

based on the conductivities in Table 4 and were computed from data given in Chapter 22 of THE GUIDE, 1931, in the following manner:

*Example 1.* Determine the coefficient of transmission ( $U$ ) in Btu per hour per square foot of pipe surface through a 1-in. thickness of magnesia insulation on a 4-in. pipe. The temperature of the pipe is 210 F and the surrounding air temperature is 70 F.

TABLE 3. AREAS OF FLANGED FITTINGS, SQUARE FEET<sup>a</sup>

| NOMINAL<br>PIPE SIZE<br>(INCHES) | FLANGED<br>COUPLING |                | 90 DEG. ELL |                | LONG RADIUS<br>ELL |                | TEE      |                | CROSS    |                |
|----------------------------------|---------------------|----------------|-------------|----------------|--------------------|----------------|----------|----------------|----------|----------------|
|                                  | Standard            | Extra<br>Heavy | Standard    | Extra<br>Heavy | Standard           | Extra<br>Heavy | Standard | Extra<br>Heavy | Standard | Extra<br>Heavy |
|                                  |                     |                |             |                |                    |                |          |                |          |                |
| 1                                | 0.320               | 0.438          | 0.795       | 1.015          | 0.892              | 1.083          | 1.235    | 1.575          | 1.622    | 2.07           |
| 1 1/4                            | 0.383               | 0.510          | 0.957       | 1.098          | 1.084              | 1.340          | 1.481    | 1.925          | 1.943    | 2.53           |
| 1 1/2                            | 0.477               | 0.727          | 1.174       | 1.332          | 1.337              | 1.874          | 1.815    | 2.68           | 2.38     | 3.54           |
| 2                                | 0.672               | 0.848          | 1.65        | 2.01           | 1.84               | 2.16           | 2.54     | 3.09           | 3.32     | 4.06           |
| 2 1/2                            | 0.841               | 1.107          | 2.09        | 2.57           | 2.32               | 2.76           | 3.21     | 4.05           | 4.19     | 5.17           |
| 3                                | 0.945               | 1.484          | 2.38        | 3.49           | 2.68               | 3.74           | 3.66     | 5.33           | 4.77     | 6.95           |
| 3 1/2                            | 1.122               | 1.644          | 2.98        | 3.96           | 3.28               | 4.28           | 4.48     | 6.04           | 5.83     | 7.89           |
| 4                                | 1.344               | 1.914          | 3.53        | 4.64           | 3.96               | 4.99           | 5.41     | 7.07           | 7.03     | 9.24           |
| 4 1/2                            | 1.474               | 2.04           | 3.95        | 5.02           | 4.43               | 5.46           | 6.07     | 7.72           | 7.87     | 10.07          |
| 5                                | 1.622               | 2.18           | 4.44        | 5.47           | 5.00               | 6.02           | 6.81     | 8.52           | 8.82     | 10.97          |
| 6                                | 1.82                | 2.78           | 5.13        | 6.99           | 5.99               | 7.76           | 7.84     | 10.64          | 10.08    | 13.75          |
| 8                                | 2.41                | 3.77           | 6.98        | 9.76           | 8.56               | 11.09          | 10.55    | 14.74          | 13.44    | 18.97          |
| 9                                | 3.00                | 4.44           | 8.71        | 11.44          | 10.57              | 13.17          | 13.18    | 17.23          | 16.78    | 22.10          |
| 12                               | 4.41                | 6.71           | 13.08       | 17.73          | 16.35              | 18.76          | 19.67    | 26.65          | 24.87    | 34.11          |

<sup>a</sup>Including areas of accompanying flanges bolted to the fitting.

TABLE 4. CONDUCTIVITIES ( $k$ ) OF VARIOUS TYPES OF INSULATING MATERIALS FOR MEDIUM AND HIGH TEMPERATURE PIPES<sup>a</sup>

|                                                                | MEAN TEMPERATURE |       |       |       |       |
|----------------------------------------------------------------|------------------|-------|-------|-------|-------|
|                                                                | 100 F            | 200 F | 300 F | 400 F | 500 F |
| 85 per cent Magnesia Type                                      | 0.425            | 0.465 | 0.505 | 0.550 | 0.590 |
| Corrugated Asbestos Type<br>(4 Plies per 1 in. thick)          | 0.530            | 0.650 | 0.770 | 0.890 |       |
| Corrugated Asbestos Type<br>(8 Plies per 1 in. thick)          | 0.480            | 0.555 | 0.630 | 0.705 |       |
| Laminated Asbestos Type<br>(30-40 Laminations per 1 in. thick) | 0.360            | 0.415 | 0.470 | 0.525 | 0.585 |
| Laminated Asbestos Type<br>(20 Laminations per 1 in. thick)    | 0.545            | 0.605 | 0.665 | 0.725 | 0.785 |
| Rock Wool Type                                                 | 0.350            | 0.410 | 0.470 | 0.530 | 0.590 |
| High Temperature Type<br>(Diatomaceous Earth and Asbestos)     | 0.515            | 0.545 | 0.575 | 0.605 | 0.635 |
| Brown Asbestos Type<br>(Felted Fibre)                          | 0.600            | 0.640 | 0.675 | 0.715 | 0.750 |

<sup>a</sup>R. H. Heilman, *Mechanical Engineering*, Vol. 46 (1924), p. 593.

*Solution.* The heat loss coefficient for a 1-in. thickness of pipe insulation for a temperature difference of 140 deg (from Fig. 5, Chapter 22, THE GUIDE, 1931) is 0.367 Btu per hour per square foot per degree Fahrenheit difference in temperature. The factor for magnesia covering at a temperature difference of 140 deg is 1.214 (by interpolation from Table 7, Chapter 22, THE GUIDE, 1931). The coefficient of transmission is therefore  $0.367 \times 1.214$  or 0.446. (See Table 5).

TABLE 5. COEFFICIENTS OF TRANSMISSION ( $U$ ) FOR PIPES INSULATED WITH 85 PER CENT MAGNESIA TYPE INSULATION

*These coefficients are expressed in Btu per hour per square foot of pipe surface per degree Fahrenheit difference in temperature between pipe and surrounding still air at 70 F*

| THICKNESS<br>OF<br>INSULATION<br>(INCHES) | NOMINAL<br>PIPE<br>SIZE<br>(INCHES) | HOT WATER              |       |       |       | STEAM             |                    |                     |
|-------------------------------------------|-------------------------------------|------------------------|-------|-------|-------|-------------------|--------------------|---------------------|
|                                           |                                     | 120 F                  | 150 F | 180 F | 210 F | 227.2 F<br>(5 Lb) | 298.7 F<br>(10 Lb) | 337.9 F<br>(100 Lb) |
|                                           |                                     | TEMPERATURE DIFFERENCE |       |       |       |                   |                    |                     |
|                                           |                                     | 50 F                   | 80 F  | 110 F | 140 F | 157.2 F           | 228.7 F            | 267.9 F             |
| 1                                         | 1/2                                 | 0.744                  | 0.754 | 0.764 | 0.774 | 0.779             | 0.802              | 0.814               |
|                                           | 3/4                                 | 0.672                  | 0.681 | 0.689 | 0.697 | 0.701             | 0.721              | 0.731               |
|                                           | 1                                   | 0.613                  | 0.621 | 0.629 | 0.637 | 0.641             | 0.659              | 0.670               |
|                                           | 1 1/4                               | 0.562                  | 0.570 | 0.577 | 0.585 | 0.589             | 0.606              | 0.617               |
|                                           | 1 1/2                               | 0.532                  | 0.539 | 0.546 | 0.553 | 0.557             | 0.573              | 0.582               |
|                                           | 2                                   | 0.500                  | 0.506 | 0.512 | 0.519 | 0.523             | 0.538              | 0.547               |
|                                           | 2 1/2                               | 0.475                  | 0.481 | 0.487 | 0.493 | 0.497             | 0.512              | 0.520               |
|                                           | 3                                   | 0.455                  | 0.461 | 0.467 | 0.474 | 0.477             | 0.492              | 0.500               |
|                                           | 3 1/2                               | 0.441                  | 0.447 | 0.452 | 0.458 | 0.462             | 0.475              | 0.483               |
|                                           | 4                                   | 0.429                  | 0.435 | 0.441 | 0.446 | 0.449             | 0.463              | 0.471               |
|                                           | 4 1/2                               | 0.420                  | 0.425 | 0.431 | 0.437 | 0.440             | 0.453              | 0.460               |
|                                           | 5                                   | 0.411                  | 0.416 | 0.422 | 0.427 | 0.430             | 0.443              | 0.450               |
| 1 1/2                                     | 6                                   | 0.402                  | 0.408 | 0.413 | 0.419 | 0.422             | 0.435              | 0.442               |
|                                           | 8                                   | 0.387                  | 0.392 | 0.397 | 0.403 | 0.405             | 0.418              | 0.425               |
|                                           | 9                                   | 0.380                  | 0.385 | 0.390 | 0.395 | 0.398             | 0.410              | 0.417               |
|                                           | 12                                  | 0.369                  | 0.374 | 0.378 | 0.383 | 0.386             | 0.398              | 0.405               |
|                                           | 1/2                                 | 0.617                  | 0.625 | 0.633 | 0.642 | 0.646             | 0.665              | 0.676               |
|                                           | 3/4                                 | 0.550                  | 0.558 | 0.566 | 0.573 | 0.577             | 0.596              | 0.606               |
|                                           | 1                                   | 0.496                  | 0.503 | 0.511 | 0.518 | 0.522             | 0.540              | 0.549               |
|                                           | 1 1/4                               | 0.453                  | 0.459 | 0.465 | 0.472 | 0.475             | 0.490              | 0.498               |
|                                           | 1 1/2                               | 0.424                  | 0.430 | 0.436 | 0.442 | 0.445             | 0.459              | 0.467               |
|                                           | 2                                   | 0.394                  | 0.400 | 0.405 | 0.410 | 0.413             | 0.427              | 0.434               |
|                                           | 2 1/2                               | 0.371                  | 0.376 | 0.382 | 0.386 | 0.389             | 0.401              | 0.408               |
|                                           | 3                                   | 0.352                  | 0.357 | 0.362 | 0.367 | 0.370             | 0.380              | 0.387               |
| 2                                         | 3 1/2                               | 0.339                  | 0.343 | 0.347 | 0.351 | 0.354             | 0.364              | 0.370               |
|                                           | 4                                   | 0.328                  | 0.333 | 0.337 | 0.341 | 0.343             | 0.353              | 0.359               |
|                                           | 4 1/2                               | 0.320                  | 0.324 | 0.328 | 0.332 | 0.334             | 0.343              | 0.350               |
|                                           | 5                                   | 0.312                  | 0.316 | 0.320 | 0.324 | 0.326             | 0.336              | 0.342               |
|                                           | 6                                   | 0.303                  | 0.307 | 0.311 | 0.315 | 0.318             | 0.328              | 0.333               |
|                                           | 8                                   | 0.287                  | 0.291 | 0.295 | 0.299 | 0.301             | 0.311              | 0.316               |
|                                           | 9                                   | 0.280                  | 0.284 | 0.288 | 0.292 | 0.294             | 0.303              | 0.308               |
|                                           | 12                                  | 0.272                  | 0.275 | 0.279 | 0.283 | 0.285             | 0.294              | 0.299               |
|                                           | 1/2                                 | 0.543                  | 0.551 | 0.558 | 0.565 | 0.569             | 0.587              | 0.597               |
|                                           | 3/4                                 | 0.484                  | 0.490 | 0.497 | 0.503 | 0.507             | 0.523              | 0.532               |
|                                           | 1                                   | 0.433                  | 0.439 | 0.445 | 0.451 | 0.454             | 0.467              | 0.476               |
|                                           | 1 1/4                               | 0.393                  | 0.398 | 0.403 | 0.409 | 0.412             | 0.424              | 0.432               |
| 2 1/2                                     | 1 1/2                               | 0.365                  | 0.370 | 0.376 | 0.381 | 0.384             | 0.397              | 0.402               |
|                                           | 2                                   | 0.338                  | 0.343 | 0.347 | 0.351 | 0.354             | 0.364              | 0.370               |
|                                           | 2 1/2                               | 0.316                  | 0.320 | 0.324 | 0.328 | 0.331             | 0.341              | 0.347               |
|                                           | 3                                   | 0.297                  | 0.301 | 0.305 | 0.309 | 0.312             | 0.321              | 0.326               |
|                                           | 3 1/2                               | 0.284                  | 0.288 | 0.292 | 0.295 | 0.297             | 0.306              | 0.311               |
|                                           | 4                                   | 0.275                  | 0.278 | 0.282 | 0.285 | 0.287             | 0.296              | 0.301               |
|                                           | 4 1/2                               | 0.266                  | 0.270 | 0.273 | 0.276 | 0.278             | 0.286              | 0.290               |
|                                           | 5                                   | 0.258                  | 0.262 | 0.265 | 0.268 | 0.270             | 0.278              | 0.283               |
|                                           | 6                                   | 0.250                  | 0.254 | 0.257 | 0.260 | 0.262             | 0.270              | 0.274               |
|                                           | 8                                   | 0.236                  | 0.239 | 0.242 | 0.245 | 0.247             | 0.255              | 0.258               |
|                                           | 9                                   | 0.228                  | 0.231 | 0.234 | 0.237 | 0.239             | 0.246              | 0.250               |
|                                           | 12                                  | 0.219                  | 0.222 | 0.225 | 0.228 | 0.230             | 0.237              | 0.240               |