Improvement of IR-emissivity of ceramic fibre by silicon carbide coating in furnaces

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Abstract

The paper describes a new method which increases radiation heat transfer of furnace refractory and partly increases the gas tightness and life span of the lining. As heating-up time is decreased, the method also makes the operation of the furnace more flexible. Application of silicon carbide furnace coating increases the emissivity of ceramic fibre insulation by 45%, while that of shamotte by 20%. The phenomenon is illustrated by infrared thermograms and their temperature analysis. IR-emissivity was measured by infrared thermograms. Industrial applications are also referred to.

1. Introduction

The appearance of some new furnace construction materials, e.g. ceramic fibre insulations and high emissivity coatings (such as 'ENECOAT') requires the revision of the wall structure of some furnaces. Research was done regarding a silicon carbide (SiC) based furnace coating. Its emissivity is considerably greater than that of the material onto which it was applied.

The basic phenomena resulting from the application of 'ENECOAT' and its thermal effects were examined in the case of several continuous furnaces of brick factories. The increase of heat radiation due to 'ENECOAT' coating of refractories decreases heat losses and results in the recuperator (cooling) part of the furnace a better cooling of brick piles and some decrease in environment pollution, too. The energy saving amounted to 4.8-6.2% and 3.8-4.4% in the case of natural gas fired and oil fired furnaces, respectively.

2. Thermophysical data

In the past forty years great attention has been paid to studying the emissivity of kiln linings [1],[2] and [3] as well as to energy conservation through utilisation of high emissivity coatings [4] and [5], the latter well complementing the use of low density insulating materials, such as ceramic fibres and refractory bricks [6] and [9].

The factors affecting the infrared radiation of furnace surfaces and high temperature industrial equipment have not yet been studied widely enough.

The efficiency by which materials radiate is defined as emissivity. Its value depends on the surface temperature and material properties of the radiating object's surface, and on the radiation wavelength. It has been shown that the emissivity of refractories drops as the temperature increases. Thus, for instance, if the emissivity of a given type of a shamotte refractory brick is 0.9 at a temperature of 130 °C , at 1030 °C the emissivity might well be 0.5 only (see Fig. 1. and Table 1.).

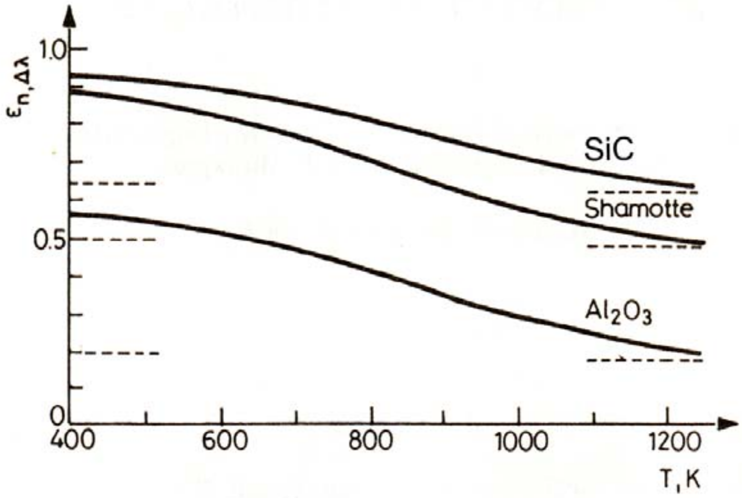

Fig. 1. *Spectral normal emissivity of SiC (as ENECOAT), shamotte and ceramic fibre (Al2O3) against material surface temperature*

Recent research has been focused on high emissivity coating of ceramic fibres, which increase the fibres' mechanical strength and the emitted energy. Experiments revealed that by employing a silicon carbide(SiC) based coating the emissivity of a ceramic fibre can be increased to 0.63 from 0.2 at 730 °C temperature (see Fig. 1.).

Table 1. *Total normal emissivity of different ceramic material*

Brick material	t, °C	Total normal emissivity
Shamotte	20	0.85
Shamotte	1000	0.75
Shamotte	1200	0.59
Corundum	1000	0.46
Magnesite	1000-1300	0.38

Ceramic fibre insulating materials (such as Al_2O_3) have poor heat radiation properties (see Fig. 2.) but their insulating property is good at operating temperatures up to 1200-1400 °C. However, ceramic fibre have much lower mechanical strength than traditional fireclay based materials. A recently opened way of dealing with these drawbacks is the application of a suitable coating materials. Their purpose is on one hand to improve the strength and surface properties of the ceramic fibre, and on the other hand to increase the infrared emissivity of the surface.

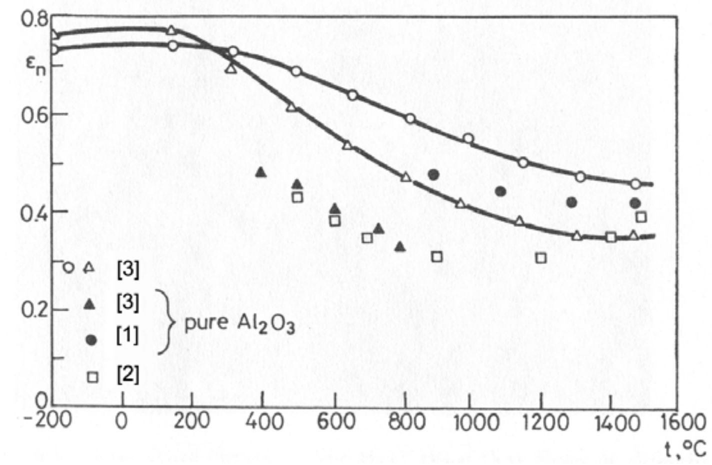

***Fig. 2**. Total normal emissivity of different Al2O3 material (in form of ceramic fibre)*

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