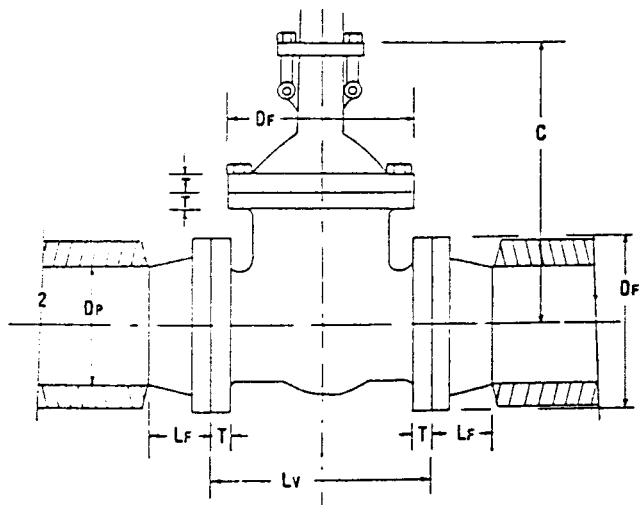


FIG. 1 Equation 1 for a Bare Valve, $A_{Bv} = [D_p (L_v + 2L_f + (C - D_p) 2) - 6T] + 1.5(D_f^2 - D_p^2) + 6 D_f T] \pi$

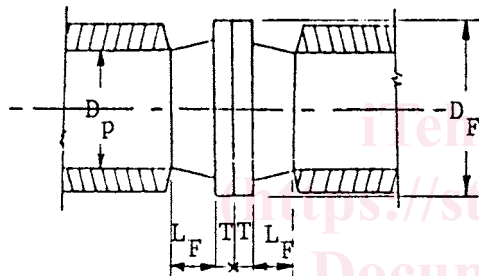


FIG. 2 Equation 2 for a Bare Flange, $A_{Bf} = [D_p (L_v + 2L_f - 4T) + (D_f^2 - D_p^2) + 4 D_f T] \pi$

4. Summary of Practice

4.1 The procedures for estimating heat loss used in this practice are based upon standard steady-state heat transfer theory as outlined in Practice C 680 (or programs conforming to it). This practice is used to estimate the heat loss per unit surface area for the particular conditions and for all configurations.

4.2 The procedures for estimating surface areas used in this practice are based on standard geometric logic: for a bare valve or flange, the contours of the metal surface are considered. For an insulated valve or flange, the fabricated shape of the finished insulation system is considered.

4.3 Data Input:

- 4.3.1 Total bare surface area and total insulation surface area of the bare valve or flange,
- 4.3.2 Service and ambient temperatures,
- 4.3.3 Wind speed,
- 4.3.4 Surface emittances,
- 4.3.5 Insulation thickness and type, and
- 4.3.6 Number of service hours per year.

4.4 System Description—Insulation thickness, insulation type, bare valve or flange surface emittance, insulation surface emittance.

4.5 Analysis—Once input data is entered, the program calculates the surface coefficients (if not entered directly), the insulation resistance, the bare metal heat loss per unit area, and the insulation surface heat loss per unit area. The rate of heat loss per unit area is computed by Practice C 680 for the appropriate diameter. For bare gate valves, the particular surface area can be taken from a look-up table. Table 1 gives these areas for typical (ANSI Class 150, 300, 600, and 900) flanged gate valves and flanges. If these valves are not considered sufficiently accurate, they can be calculated using Eq 1 (see Fig. 1) and Eq 2 (see Fig. 2). Similar equations can be developed for other types of valves and flanges. For the insulation, the outer surface area may be obtained from the insulation fabricator or contractor.

5. Significance and Use

5.1 Manufacturers of thermal insulation for valves typically express the performance of their products in charts and tables showing heat loss per valve. These data are presented for both bare and insulated valves of different pipe sizes, ANSI classes, insulation types, insulation thicknesses, and service temperatures. Additional information on effects of wind velocity, jacket emittance, bare valve emittance, and ambient conditions may also be required to properly select an insulation system. Due to the infinite combination of pipe sizes, ANSI classes, insulation

TABLE 1 Calculated Surface Areas of Bare Valves

NPS, in.	ANSI Class			
	150 ft ² (m ²)	300 ft ² (m ²)	600 ft ² (m ²)	900 ft ² (m ²)
2	2.21 (0.205)	2.94 (0.273)	2.94 (0.273)	5.20 (0.483)
2½	2.97 (0.276)	3.51 (0.326)	3.91 (0.363)	6.60 (0.613)
3	3.37 (0.313)	4.39 (0.408)	4.69 (0.436)	6.50 (0.604)
4	4.68 (0.435)	6.06 (0.563)	7.64 (0.710)	9.37 (0.870)
6	7.03 (0.653)	9.71 (0.902)	13.03 (1.210)	15.80 (1.468)
8	10.30 (0.957)	13.50 (1.254)	18.40 (1.709)	23.80 (2.211)
10	13.80 (1.284)	18.00 (1.672)	26.50 (2.462)	32.10 (2.982)
12	16.10 (1.496)	24.10 (2.239)	31.90 (2.964)	41.90 (3.893)
14	22.80 (2.118)	32.50 (3.019)	39.70 (3.688)	48.20 (4.978)
16	27.60 (2.564)	39.30 (3.651)	50.50 (4.691)	57.00 (5.295)
18	31.70 (2.945)	49.40 (4.589)	59.80 (5.555)	69.70 (6.475)
20	37.70 (3.502)	59.10 (5.490)	71.30 (6.624)
24	49.10 (4.561)	83.50 (7.757)	95.10 (8.835)
30	72.20 (6.707)	123.30 (11.46)	141.70 (13.6)
36	107.30 (9.968)	164.00 (15.24)	199.00 (18.49)

types and thicknesses, service temperatures, insulation cover geometries, surface emittances, and ambient conditions, it is not possible to publish data for each possible case.

5.2 Users of thermal insulation for piping systems faced with the problem of designing large systems of insulated piping, encounter substantial engineering costs to obtain the required thermal information. This cost can be substantially reduced by both the use of accurate engineering data tables, or by the use of available computer analysis tools, or both.

5.3 The use of this practice by the manufacturer, contractor, and users of thermal insulation for valves and flanges will provide standardized engineering data of sufficient accuracy and consistency for predicting the savings in heating energy use by insulating bare valves and flanges.

5.4 Computers are now readily available to most producers and consumers of thermal insulation to permit use of this practice.

5.5 The computer program in Practice C 680 has been developed to calculate the heat loss per unit length, or per unit surface area, of both bare and insulated pipe. With values for bare valve or flange surface areas, heat loss can be estimated. By estimating the outer insulation surface area from an insulation manufacturer's or contractor's drawings, the heat loss from the insulation surface can likewise be calculated by taking the product of heat loss per unit area (from programs conforming to Practice C 680) and the valve or flange insulation surface area. The area of the uninsulated surfaces may also need to be considered.

5.6 The use of this practice requires that the valve or flange insulation system meets Guide C 1094 and Practice C 450, where applicable.

6. Calculation

6.1 This calculation of heat gain or loss requires the following:

6.1.1 The thermal insulation shall be assumed to be homogeneous as outlined by the definition of thermal conductivity in Terminology C 168.

6.1.2 The valve or flange size and operating temperature shall be known.

6.1.3 The insulation thickness shall be known.

6.1.4 Values of wind speed and surface emittance shall be available to estimate the surface coefficients for both the bare surface and for the insulation.

6.1.5 The surface temperature in each case shall be assumed to be uniform.

6.1.6 The bare surface dimensions or area shall be known.

6.1.7 The outer surface area of the insulation cover can be estimated from drawings or field measurements.

6.1.8 Practice C 680 or other comparable methodology shall be used to estimate the heat loss from both bare and insulated surfaces.

6.2 *Estimation of Rate of Heat Loss from the Bare Surface*—Since Practice C 680 needs to perform iterations in calculating heat flow across an insulation surface, an uninsulated surface must be simulated. To do this, select a thin insulation (with a thickness of 0.02 in. (0.5 mm)) and a thermal curve giving a high thermal conductivity. It is recommended

that Type 1 be selected for which the following constants are assigned: $a = 10 \text{ Btu}\cdot\text{in.}/\text{h}\cdot\text{ft}^2\cdot\text{F}$ (1.44 W/m \cdot c), $b = 0$, and $c = 0$.

6.2.1 Run Practice C 680 for either a horizontal or a vertical pipe of the appropriate diameter, inputting the ambient air temperature, wind speed, and bare valve surface emittance. Unless information is available for estimating the bare valve surface emittance, it is suggested that a value of 0.9 be selected. Select output in units of heat loss per unit surface area. This value of heat loss per unit bare surface area is designated q_B .

6.3 *Use of Practice C 680 for the Insulated Valve or Flange*—Since Practice C 680 is designed to calculate heat loss for insulated flat surfaces and for pipes, it is necessary to treat the insulated valve as an insulated pipe. It is recommended that the diameter of the pipe, to which the valve fits, or the diameter of the flanges be selected for the calculation. Input the same ambient air temperature and wind speed as in 6.1 and estimate the insulation surface emittance. For a removable insulation cover, this would be the emittance of the fabric or metal jacket. For conventional insulation, this is either the emittance of that material or of the jacketing, if jacketing is used. The value of heat loss per unit insulation surface area is designated q_I .

6.4 *Surface Area of the Bare Valve or Flange*—Fig. 1 gives a diagram of a gate valve with the dimensions D_P , L_V , T , L_F , D_F , and C as indicated. Eq 1 (see Fig. 1) gives a method for estimating the surface area of valves, and Eq 2 (see Fig. 2) gives a method for estimating the surface area of flanges. Table 1 gives the results of calculating the surface area for 2-in. through 36-in. NPS gate valves for ANSI classes of 150, 300, 600 and 900. The value of a bare valve or flange is designated A_B .

6.5 *Surface Area of the Insulated Valve or Flange*—The estimation of the outer insulation surface area is best performed by the manufacturer or the insulation contractor. This surface area will depend on the dimensions of the valve or flange being insulated, the thickness of the insulation, and the extent of coverage to either side of the valve or flange. This practice does not recommend a specific method for arriving at this area, which would be designated as A_I .

6.6 *Calculation of Bare Valve or Flange Heat Loss*—This value is determined by taking the product of the bare valve or flange heat loss per unit surface area and of the bare surface area. It will be designated as Q_B :

$$Q_B = q_B A_B \quad (1)$$

6.7 *Calculation of Insulated Valve or Flange Heat Loss*—This value is determined by taking the product of the insulated valve or flange heat loss per unit surface area and of the insulation outer surface area. It would be designated as Q_I :

$$Q_I = q_I A_I \quad (2)$$

6.8 *Calculation of Heat Loss Savings*—This value is determined by taking the difference between the values of heat loss for the bare and the insulated valve or flange. It would be designated as Q_{B-I} :

$$Q_{B-I} = Q_B - Q_I \quad (3)$$