



## Standard Practice for Evaluating Thermal Conductivity of Gasket Materials<sup>1</sup>

This standard is issued under the fixed designation F 433; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This practice covers a means of measuring the amount of heat transfer quantitatively through a material or system.

1.2 This practice is similar to the Heat Flow Meter System of Method C 518, but modified to accommodate small test samples of higher thermal conductance.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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 518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus<sup>2</sup>

D 2214 Test Method for Estimating the Thermal Conductivity of Leather with the Cenco-Fitch Apparatus<sup>3</sup>

F 104 Classification System for Nonmetallic Gasket Materials<sup>4</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *thermal conductivity,  $k$ , of a solid material*—the time rate of steady heat flow, watts (or Btu/h), through a unit area,  $\text{m}^2$  (or  $\text{ft}^2$ ), per unit temperature gradient in the direction perpendicular to an isothermal surface  $^{\circ}\text{C}/\text{m}$  (or  $^{\circ}\text{F}/\text{in.}$ ). The  $k$ -factor is expressed  $\text{W}/\text{m}\cdot\text{K}$  ( $\text{Btu}\cdot\text{in.}/\text{h}\cdot\text{ft}^2\cdot^{\circ}\text{F}$ ).

#### 3.2 Symbols:

|     |                                                                                                                                        |
|-----|----------------------------------------------------------------------------------------------------------------------------------------|
| $k$ | = thermal conductivity, $\text{W}/\text{m}\cdot\text{K}$ ( $\text{Btu}\cdot\text{in.}/\text{h}\cdot\text{ft}^2\cdot^{\circ}\text{F}$ ) |
| $C$ | = thermal conductance, $\text{W}/\text{m}^2\cdot\text{K}$ ( $\text{Btu}/\text{h}\cdot\text{ft}^2\cdot^{\circ}\text{F}$ )               |

|               |                                                                                                                                                      |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\Delta x$    | = sample thickness, mm (in.)                                                                                                                         |
| $A$           | = sample cross-sectional area, $\text{m}^2$ ( $\text{ft}^2$ )                                                                                        |
| $q$           | = heat flow, W (Btu/h)                                                                                                                               |
| $\phi$        | = heat flow transducer output, mV                                                                                                                    |
| $N$           | = heat flow transducer calibration constant, $\text{W}/\text{m}^2\cdot\text{mV}$ ( $\text{Btu}/\text{h}\cdot\text{ft}^2\cdot\text{mV}$ )             |
| $N\phi$       | = heat flux, $\text{W}/\text{m}^2$ ( $\text{Btu}/\text{h}\cdot\text{ft}^2$ )                                                                         |
| $\Delta T$    | = temperature difference, $^{\circ}\text{C}$ ( $^{\circ}\text{F}$ ) or mV                                                                            |
| $T_1$         | = temperature of lower sample surface, $^{\circ}\text{C}$ ( $^{\circ}\text{F}$ ) or mV                                                               |
| $T_2$         | = temperature of upper sample surface, $^{\circ}\text{C}$ ( $^{\circ}\text{F}$ ) or mV                                                               |
| $T_h$         | = temperature of HFT surface facing sample, $^{\circ}\text{C}$ ( $^{\circ}\text{F}$ ) or mV                                                          |
| $T_c$         | = temperature of upper heater surface facing sample, $^{\circ}\text{C}$ ( $^{\circ}\text{F}$ ) or mV                                                 |
| $T$           | = temperature, $^{\circ}\text{C}$ ( $^{\circ}\text{F}$ )                                                                                             |
| $\delta$      | = total temperature drop across interfaces between sample and adjacent surfaces, $^{\circ}\text{C}$ ( $^{\circ}\text{F}$ ) or mV                     |
| $\rho$        | = coefficient of thermal resistance at interfaces, $\text{m}^2\cdot\text{K}/\text{W}$ ( $\text{h}\cdot\text{ft}^2\cdot^{\circ}\text{F}/\text{Btu}$ ) |
| $\alpha$      | = correction constant                                                                                                                                |
| subscript $s$ | = unknown sample                                                                                                                                     |
| subscript $r$ | = known calibration sample                                                                                                                           |

### 4. Summary of Practice

4.1 The sample and the heat flow transducer (HFT) are sandwiched between two controlled heater plates. The lower heater is set at a higher temperature than the upper plate to produce a flow of heat through the sample. The differential of these two temperatures,  $\Delta T$ , sensed by thermocouples, is amplified along with the electrical output,  $\phi$ , of the HFT and is directly proportional to the heat flow through the sample, expressed as  $\text{W}/\text{m}^2$  ( $\text{Btu}/\text{h}\cdot\text{ft}^2$ ). See Appendix for further information. This recommended practice can be used for measuring heat transfer at a hot side temperature up to  $200^{\circ}\text{C}$  ( $392^{\circ}\text{F}$ ). See Figs. 1-5.

### 5. Significance and Use

5.1 This practice is designed to compare related materials under controlled conditions and their ability to maintain a minimum amount of thermal conductance. Test results should be correlated with field results in order to predict heat transfer properties in particular applications.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee F03 on Gaskets and is the direct responsibility of Subcommittee F03.10 on Composite Gaskets. Current edition approved October 10, 2002. Published October 2002.

<sup>2</sup> Annual Book of ASTM Standards, Vol 04.06.

<sup>3</sup> Annual Book of ASTM Standards, Vol 15.04.

<sup>4</sup> Annual Book of ASTM Standards, Vol 09.02.