TUESDAY, AUGUST 24, 2004, P.M.

SESSION 25: FOURTH INTERNATIONAL SYMPOSIUM ON ADVANCES IN REFRACTORIES FOR THE METALLURGICAL INDUSTRIES

CASTABLES
Sponsors: Materials Science and Engineering, The Metallurgical Society of CIM, The Refractory Ceramics Division of the American Ceramic Society and The Canadian Ceramic Society.
Room: Webster A
Chairmen: M. BECKER, Alcoa World Chemicals, Leetsdale, Pennsylvania, U.S.A., and
T. GOODWIN, Resco Products, Welland, Ontario, Canada

PAPER 25.1 — 14:00
METALLIC FIBER REINFORCED REFRACTORY CONCRETES.
T. CUTARD, F. NAZARET and E. CAILLEUX, École des Mines d'Albi, Albi, France

This paper deals with the study of the mechanical behavior in the 20°C-900°C temperature range of refractory concretes reinforced with metallic fibers. Fibers are introduced to improve the damage resistance and to minimize the quasi-brittle behavior of refractory concretes. In some cases, a plastic or ductile like behavior can be obtained.

Two approaches are considered in these studies. The first one is based on the micromechanical scale. Main objectives are to understand, quantify and predict the thermomechanical behavior of monofiber microcomposites. Such considerations are helpful to optimize the composite formulation for a better behavior. The second one is based on the macromechanical scale. Main objectives are to characterize and to model the macroscopic thermomechanical behavior of randomly reinforced refractory concretes. A particular attention is firstly paid to the relationships between the microstructural changes and the mechanical properties and secondly to the structural size effects.

PAPER 25.2 — 14:25
FIBER-CONTAINING REFRACTORY CASTABLES AND THEIR DRYING BEHAVIOR.
R. SALOMÃO and V.C. PANDOLFELLI, Federal University of São Carlos, São Carlos, Brazil

Polymeric fibers have been widely used in concretes and in refractory castables since their development in the early 70s. In addition to benefiting the mechanical strength of green castables, the use of fibers has been reported as an alternative method to minimize the risks of spalling and structural damage during drying and first heat-up. However, it is not entirely clear how fibers affect the drying behavior of refractory castables, rendering it difficult to make a reliable choice of the most suitable fiber for each castable formulation and drying process. This lack of further research also hinders the development of new types of more efficient fibers. The objective of this work was to elucidate the mechanism whereby polymeric fibers affect the drying behavior of refractory castables, using permeability evaluation techniques and fibers' thermal characterization.

PAPER 25.3 — 14:50
ROLE OF GRAPHITE PELLETS ON THERMO-MECHANICAL PROPERTIES OF BASIC CASTABLES.
H. HE, S. PALCO, G. PASCHEK, E. PARANSKY and M. RIGAUD, École Polytechnique, Montréal, Québec, Canada

Some of the negative impacts of carbon addition on the strength of castables are yet to be overcome in order to fulfill its potential benefits for oxidation resistance. This paper reports the results of recent studies conducted at CIREP on the effects of different types of carbon additives on the thermo-mechanical properties of magnesia-based castables. Experimental techniques included measurements of the hot modulus of rupture (HMOR), hot modulus of elasticity (HMOE), as well as the wedge-splitting test (WST). The comparison of evolving microstructures was carried out employing scanning electron microscopy with microanalysis attachment (SEM/EDS) and X-ray diffraction (XRD). HMOR values of 12 MPa at 1300°C have been reached in MgO-SiO_2-C castables containing up to 7% carbon.

COFFEE BREAK — 15:15 – 15:45

PAPER 25.4 — 15:45

FLOW AND PROPERTIES OF AL2O3-SIC-C CASTABLES FOR BF TROUGH.

Z. CHEN, B. MYRHRE, B. SANDBERG, Elkem Materials ASA, Norway,
X. HE, Z. WANG and N. ZHOU, Luoyang Institute of Refractories Research, Henan, China

Effects of microsilica and reactive alumina type on flowability, flow decay and working time of Al_2O_3-SiC-C castables for blast furnace trough were investigated. The results show that at a targeted self flow values of (80 ± 10)%, water demand markedly decreases with increased microsilica addition. The nature of reactive alumina has a strong influence on flowability of the castables. Higher microsilica content contributes to a longer working time. The flow decays gradually until the working time and then drops abruptly. In addition, microsilica have positive effect on both cold strength and hot strength.

PAPER 25.5 — 16:10

MICROSTRUCTURAL CHANGES AND HIGH TEMPERATURE MECHANICAL BEHAVIOR OF TWO REFRACTORY CASTABLES.

H. MARZAGUI, T. CUTARD, École des Mines d'Albi, Albi, France,
E. YEUGO, M. HUGER and C. GAULT, École Nationale Supérieure de Céramiques Industrielles, Limoges, France

This paper deals with studies made in the field of the French research network PROMETHEREF. Two refractory castables are considered in this program, a bauxite based one and an andalousite based one. A particular attention is paid to microstructural changes during the first heating and on their effects on the high temperature mechanical behavior. Microstructural evolutions have been detected and characterized by the way of dilatometry, scanning electron microcopy and X-ray diffraction. In-situ observations by environmental scanning electron microscopy gave complementary results on these microstructural changes. They deal with microcrack formation, phase changes, crystallization, liquid phase formation and sintering. By propagation of ultrasonic waves, high temperature continuous measurements of the Young's modulus have been made. Results confirm the existence of microstructural changes and allow to quantify the Young's modulus variations all along specific thermal cycles. High temperature tensile tests and four point bending tests were made in the same temperature range. Behavior evolutions could be found and interpreted with the help of previously mentioned results.

PAPER 25.6 — 16:35

SPINEL BONDED BASIC CASTABLES.

G. OPREA, G. YE, S. ZHOU, S. MURUGESAN, A. MONSHI, T. TROCZYNSKI, University of British Columbia, Vancouver, British Columbia, Canada,
M. BROTHERS, Teck Cominco Metals Ltd., Trail, British Columbia, Canada,
D. HARRIS, Clayburn Industries Ltd., Abbotsford, British Columbia, Canada, and
J. RIGBY, RHI Canada, Burlington, Ontario, Canada

The spinel-added and in-situ spinel bonded castables have been developed and widely used in steel industry. It is challenging to develop magnesia-based castables for the non-ferrous industry because the temperatures in industrial furnaces are significantly lower than those in the steel industry and therefore the binding systems of these castables must have the capability to develop a ceramic matrix below 1300°C. It is also challenging to develop a good binding system without addition of fume silica, because the hydration of magnesia may take place during installation, curing and firing of the castables. This work presents the experimental results on developing magnesia-based cement-free, silica fume-free refractory castables using hydratable alumina as the hydraulic binder and a spinel phase as the final ceramic binder. In order to activate the sintering and have a ceramic matrix well developed at the relatively low required temperatures, ultrafine aluminas, chromia, magnesium-aluminate spinel and aluminum titanate powders were used as components of the binding system.