



Concerted Effort in the European Refractory Sector to Consolidate and Make EN Testing Standards Future-Proof

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EN testing standards for refractory products are widely used throughout Europe, and even worldwide, for quality evaluation and the establishment of technical data sheets. European standards (EN) have helped with the harmonisation of trade within Europe and globally. Although EN testing standards are well-established and accepted, their roots stretch back over 60 years and to this day, their content has only been adjusted to modern processing technology. No global and in-depth investigation of the repeatability, precision and reproducibility of EN testing standards for refractory products have been carried out for decades.

Based on the common understanding that the fundament of EN testing standards for refractories needs to be consolidated and made future-proof, a research and innovation (R&I) consortium of refractory producers and refractory research institutes from throughout Europe have been formed to investigate, review and improve current EN testing standards. Started on 1 October 2013, the 24 month-long project ReStaR now enters into its final execution phase.

1 Introduction

ReStaR is the acronym of "Review and improvement of testing Standards for Refractory products" and brings together thirteen partners from the refractory sector for an European concerted R&I effort. The project is being supported by funding from the "Research for the benefit of SMEs" scheme under the 7th Research Framework Programme of the European Union. This funding scheme focuses on strengthening the competitiveness of SMEs and improving industrial competitiveness across the European Union. ReStaR is the first multinational refractory research project involving SMEs that is accepted for European funding. Supported by the European Refractory Producers Federation PRE, the representative organisation of the European refractory industry (Brussels/BE), and coordinated by the European Centre for Refractories ECREF (Höhr-Grenzhausen/DE), the project ReStaR aims at improving, promoting and ensuring the reliability, precision and efficiency of the most important EN testing standards for refractory products. The ReStaR project focuses primarily on five testing methods that are

applied to determine key physical properties of refractories: bulk density, open porosity, cold crushing strength, modulus of rupture, permanent linear change and refractoriness under load.

The European testing standards, describing how to apply these testing methods, introduce testing parameters as well as instructions for the test specimen's preparation that influence, to a greater or lesser degree, the results and the repeatability of a given testing method. Too vague definition of these testing parameters also leads to divergent laboratory practices and fluctuation in the results, in spite of adhering to the standards.

Different ways were adopted to review and improve the corresponding EN testing standards:

- Be more specific as regards testing parameters which are defined too vaguely in the current version of the EN testing standards, with the aim to improve repeatability and reproducibility of the testing results.
- Introducing new testing parameters, leading to an improvement of repeatability

and reproducibility of the results or helping to perform more reliable measurements.

- Possibly relaxing testing parameters that are too restrictive or burdensome, if this does not or does only marginally impact the repeatability and reproducibility of the testing results. Thereby, more flexibility in the use of EN testing standards may

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Tab. 1 The ReStaR project consortium

Participant	Role in the ReStaR consortium	Country	
European Centre for Refractories (ECREF)	Coordinating body	Germany	
Cerame-Unie/PRE	European Refractories Producers Association	Belgium	
Forschungsgemeinschaft Feuerfest e.V. (FGF)		Germany	
Instituto Tecnológico de Materiales (ITMA)		Spain	
ICAR		France	
Instytut Ceramiki i Materialow Budowlanych (ICiMB)		Poland	
Centre de Recherches de l'Industrie Belge de la Céramique (CRIBC)		Belgium	
LUCIDEON		Great Britain	
RHI		Austria	
Calderys		France	
Etablissement Haasser		SME refractory producer	France
Refractaria S.A.		SME refractory producer	Spain
European Committee for Standardization	Technical Standardization Committee	Belgium	

be achieved and they will become more user-friendly in their use, especially for SMEs.

More information about the background and objectives of the R&I project is available in issue 4/2013 of refractories WORLDFORUM [1] and on the project website (www.restar.eu).

2 Project progress

For the sound project execution with focus on the testing methods a four step work plan is applied:

- Phase 1: Analysis of the testing method to identify the relevant influencing testing parameters
- Phase 2: Appraisal of the influencing factors
- Phase 3: Checkout of the optimized testing method
- Phase 4: Drafting of reviewed testing standards.

The first phase of the project was dedicated to a systematic and comprehensive investigation of the potential testing parameters that can influence the repeatability, reliability and efficiency of each of the testing standards under examination (phase 1). Using various designs of experiments and statistical evaluation, influencing testing parameters were identified and qualified. Some intuitive effects were experimentally confirmed. Other testing parameters were found to have much less impact than ex-

pected. Finally even counter-intuitive effects were brought to light.

The second phase of the project aims at quantifying the impact of the testing parameters, identified in phase 1, that are relevant in practice. For each testing method under investigation, specifically designed study (factorial experiments) involving at least four different RTD performers were performed. A factorial experiment is a strategy to draw conclusions about more than one factor, or variable in an astute and time-saving manner. Factors are thereby deliberately simultaneously varied, instead of one at a time. Using statistical laws, an efficient evaluation of the effects and possible interactions of the influencing testing parameters are achieved. In addition, data relating to the reproducibility of the investigated methods for different kind of refractory materials were assessed.

Results and findings gained during phase 1 and phase 2 of the ReStaR project are summarized in a series of articles present in this issue of refractories WORLDFORUM [2–3, 5–6].

3 Future activities

After completing phase 2, collaborative tests (round robin test) involving eight RTD performers and two SMEs refractory producers will be carried out (phase 3). For each testing method under investigation, samples from five kind of refractory prod-

ucts (dense shaped, dense unshaped, carbon bonded shaped, heat-isolating shaped and heat-isolating unshaped) are distributed within the project partners and tested according to the better defined investigated testing standards. Based on the results of these collaborative tests, precision data will be gained and support a revision process for the testing standards under examination. Finally, on the basis of the expertise and results gained during the phases 1 to 3 of the ReStaR project, drafts for revised testing standards and recommendations for the investigated EN testing standards will be worked out (phase 4). In parallel, dissemination of the results raises the awareness of the refractory industry's stakeholders through information.

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