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Thermal Aging Effect on Thermal Conductivity Properties of Mineral Wool Pipe Samples at High Temperature

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Extended Abstract

Materials which are used for industrial insulations should be properly characterized by relevant properties such as thermal conductivity, fire safety, mechanical properties etc. But one of the main important parameter for industrial insulation materials and industrial applications is the long-time stability of insulation material properties or a knowledge about the change properties in time [1,2]. The goal of this investigation was to find the difference of thermal conductivity of mineral wool samples after high temperature treatment/thermal aging. Additionally mechanical properties of the samples were also monitored.

Three, with different diameters, mineral wool pipe samples obtained from the market were taken for investigation. Maximum service temperature for mineral wool product declared by manufacturer was 640°C, what means that above this temperature product should not be used. Density and thickness of the samples were respectively c.a. 100 kg/m^3, 40 mm and diameter of the samples were: 102, 122, 128 mm.

Thermal conductivity results of pipe samples were obtain from a state-of-the-art guarded end two chambers pipe apparatus, Quade Measurements based on EN 8497 [3]. Length of the heaters (and samples) were 1 meter. A pipe sample was mounted on the heater (depending on the diameter of the sample, different heater was used) and four thermocouples were located on the surface of the sample longitudinally at the centre of equal lengths of the test section and shall be equally spaced circumferentially in helical pattern. Samples were tested at different mean temperatures: T_{mean} = 100°C, 200°C, 300°C, 400°C, 500°C, 600°C. The difference of temperature between the pipe heater (warm side) and surface of the sample (cold side) was respectively from ΔT = 100K to 400K. Uncertainty of the results were ± 5%.

Mechanical properties were tested on the Universal Testing Machines Hounsfield U.T.M. Samples for mechanical properties tests were prepared by 48 hour heating by the heater (similar to the heater in the pipe apparatus). Temperature of the heater was: $T_{warm\ side}$ = 100°C, 200°C, 300°C, 400°C, 500°C, 600°C; ambient temperature: room temperature (23 ± 2) °C. The compressive strength of the laboratory samples after heating/ageing were recorded. The stress during the test was perpendicular to the surface of the laboratory samples.

Results showed there were significant change of the thermal and mechanical properties of the mineral wool samples. As one could expect after high temperature treatment/thermal aging the mechanical properties of the mineral wool pipe products decreased. A strong correlation between temperature of the sample treatment and values of the compressive strength of samples (for the same diameters) were observed. Interesting effect was observed for thermal conductivity results. The differences between thermal conductivity results at the same temperature of samples before and after temperature treatment were noticed. In contrast to mechanical properties, the increase of thermal properties was observed (thermal conductivity of samples after temperature treatment was lower than before temperature treatment).

References

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