Estimate of the Heat Gain or Loss and the Surface Temperatures of Flat, Cylindrical, and Spherical Refractory Lining Systems

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Introduction

ASTM C680 provides equations and guidance for thermal heat transfer calculations. Accurate refractory thermal calculations could not be produced by following ASTM C680.

API 985 was written to address these concerns, providing a corrected and better organized set of equations and formulas and explanations and guidelines for their use.

The calculation of surface temperature and heat flux is mathematically complex and because of the iterative nature of the method, computers are best able to handle the calculations. Programs can facilitate user adjustments for the various parameters, as necessary to achieve desired results, via an interactive terminal. For those interested in creating a computer program, this practice provides a set of case study examples which can be used in the development process for program verification.

Estimate of the Heat Gain or Loss and the Surface Temperatures of Flat, Cylindrical, and Spherical Refractory Lining Systems

1 Scope

1.1 This document provides algorithms and calculation methodologies, commentary and case studies for estimating heat flux and surface temperature of various configurations of refractory-lined equipment.

1.2 This practice assumes that the refractory systems can be well defined in rectangular, cylindrical or spherical coordinate systems and that the refractory systems are composed of homogeneous, uniformly dimensioned materials that produce heat flow between two different temperature conditions.

1.3 Qualified personnel familiar with refractory systems design and analysis can address the applicability of the heat transfer theory in this practice to their specific user case. The range and quality of the thermal property data ("k" values) of the refractory materials comprising the lining system can have a severe impact on the calculation results.

1.4 All values in this practice are inch-pound units. Values in parentheses are mathematical conversions to SI units that are provided for information only.

1.5 A computer program can be generated from the algorithms and computational methodologies defined in this practice for horizontal and vertical plates, cylinders, pipes and hollow sphere systems.

2 Normative References

There are no normative references in this document.

3 Terms, Definitions, Abbreviations, Acronyms, and Symbols

3.1 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
cold face
The surface of a refractory lining against the metal casing surface, not directly exposed to the heat source.

3.1.2
emissivity
The capacity of a material for radiating heat; commonly expressed as a fraction or percentage of the ideal "black body" radiation of heat, which is the maximum theoretically possible.

3.1.3
heat flux
The rate of heat energy transfer per unit area.

3.1.4
hot face
The surface of a refractory section exposed to the source of heat.

3.1.5
hot face layer
In a multilayer or multicomponent lining, the refractory layer exposed to the highest temperatures.