Thermal and mechanical cyclic tests and fracture mechanics parameters as indicators of thermal shock resistance – case study of silica refractories

V. Tadaion*, T. Tonnesen, R. Telle

Institute of Mineral Engineering, RWTH Aachen University, D-52064, Aachen, Germany

K. Andreev

Ceramics Research Centre, Tata Steel Europe, 1951MD, Velsen Noord, The Netherlands

Q. Zhu, W. Wang, Y. Yin

The State Key Laboratory of Refractories and Metallurgy, Wuhan University of Science and Technology, 430081, Wuhan, China

Refractory linings of high-temperature industrial units often fail to sustain repetitive thermal loads induced by temperature fluctuations. Herein we have investigated the thermal shock resistance of two conventional silica bricks and two novice fused silica materials by three alternative methods. The applied methods were fracture mechanics tests of monotonic loading, cyclic thermal shock tests and strain-controlled cyclic fatigue tests. The fused silica materials crystallise rather rapidly in service. For this, the crystallised fused silica is more applicable for judging the behaviour of the fused silica linings. All three methods consistently predict superior thermal shock resistance for the crystallised fused silica due to less brittle behaviour. Strain tolerance is the key property to correlate the results of the utilized methods and those with the service loads. The strain-controlled fatigue test allows assessment of strain limits in the cyclic loading conditions and hence combines the benefits of the cyclic thermal shock and monotonic fracture mechanics tests.

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** Presenting author*

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Vahid Tadaion
Doctoral Candidate

RWTH Aachen University
Faculty of Georesources and Materials Engineering
GHI - Institute of Mineral Engineering
Department of Ceramics and Refractory Materials
Division Refractories

Mauerstrasse 5
52064 Aachen
Phone: +49 241 80-94983
Fax: +49 241 80-92226
Tadaion@ghi.rwth-aachen.de
www.ghi.rwth-aachen.de