

e-Newsletter N°46 – December 2021

www.icar-cm2t.com

Studies: Attack of refractory and metallic materials under hydrogenated conditions

In order to characterise the attack of many different materials by very specific gas compositions (Hydrogenated, Sulphurous, Carboreductive...) ICAR-CM2T offers, through customised tests, a wide choice of chemical compositions of atmospheres, under pressure or not and at extreme temperatures. The particularity of these tests is to be able to show, by non-destructive characterisation methods or by sampling, the evolution of the behaviour of materials in the face of these different attacks as a function of time.

Dedicated gas mixing equipment, suitable for hydrogen

It was made possible to put refractory materials in "real condition" with the help of a mix equipment. Materials from the steel industry can be brought into contact with highly carbo-reducing atmospheres (CO + H2), materials from the glass industry with soda atmospheres or materials selected for future developments in hydrogen combustion in the presence of fuel mixtures with a high H2 content.

The output of this device is connected to various heat treatment equipment. For some applications, a sealed furnace with a cooled door ensures the purity of the atmosphere to be brought into contact with the materials by a purging system (vacuum and inert gas filling cycles). It was also tested and approved the possibility of joining the outlet of the mixing plate to a mist tank allowing the addition of water particles charged with ionic species in the gas flow and to observe the impact of these ions on certain materials at over 1400°C.



Multi-gas mixing plate



furnace whose walls can also react with the gas mixture was considered and passivation solutions were successfully tested. The picture on the right shows a copper mask ordered for testing under a 15% H2 in carbon monoxide mixture. Such a mixture in a temperature range close to 600°C leads to a very strong reaction of the stainless steel walls constituting the housing. The use of this mask made it possible to protect the walls and to carry out such a test.

The possibility of carrying out the tests in a

Sealed box oven

We are planning future tests under 100% H2 at temperatures of around 1000°C.

Some examples of experimental conditions

A recent test was carried out on a composition of 75% H2 and 25% CO at 2 bars at 630° C for 4 cycles of 60h.

Samples were taken at the end of each 60h cycle, and the same 3 specimens were selected for systematic resonance frequency characterisation tests at the end of each cycle.

The results made it possible to discriminate between the 7 materials present in relation to each other in the face of this treatment.

The figure opposite shows an example of the depletion of the mechanical properties induced by a hydrogenated and carbo-reductive gas treatment on the selected materials over time.



Copper passivating mask

Discrimination between different materials in terms of their resistance to hydrogen

ICAR-CM2T – Ingénierie Matière - 4 Rue Lavoisier - 54300 MONCEL LES LUNEVILLE Tél. : +33 (0)3 83 76 39 39 - Fax : +33 (0)3 83 76 39 40 1/3



e-Newsletter N°46 – December 2021



Arrangement of several materials in the alumina box for reaction with sodium



Measurement of the attack of the materials making up a glass furnace in the presence of sodium following the incorporation of hydrogen into the flue gas at 1410°C.

In the glassmaking environment, the addition of hydrogen as a fuel leads to the sublimation of sodium. A specific bench was designed to admit sodium species inside an alumina box maintained at 1410°C in order to observe the evolution of the mechanical properties and appearance of the refractory materials placed inside, over time. Three cycles of one week each were carried out and a non-destructive characterisation of the specimens by resonance frequency allowed the evaluation of the attack during the different cycles. This test was carried out 3 times in total for 3 different sodium contents relating to the stressing of these materials in the presence of more or less hydrogen as fuel.

Resonance frequency analysis was used to demonstrate the evolution of the chemical attack as a function of different sodium contents in the box atmosphere.

The use of pulse-excited resonance frequency measurement allowed the effects of sodium attack on siliceous phases in particular to be accurately determined. An example of the gas mixture used in this test was:

71% N_2 + 22% H_2O + 160ppm NaOH + 7% CO_2



Evolution of mechanical properties measured by resonance frequency

If you are interested in this type of testing... please contact us to discuss feasibility according to the test conditions envisaged...

Bibliography :

This selection of publications is the result of the Technological Watch carried out by the Documentation Department of the SFC (French Ceramics Society). For more information on these scientific, technical or competitive monitoring products: monthly monitoring bulletin, specific targeted monitoring, access to the "CeramBase" monitoring database, contact the SFC at the following address : soc.fr.ceram@ceramique.fr





-Corrosion-resistant refractory linings for hazardous waste treatment in rotary kilns

NIU C., STIMPFL C., ZHAO D.

China's Refractories, vol.30, 2/2021, pp. 12-15, 7 fig., 1 tab., bibliography (8 ref.), ANG.

In this study, the corrosion resistance of alumina-chromium and alumina-silica refractory bricks is tested by exposing them to slag from hazardous waste incineration. The samples are examined macroscopically and mineralogically. They show that the chromiumalumina bricks have high corrosion resistance when in contact with the slag, while the silicon carbide-containing silica-alumina bricks show good overall performance.

Key-words: REFRACTORY. ROTARY KILN. WASTE. ALUMINA. SILICA. CHROMIA. SLAG.

-Improved explosion resistance of low cement refractory castables

PENG H., MYHRE B.

Refractories Worldforum, vol. 13, n°03, 08/2021, pp. 59-64, 11 fig., 3 tab., bibliography (10 ref.), ANG.

The explosion resistance of low-cement refractory concrete containing different types of drying agents was investigated with laboratory and industrial scale samples. According to the study, these agents have a great impact on the workability of fresh concrete and on the explosion resistance during drying.

Key-words: REFRACTORY CASTABLES. DRYING STEP. EXPLOSION. DRYING AGENTS



ICAR-CM2T – Ingénierie Matièr<mark>e - 4 Rue Lavoisier - 54300 MONCEL LES LUNEVILLE</mark> Tél. : +33 (0)3 83 76 39 39 - Fax : +33 (0)3 83 76 39 40

www.icar-cm2t.com



e-Newsletter N°46 – December 2021

info@icar-cm2t.com

SPECIALIZED DAYS "Materials in extreme conditions" LUNEVILLE - 24 and 25 May 2022 N YOUR DIARIES

Whether it is a question of high temperatures, cyclical high mechanical stresses, an aggressive chemical environment, wear and tear or all of these at the same time, these conditions can very quickly lead to the ruin of the materials concerned, repeated production stoppages, too frequent replacements, safety, energy and environmental problems...

The solutions can be diverse: optimisation of solid materials (ceramic materials, refractories, metallic materials), combinations of judiciously chosen complementary phases, surface treatments and/or functionalisation, on both metallic and ceramic substrates, or even other types of materials in a more global manner, etc.

The main objective is to bring together, during two days of exchanges, manufacturers, users and installers of materials and researchers from laboratories working in the field of high temperatures and related applications.

Qualiop processus certifié

Under the

aegis of

RÉPUBLIQUE FRANÇAISE

N° Activity Declaration : 41.54.00693.54 N° Qualiopi Referencing: RNQ / 2111-013

The quality certification was issued for the following category of action: TRAINING ACTIONS



ICAR-CM2T is pleased to inform you of the recent QUALIOPI certification obtained at the end of November 2021 for 3 years. The past audit showed that all the criteria expected of us as a training organisation were met.

Just as was the case with the Datadock certification that we previously held, this Qualiopi certification allows trainees to benefit from the reimbursement of costs by the paritarian organisations.

Forecast of future training courses in our premises (in French only)

o From the 23rd to the 25th March 2022 in Moncel-les-Lunéville o From the 21th to the 23rd september 2022 in Moncelles-Lunéville Refractory materials: Generalities (18h) - STR1 THE PARTY

o From the 22th to 24th june 2022 in Moncel-les-Lunéville Implementation of refractory materials (18h) - STR2

o Octobre 5th 2022 in Moncel-les-Lunéville Thermal calculations (7h) - STR4

o From the 21th to the 23rd novembre 2022 in Moncel-les-Lunéville (STR3.1)

o From the 23rd to 25th novembre 2022 in Moncel-les-Lunéville (STR3.2)

Behavior in use – STR3.1 / Used refractory treatment – **STR3.2**

o From the 29th nov to 2nd dec. 2022 in Moncel-les-Lunéville Materials for high temperature use (partnership with CTIF)

A training on Cold Spray technology is being prepared... We will keep you informed of the date in 2022...

And always the possibility of carrying out intra-company training courses throughout the year on all metallic and refractory materials... If you would like more information...CONTACT US...

Qualiopi E E RÉPUBLIQUE FRANÇAISE

The ICAR-CM2T team wishes you a Merry Christmas 2021 and a Happy New Year 2022... Take care.

3/3

ICAR-CM2T – Ingénierie Matière - 4 Rue Lavoisier - 54300 MONCEL LES LUNEVILLE Tél. : +33 (0)3 83 76 39 39 - Fax : +33 (0)3 83 76 39 40