



One day short course
Tuesday September 26th , 2023
8:00 a.m. – 4:00 p.m



FIRE SHORT COURSE: Drying of Refractory Castables from scientific fundamentals to technological applications

Learning Outcomes: The course will provide a state-of-the-art understanding of refractory castable drying, highlighting the general aspects and stages of the process, the phase transformations for different binder systems, the main drying agents' mechanisms, experimental and modeling techniques used for deepening into this complex subject, and ultimately, insights for the design of heating schedules based on computer simulations. The fundamentals and examples to be presented will highlight that the safe and efficient drying of refractory castables is a challenging and key task, mainly in the current context of maximum energy efficiency and lowest environmental impacts.

Audience: Engineers, scientists, students, technicians and managers who are interested on understanding the fundamentals and how they can be applied to safely conduct the drying of monolithics.

Prerequisites: None are required. Nevertheless, some technical background in ceramics and materials science at an undergraduate level would be helpful. The course is intended for a broad spectrum of people willing to learn the fundamentals of drying refractories and how to obtain insights into the design of a heating schedule.

Included in the registration: PDF copies of the most significant papers related to the topics to be presented in the course, lunch and 2 coffee breaks.

Registration Fees: Regulars: € 450,00 - Industrial FIRE members: € 390,00
Students: € 150,00

Online Registration: [FIRE Short Course Registration](#)



Venue: Kap Europa
Osloer Str. 5
60327 Frankfurt am Main
Germany



HOST
Deutsche Feuerfest Industrie e.V. 

ORGANISATION
European Centre for Refractories 

UNITECR 2023



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Course Outline

1. General aspects of the drying process of dense refractory castables

Problem introduction

2. Main drying stages

Evaporation, ebullition and hydrate decomposition

Moisture clogging, thermomechanical strains and spalling mechanisms

3. Phase transformations of some binder systems

Hydraulic binders: Calcium aluminate cement (CAC) and hydratable alumina (HA)

Colloidal silica and alumina

Chemical binder (phosphates)

4. Main drying agents and how do they affect the castables' properties

Polymeric fibers

Types of fibers added to refractory castables to enhance their drying behavior

How does the particle size distribution (PSD) affect the fibers' selection?

Geometrical aspects of the fibers (experimental and numerical results)

How to select a polymeric fiber?

Metallic additives applied for improving the gas permeability of refractories

Other likely additives

5. Experimental techniques used to assess the water removal of dense ceramics

TGA and explosion tests

Large scale tests

In situ measurements of the water vapor pressure

Magnetic Resonance Imaging (MRI), Nuclear Magnetic Resonance (NMR) and X-ray Tomography

Neutron Tomography

Industrial Process Sensors

6. Modelling of drying

Historical Development

What suits our needs?

Where and how can we apply such models?

Future trends and forecasts

7. Design of drying schedules for different refractory compositions

The multiple options for drying curves

Heating rates' influence on the drying behavior

TGA results

Neutron tomography results

Numerical models

Constant heating rate

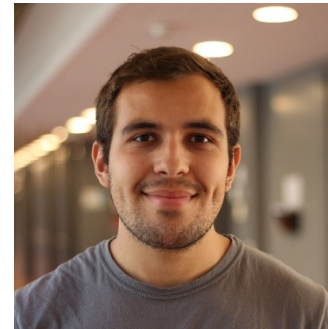
Use of plateaus

Continuous heating or temperature plateaus

Impact of the castables' dimensions on the spalling resistance
(ELKEM/GEMM experiments + models)

8. Final remarks

Lecturers:



Eng. MSc. Murilo H. Moreira



Prof. Victor C. Pandolfelli



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